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Stability of the Money Demand Function Revisited: Evidence from Sierra Leone

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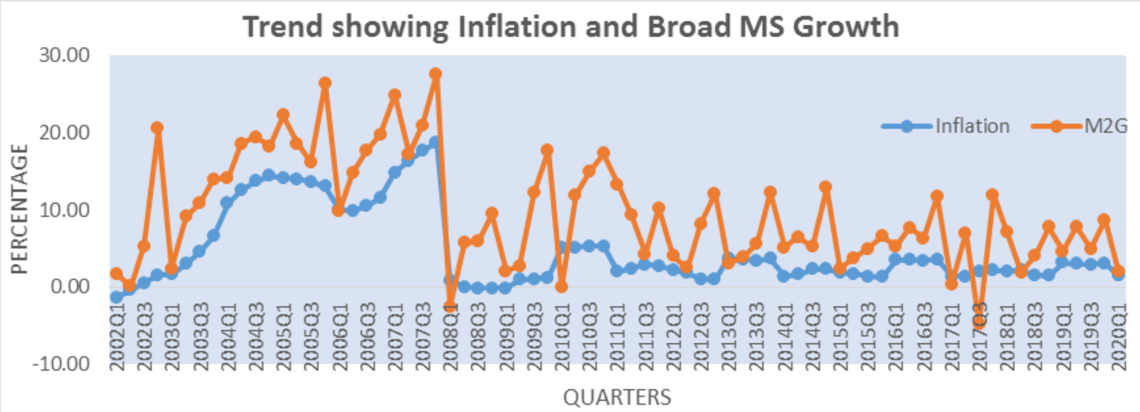
Abstract: The study empirically examined the stability of the money demand function that justifies the adoption of the monetary aggregate targeting framework by the Bank of Sierra Leone using quarterly data spanning from 2002 to 2018. To account for structural breaks emanating from policy shocks and regime shifts in the data such as the civil unrest from 1991-2002, the Ebola Virus Disease (EVD) outbreak from 2014-2016, the mudslide in 2017 and other global shocks, the study conducted unit root tests with structural breaks and regime shift. The long-run estimates of the ARDL model confirm the stability of the money demand functions. In particular, the results show high income elasticity of money demand when narrow money was used as the dependent variable, implying a cash based economy that requires serious consideration in the conduct of monetary policy. Given that the economy is still rudimentary with high propensity of underground economic activities, it is palpable that monetary policy will continue to be challenged especially when the central bank continues to struggle in mopping up excess liquidity in the banking system as a result of the enormous shadow activities in the country. Hence, any policy that is geared towards targeting the narrower definition rather than broader definition of money could help mitigate the challenges associated with withdrawing excess liquidity from the banking system and thus enhances the conduct of an effective monetary policy.

Keywords: Money Demand, Monetary Policy, Narrow Money, Broad Money, ARDL, CUSUM, CUSUMSQ

1. Introduction

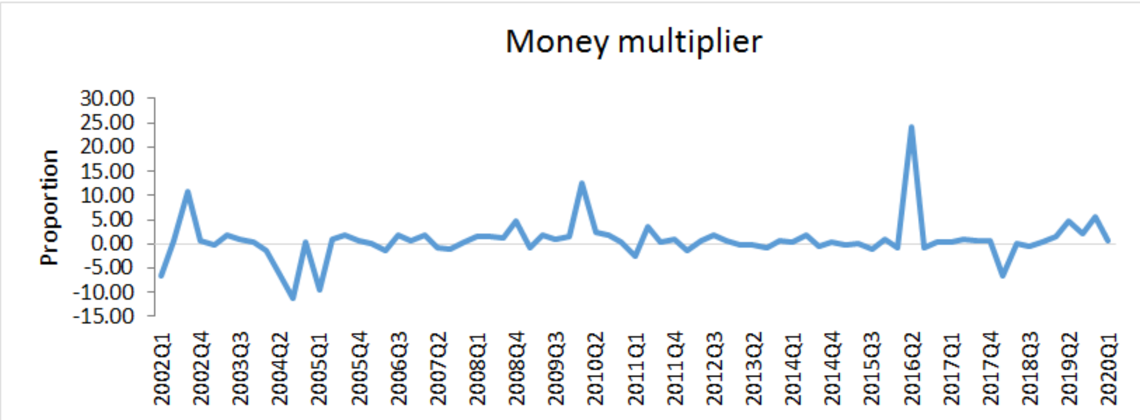
The stability of the money demand function is crucial in the conduct of monetary policy and serves as one of the prerequisites for the adoption of the monetary aggregate targeting (MAT) framework. This framework thrives on a stable and predictable relationship between broad money growth and inflation. It also requires relative stability in the money multiplier [1]. However, despite showing some amount of relative stability using plots of cumulative sum of recursive residuals (CUSUM) and cumulative sum of squares of recursive residuals (CUSUMSQ), there seems to be no predictable nexus between broad money growth and inflation in Sierra Leone. Also, some amount of relative instability has been overserved in the money multiplier [16]. Figures 1 and 2 present trends in broad money growth and inflation and the money multiplier, respectively. According to Figure 1, broad money growth does not seem to track inflation, implying the absence of a strong and predictable relationship between the two variables. This makes the implementation of a successful monetary targeting framework difficult.

On the same token, Figure 2 shows the presence of high instability in the money multiplier as the trend shows continuous volatility. Based on the figures, it might be suggested that the application of the MAT framework by the Bank of Sierra Leone is questionable.



Source: Research Department, Bank of Sierra Leone

Figure 1. *Trends in broad Money growth and inflation.*



Source: Research Department, Bank of Sierra Leone

Figure 2. *Money Multiplier.*

Presumably, during the 1970s, interest rate rule that incorporates a nominal anchor based on an explicit inflation target was the key instrument of monetary policy and became the vogue in the formulation of theoretical models of monetary policy. However, in spite of the use of interest rate as a nominal anchor, inflation was still a fundamental macroeconomic challenge in most developing countries during the 1970s and 80s [23]. This alarming trend drew the attentions of policymakers that the use of interest rate as an operating target for monetary policy was partly to be blamed for the accelerating inflation rate during this period. This led to the adoption of the quantity of money as an intermediate target as well as an indicator of monetary policy conditions. Because the argument was that controlling the quantity of money supply would implicitly mean controlling inflation. But the use of monetary aggregate as a nominal anchor proved futile as it was not able to accurately predict inflation conditions in these economies [6]. Consequently, most countries aborted the use of monetary aggregates as intermediate target towards the end of the 1980s and focused their attentions to a broader measure that gave them the leeway to include additional indicators based on prevailing conditions in the economy.

Sierra Leone is a cash based economy whereby large volume of transaction is in cash. Therefore, it is important to estimate the demand for money using currency. Notwithstanding, the central bank still uses the monetary aggregate targeting framework with the quantity of money supply as its intermediate target and the monetary policy rate as its policy instrument. The use of monetary control does not help the central bank to precisely predict a stable relationship between the quantity of money supply and inflation or output. Also, the MPR has not been able to explicitly address the problems of liquidity in the country. The monetary policy of the BSL has also not had the desired effect on the real economy as well as addressing the challenges in the financial sector. The stability of the money demand function is also unverified, thus questioning the credibility of the monetary aggregate as an appropriate intermediate target of the BSL. However, few studies have examined the stability of the money demand function in Sierra Leone and found it to be relatively stable [16]. It is widely believed that developing countries that adopted the monetary aggregate targeting framework to control money supply would probably experience some degrees of certainties with the use of monetary aggregates as an intermediate target. Albeit it might be possible to achieve the intermediate target of the central bank within the domain of the central bank balance sheet, the accuracy of achieving these targets as a way of inducing inflation or output remains uncertain for developing countries [6]. On the basis of the foregoing, the study departs from previous studies in three main respects. First, in the case of Sierra Leone, very limited studies have been undertaken to establish whether the demand for money is stable. These studies used annual data and mostly concentrated on the broad measure of monetary aggregates. Second, the current study estimated both narrow (currency) and broad measures using quarterly data. It also accounts for structural breaks and regime shift in the economy. Hence, this study attempts to test the stability of the money demand function in Sierra Leone.

The study is organized into five sections, beginning with the introductory section. Section two reviews the literature that comprises theoretical and empirical literature. Section three presents theoretical and empirical models as well as the estimation techniques of the study. Section four presents and discusses the empirical results of the study. Finally, section five concludes and proffers recommendations based on the major findings of the study.

2. Literature Review

2.1. Theoretical Literature

The theoretical underpinning of monetary policy analysis finds its root from the doctrine of the Quantity Theory of Money (QTM) posited by Friedman in the early 1970s and the efficiency model of monetary policy. These theories have been tested and applied widely by many scholars of monetary economics and are accordingly adapted in this study. Also, given the impact of the external performance on monetary policy, the study also explores the purchasing power parity theory to describe the role of the external sector in the conduct of monetary policy. The framework starts with the quantity theory of money, which gained its root from the equation of exchange that was credited to Irving Fisher in the early 19th century. This equation says that the transfer of goods, services and securities is equivalent to the amount of money that corresponds to such transfer. Friedman [9] described the QTM as a money demand function with restricted set of variables that is based on the assumption that the money demand function is stable. Friedman [9] made an explicit disaggregation of the QTM in terms of nominal quantity of money and real quantity of money. The nominal quantity of money is based on the units of measurement that is assigned to money for the purchase of a set of quantity of goods and services. Whereas, the real quantity of money is based on the quantum of goods and services that the money can purchase. Fisher [10] describes the QTM as the key determining factor of the price level in the economy. According to Fisher [5], a change in the quantity of money generates an equal change in the price level. He used the equation of exchange to describe this phenomenon as follows:

$$PQ = YV + Y'V' \tag{1}$$

Where P is the price level, Q is total quantity of goods and services in the economy that are exchanged for transactions purposes, Y is total quantity of money, V is total velocity of money in circulation, Y' is total quantity of available credit and V' is the velocity of circulation of the available credit money. This is normally captured by the velocity of money. The QTM assumes that if the velocity of money remains stable, then any change in money supply affects real income. Implying, controlling money supply implicitly means controlling nominal income and by extension controlling inflation. Thus, the real quantity of money is obtained at the price prevailing in the market at the time of the computation. And this price is the ultimate bridge that binds the nominal and real quantity of money.

Hence, it is safe to say that the QTM suggests that what matters most to holders of money is the real quantity instead of the nominal quantity and that they are always happy to be in possession of a particular quantity of money at every point in time. Friedman [9] alluded to the fact that the most popular version of the quantity theory of money is the transactions component of money holding that was promulgated by Fisher [10] in the equation of exchange, which has been augmented by many scholars over time. Presumably, the modified form of the equation of exchange has been presented in the following form.

$$M^d = \tfrac{1}{V} \times PQ \tag{2}$$

Assuming the inverse velocity denotes τ , implies equation (2) now reads as

$$M^d = \tau PQ \tag{3}$$

According to equation (3), the amount of money households demand is a function the nominal income (PQ). However, the equation of exchange has been built on the fundamental assumption that interest rate is negligible in the determination of money. But this assumption has been refuted in the modified Keynes' [13] seminar work, that the interest rate plays a critical role in the determination of real money balances. This assumption permeates into the modified real money balances as denoted by equation (4).

$$m = f(realGDP, i) \tag{4}$$

According to equation (4), real money balances is a function of real income and nominal interest rate. Consequently, equation (4) is modified to capture the effect of a small open economy country case, and is presented below.

$$\tfrac{M^d}{P} = \theta_1 rGDP + \theta_2 \inf - \theta_3 tbr + \theta_4 nexr + \theta_5 USfr \tag{5}$$

From equation (4), rGDP is real income, inf is CPI inflation, tbr is 91-day treasury bills rate, nexr is nominal exchange rate and USfr is United States' federal rate.

2.2. Empirical Literature

The extant literature put emphasis on the stability of the money demand function as a prerequisite for the monetary aggregate framework of monetary policy. Some studies have used the cumulative sum of recursive residuals and the cumulative sum of square of recursive residuals to establish the stability of the money demand function. Earlier studies on the stability of money demand function in Sub-Saharan Africa include Kallon [11] who investigated the demand for money in Ghana using two-stage least squares technique. Quarterly data spanning from 1966q1 to 1986q4 on real cash balances, real GNP, discount rate, real money balances (M1), foreign interest rate and inflation. The result found no evidence of the effect of foreign interest on real money balances. However, inflation exhibited a negative and significant effect on the demand for money. There was also evidence of stability of the money demand function owning to the fact that the Ghanaian financial sector was rudimentary during the early 1990s with a lot of structural and institutional encumbrances [13].

Bahmani-Oskooee & Wang [2] estimated the stability of the money demand model in China using quarterly data from 1983q1 to 2002q4 on monetary aggregates in real tem, narrow and broad money (M1 and M2), real GDP, domestic and foreign interest rates and the nominal effective exchange rate. The results show significance coefficients with the expected signs of M1 and M2 against their determinants. However, the stability test results show stability in the money demand function when M1 was used as the dependent variable and some amount of instability when M2 was used as the dependent variable. Owoye and Onafowora [20] also confirmed the stability of the money demand function in Nigeria using quarterly data for the period 1986q1 to 2001q4.

Drama and Yao [8] found no evidence of stability of the money demand model in Cote d'Ivoire when they estimated broad money demand model using annual data for the period 1980 to 2007 on real GDP and interest rate, although a long-run equilibrium relationship existed between broad money and its determinants. However, when the estimated narrow money demand for the same period, they found that a stable relationship existed between narrow money and its explanatory variables. They also found that the narrow money demand model was stable. Dagher and Kovanen [7] re-examined the stability of the money demand function in Ghana using the bounds test approach to cointegration. Quarterly data spanning from 1990q1 to 2009q4 was used on broad money (M2+), inflation, real output, domestic deposit interest rate, domestic and US treasury bill rates, nominal effective exchange rate and US $ LIBOR rate. The long-run results show that real output and exchange rate were the main drivers of money demand in Ghana. The short-run results show an income elasticity of money demand that was closed to unity. The CUSUM and CUSUMSQ plots confirm stability of the money demand function in Ghana.

Mansaray and Swaray [16] investigated the stability of the money demand function in Sierra Leone using the ARDL cointegration technique on annual data spanning from 1981 to 2010 on broad money, real GDP, exchange rate, inflation, 91-day treasury bill rate and foreign interest rate. The stability of the money demand model was ascertained using the CUSUM and CUSUMSQ. Kumar et al. [15] also assessed the stability of the money demand function in Nigeria using annual data for the period 1960 to 2008 on real GDP, nominal interest rate, real effective exchange rate, inflation and narrow money (M1). Stability in the money demand function was confirmed by the CUSUM and CUSUMSQ plots. Niyimbanira [19] investigated the stability of the money demand function in South Africa using quarterly data for the 1990q1 to 2007q4 on real money demand, real GDP, 91-day treasury bills rate, inflation and exchange rate. There was no evidence of stability of the money demand function according to the study.

Zgambo and Chileshe [25] tested the stability of the money demand function using the autoregressive distributed lag (ARDL) modeling framework of cointegration. Quarterly data spanning from 1995q2 to 2013q3 were used on real money balances, real GDP, consumer price index, treasury bill rate, and nominal exchange rate. Plots of the cumulative sum of recursive residuals and cumulative sum of square residuals indicate that the latter did not lie within the critical bounds, indicating some level of instability in the money demand function. Kiptui [14] estimated the money demand model for Kenya using quarterly data for the 2000q1 to 2013q4 on monetary aggregates (comprising M1, M2 and M3), inflation rate, real income, nominal deposit rate, 91-day treasury bills rate, nominal exchange rate and measure of volatility (variations in inflation rate, interest rate, exchange rate and stock market). The bounds testing approach to cointegration was applied to each of the models. The long-run results confirm a stability relationship between the respective monetary aggregates and their determinants. The coefficients of income elasticity in the long-run were in conformity with theory. Stability of the models was confirmed using CUSUM and CUMSUMSQ plots for each of the model. However, there was mixed result for the narrow money (M1) as the CUMSUMSQ plot contradicts the CUSUM plot for stability.

Nchor and Adamec [18] also investigated the stability of the money demand function in Ghana using annual data from 1990 to 2014 on narrow money (M1), broad money (M2), real GDP and the 91-day treasury bills rate. Stability was confirmed in both models using the CUSUM and CUSUMSQ stability plots. The Chow test was also performed to test for structural breaks in the model. The results show the existence of long-run and short-run relationships among narrow money, broad money and their determinants. The result also confirm stability in both models and this was confirmed with the structural break test. Boucekkine et al. [4] investigated the stability of the long-run money demand in Algeria using annual data from 1979 to 2019 on real GDP, inflation, treasury bills rate and exchange rate. They estimated three monetary aggregate measures including narrow money (M1), broad money (M2) and fiat money. The ARDL results show that in the long-run, a stable relationship existed between real narrow money and real broad money the scale variable (real GDP), inflation, interest rate and exchange rate with expected signs. Plots of the CUSUM and CUSUMSQ tests show stability in the money demand model for broad money. Only the CUSUM plots for narrow money and fiat currency show stability for the money demand models with a contradiction from the CUSUMSQ plots for both model.

3. Methodology

3.1. The Empirical Model

Following from previous studies on the stability of the money demand function including Bahmani-Oskooee & Shabsigh [1]; Bahmani-Oskooee & Wang [2]; Dagher & Kovanen [7]; Mansaray & Swaray [16]; Zgambo and Chileshe [25]. The literature suggests that the demand for money increases with increase in income and decreases with an increase in real interest rate. This means the demand for money is an increasing function of income but a decreasing function of real interest rate [25]. So income and interest rate enter the money demand function with positive and negative signs, respectively. Based on this theoretical construct, the empirical models of the money demand function with M1 and M2 as the dependent variables, respectively take the form of equations (6) and (7).

$$\log m1_t = \gamma_0 + \gamma_1 \log rgdp_t + \gamma_2 tbr_t + \gamma_3 \log exr_t + \gamma_4 USfr_t + \kappa_t \tag{6}$$

$$\log m2_t = \lambda_0 + \lambda_1 \log rgdp_t + \lambda_2 tbr_t + \lambda_3 \log exr_t + \lambda_4 USfr_t + \eta_t \tag{7}$$

$$\gamma_1, \lambda_1 \succ 0; \gamma_2, \lambda_2 \prec 0; \gamma_3, \lambda_3 \succ 0 or \prec 0; \gamma_4, \lambda_4 \succ 0 or \prec 0$$

Where money demand represents monetary aggregate (M1 and M2), output denotes real gross domestic product (RGDP), TBR denotes 91-day treasury bills rate, EXR denotes nominal effective exchange rate and USfr denotes United States' federal interest rate [12].

3.2. A Priori Expected Signs

In terms of a priori signs, it is expected that output positively affects real money balances based on the transaction demand for money given that households hold money mainly for transactions purposes. The short-term treasury bills rate is used as proxy for interest rate and is expected to pose a negative effect on the demand for money based on the speculative demand for holding money. Nominal effective exchange rate is expected to exert either a positive or negative effect on the demand for money. It will be considered positive if the desired depreciation is considered as an increase in wealth that tends to increase the demand for money. Similarly, it can be considered negative if the depreciation causes agents to engage in hoarding activities [3]. Finally, the foreign interest rate enters the model to capture the effects of the external sector and is expected to exhibit either a positive or negative sign as well. Based on the literature on currency substitution, when foreign interest rate increases relative to its domestic counterpart, domestic asset holders are forced to hoard or hedge against the effect of the depreciation of the domestic currency. Under this circumstance, foreign interest rate is expected to pose a negative sign and vice versa [11].

3.3. ARDL Models of the Money Demand Function

The autoregressive distributed lag (ARDL) approach to cointegration, otherwise known as the Bounds test technique has been popularized as an improved technique to cointegration compared to the traditional Engle-Granger and Johansen cointegration techniques because of the inherent advantages it possesses and has been widely applied [21]. The ARDL is friendly to small sample properties of times series models. It also bears no restrictions on the order of integration of variables as it can be conveniently applied to both I (0) and I (1) variables as long as none of the variables has an order greater than one. In other words, its application does not require pretesting of the variables for unit root compared to the Johansen technique that requires variables to be integrated of the same order. It also resolves the problem of endogeneity with the inclusion of the lagged form of a dependent variable as explanatory variable in the model.

Hence, based on the aforementioned advantages, the ARDL models of equations (6) and (7) are thus formulated as shown in equations (8) and (9), accordingly with narrow money (M1), broad money (M2) and inflation rate serving as dependent variables, respectively.

$$\begin{aligned}\Delta \log m1_t = {} & \gamma_0 + \sum_{t=1}^{p} \gamma_{1i} \Delta \log m1_{t-i} + \sum_{t=0}^{p} \gamma_{2i} \Delta \log rgdp_{t-i} + \sum_{t=0}^{p} \gamma_{3i} \Delta \inf_{t-i} + \sum_{t=0}^{p} \gamma_{4i} \Delta tbr_{t-i} + \sum_{t=0}^{p} \gamma_{5i} \Delta \log exr_{t-i} + \sum_{t=0}^{p} \gamma_{6i} \Delta USfr_{t-i} \\ & + \delta_1 \log m1_{t-1} + \delta_2 \log rgdp_{t-1} + \delta_3 \inf_{t-1} + \delta_4 tbr_{t-1} + \delta_5 \log exr_{t-1} + \delta_6 USfr_{t-1} + \chi ect_{t-1} + \varpi_t\end{aligned} \tag{8}$$

$$\begin{aligned}\Delta \log m2_t = {} & \lambda_0 + \sum_{t=1}^{p} \lambda_{1i} \Delta \log m2_{t-i} + \sum_{t=0}^{p} \lambda_{2i} \Delta \log rgdp_{t-i} + \sum_{t=0}^{p} \lambda_{3i} \Delta \inf_{t-i} + \sum_{t=0}^{p} \lambda_{4i} \Delta tbr_{t-i} + \sum_{t=0}^{p} \lambda_{5i} \Delta \log exr_{t-i} + \sum_{t=0}^{p} \lambda_{6i} \Delta USfr_{t-i} \\ & + \theta_1 \log m2_{t-1} + \theta_2 \log rgdp_{t-1} + \theta_3 \inf_{t-1} + \theta_4 tbr_{t-1} + \theta_5 \log exr_{t-1} + \theta_6 USfr_{t-1} + \rho ect_{t-1} + \varpi_t\end{aligned} \tag{9}$$

Equations (8) and (9) depict the ARDL model that present both short-run and long-run models simultaneously. On the right-hand side of the equations, the first part with the summation sign represent the short-run model while the non-summation sign part denote the long-run part of the model. Δ denotes first-difference operator; γ_{ij} denotes the short-run parameter estimates of the short-run model; δ_{ij} denotes the long-run multipliers of the long-run model and χ denotes the coefficient of the error correction term, otherwise known as the speed of adjustment coefficient in equation (8). Also, λ_{ij} and θ_{ij} denote the short-run and long-run parameter estimates while ρ denotes the speed of adjustment coefficient of equation (9). The Null and Alternative Hypotheses of the long-run models for cointegration in equations (8) and (9) are respectively presented below as:

Null and alternative hypotheses of no long-run relationship in equation (8), implying no cointegrating relationship is given as

$$H_0 : \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = 0 \Rightarrow \text{ the absence of cointegration}$$

$$H_1 : \delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq \delta_5 \neq 0 \Rightarrow \text{ the presence of cointegration}$$

Null and alternative hypotheses of the absence of long-run relationship in equation (9), implying no cointegration is denoted as

$$H_0 : \theta_1 = \theta_2 = \theta_3 = \theta_4 = \theta_5 = 0 \Rightarrow \text{ the absence of cointegration}$$

$$H_1 : \theta_1 \neq \theta_2 \neq \theta_3 \neq \theta_4 \neq \theta_5 \neq 0 \Rightarrow \text{ the presence of cointegration}$$

The presence or absence of cointegration from the above formulations depends on the WALD test statistic which is generated within the system and compared with the F-statistic in Narayan [17].

3.4. Diagnostic and Parameter Stability Test

The stability of the money demand function and the money multiplier is crucial in assessing the efficacy of monetary policy, and is well documented in the extant literature [2]. Some studies have used the cumulative sum of squares recursive residuals (CUSUMSQ) or a combination of both cumulative sum of recursive residuals (CUSUM) and cumulative sum of squares residuals [2, 5]. Hence, to establish the stability of the estimated money demand function, the current study relies on the CUSUM and CUSUMSQ plots and the Ramsey Reset diagnostic test.

3.5. Unit Root Test

The time series properties of the data set are established using the unit root test results with the application of ADF and PP test kit. Equations (10) and (11) present the ADF and PP tests.

$$\Delta g_t = \psi g_{t-1} + h_t^{'}\lambda + \delta_1 \Delta g_{t-1} + \delta_2 \Delta g_{t-2} + \delta_p \Delta g_{t-p} + v_t \quad (10)$$

Equation (10) is the standard ADF test. However, Phillips and Perron [22] suggested an alternative technique of handling autocorrelation when testing for unit root in time series data by estimating equation (11), giving rise to the standard PP test.

$$\Delta g_t = \psi g_{t-1} + h_t^{'}\lambda + \theta(t - \tfrac{T}{2}) + \sum_{i=1}^{p} \theta_i \Delta g_{t-i} + \mu_t \quad (11)$$

3.6. Unit Root Test with Structural Break

In situations where we suspect structural break in the data, Perron [22] argued that the tradition unit root tests (DF, ADF, PP, KPSS, etc.) tend to bias the estimates, especially when the data are trend stationary with structural break. Hence, he suggested four ways that warrant the estimation of unit root with a single break under this circumstance. They include the following: in situation where the break occurs either slowly or instantaneously; the break comprises level shift, trend or both; the break date is either known or unknown and the data are either trending or not trending. Based on these categories, the study follows Vogelsang and Perron [24] and Zivot and Andrews [26] to highlight the specification underlying the testing technique of unit root with structural break. The study considers the scenario with intercept break only as:

Scenario: An intercept break variable denoted by $du_t(t_b) = 1(t \geq t_b)$ that takes the value zero for all dates before the break date and one otherwise. Equation (12) describe unit root test with intercept break only.

Category: No trending data with intercept break

$$g_t = \mu + \theta du_t(t_b) + \varpi d_t(t_b) + \phi g_{t-1} + \sum_{i=1}^{p} f_i \Delta g_{t-1} + \varepsilon_t \quad (12)$$

3.7. Data Description and Sources

This study uses quarterly data on monetary aggregate (M1 and M2), real GDP, CPI inflation, 91-day treasury bill rate, nominal effective exchange rate, and US federal funds rate covering the period 2002 to 2018 to estimate the money demand models.

Table 1. *Summary of data, measurement and sources.*

Variable	Measurement	Sources
Real Gross Domestic Product (RGDP)	Gross Domestic Product at constant prices using 2005 as base year	Statistics Sierra Leone (Stats SL)
Nominal Exchange Rate (ER)	Quarterly average of the price of one US dollar against the Leone	Bank of Sierra Leone (BSL)
Monetary aggregates (M1 and M2)	Net claims on government by the commercial bank and the central bank as well as currency in the hands of the public and in commercial banks' vaults	Bank of Sierra Leone (BSL)
Inflation (INF)	Growth rate of the consumer price index	Bank of Sierra Leone (BSL)
Treasury Bill Rate (TBR)	91-Day Treasury Bill Rate	Bank of Sierra Leone (BSL)

4. Results and Discussion

4.1. Descriptive Statistics

It is generally believed that before using any data set for econometric analysis, it is but fitting that you conduct summary statistics on each of the variables; and the current study is no exception. Table 2 shows summary statistics on each of the variables.

Table 2. *Descriptive Statistics of the Variables: 2002q2-2018q4.*

Statistic	LM1	LM2	LRGDP	TBR	LEXR	USFR
Mean	13.683	14.372	8.862	14.092	4.920	1.379
Median	13.663	14.431	8.840	14.715	4.877	0.885
Maximum	15.006	15.805	9.295	27.310	5.405	5.260
Minimum	12.111	12.592	8.329	1.080	4.473	0.070
Std. Dev.	0.881	0.994	0.276	7.731	0.239	1.618
Skewness	-0.081	-0.199	-0.084	-0.012	0.435	1.290
Kurtosis	1.725	1.718	1.757	1.932	2.396	3.476
Jarque-Bera	4.680	5.104	4.455	3.235	3.175	19.505
Probability	0.096	0.078	0.108	0.198	0.204	0.000
Sum	930.441	977.270	602.592	958.275	334.590	93.780
Sum Sq. Dev.	51.983	66.145	5.101	4004.387	3.830	175.499
Observations	68	68	68	68	68	68

Source: Author's Computation.

The Table shows the mean, median, maximum, minimum, and standard deviation of each of the variable with sixty-eight observations. The key ingredients of the summary statistics are the Skewness, Kurtosis and Jarque-Bera results. A Skewness value of zero means the variable is normally distributed. The Table shows that all the variables are normally distributed because each fall within the zero value except the US federal rate that shows a value of unity. Also, the Kurtosis value of at least three means that the variable is normally distributed. But the Table shows that none of this value except US federal rate that shows a value of at least three. Finally, the Table shows that the probability values of the Jarque-Bera test indicate that almost all the variables are normally distributed except the US federal rate.

4.2. Unit Root Analysis

Having presented descriptive statistics of the variables, unit root tests were also conducted using the Augmented Dickey-Fuller and Phillips-Perron test techniques, with intercept only and the results are depicted in Table 3.

Table 3. *Results of Unit Root Test with Intercept Only.*

Variable	Augmented Dickey-Fuller Test		Phillips-Perron Test	
	Test-statistic	P-value	Test-statistic	P-value
Variables in their Level Forms				
Narrow Money (M1)	-1.0783	0.7193	-1.8509	0.3532
Broad Money (M2)	-1.7290	0.4122	-2.7863	0.0656*
Real GDP	-1.2150	0.6633	-1.5610	0.4968
91-Day TBR	-1.4953	0.5300	-1.7694	0.3924
Nominal EEXR	-1.1033	0.7098	-1.0851	0.7171
US Federal Rate	-3.2088	0.0240**	-1.7031	0.4251
Variables in their First Difference Forms				
Narrow Money (M1)	-3.8155	0.0045***	-11.2111	0.0000***
Broad Money (M2)	-9.8367	0.0000***	-10.0835	0.0000***
Real GDP	-4.0949	0.0019***	-4.1383	0.0017***
91-Day TBR	-6.6547	0.0000***	-6.6547	0.0000***
Nominal EEXR	-4.4060	0.0007***	-4.2624	0.0011***
US Federal Rate	NA	NA	-4.6123	0.0004***

Source: Author's Computation; where (***) & (**) denote significance at the 1% and 5% levels, respectively.

From Table 3, with intercept only, both the ADF and PP results show that all the variables are stationary after first differences.

4.3. Unit Root Analysis with Structural Break

Most time series data are overwhelmed with structural breaks emanating mostly from policy shocks and regime shifts. These tend to bias the unit root test results and thus, the need to account for these shocks by identifying the structural breaks in the data. Table 4 presents results of the unit root test with structural breaks and with innovative outliers. The break dates are used to create dummies that represent each of the structural shift in the economy during the study period.

Table 4. *Perron Unit Root with Break Test on the Variables.*

Variable	Augmented Dickey-Fuller Test-Statistic	Break Date	Break Dummy (P-value)	Intercept Dummy (P-value)
Trend Specification: Intercept only				
Narrow Money (M1)	-2.3133	2009q2	0.0611*	0.0508**
Broad Money (M2)	-4.2226	2009q2	0.0880	0.0038***
Real GDP	-2.3941	2011q1	0.2918	0.0443**
91-Day TBR	-3.4324	2012q3	0.2410	0.0019***
Nominal EXR	-3.3688	2015q2	0.2923	0.0003***
US Federal Rate	-5.5412	2009q3	0.0003***	0.0004***

Source: Author's Computation; where (***), (**) & (*) denote significance at the 1%, 5% and 10% levels, respectively.

4.4. Autoregressive Distributed Lag Estimates of the Money Demand Models

The existence of cointegrating relationship in the money demand models is ascertained by the results of the bounds test [21]. Table 5 depicts the bounds test results when narrow money (M1) and broad money (M2) are used as dependent variables. The Table indicates that with a sample size of sixty-five and four regressors, the estimated F-statistic for each of the model is greater than all the upper critical bound values at the 1 per cent significance level, implying the presence of cointegration relationship among the variables.

Table 5. *Bounds Test Results for Cointegration.*

Null Hypotheses: No long-run relationship exists among the variables in the models				
	Critical Bound Values: k = 4 and n = 65			
	Model 1 (M1)		Model 1 (M2)	
	I (0)	I (1)	I (0)	I (1)
10%	2.335	3.232	2.200	3.090
5%	2.750	3.755	2.560	3.490
1%	3.725	4.940	3.29	4.370
F- Statistics	9.090		13.190	

Source: Author's Computation.

Table 5 necessitates the estimation of both long-run and short-run dynamic models as presented in Tables 6 and 7, respectively. According to the long-run results in Table 6, when M1 is the dependent variable, real output carries the expected sign and significant at the 1 per cent level. The coefficient indicates that an increase in real income by 1 per cent increases the demand for narrow money by 2.86 per cent. The high income elasticity (2.86 per cent) portrays the transactions demand for money as well as the rudimentary nature of the financial sector in Sierra Leone. Sierra Leone is a cash based economy with high transaction cost of financial intermediation. This result is in conformity with studies by Kallon [11]; Nchor and Adamec [18] in Ghana.

Similarly, the nominal effective exchange rate coefficient is positive and significant at the 5 per cent level. The coefficient indicates that an increase in nominal effective exchange by 1 per cent increases the demand for narrow money by 0.34 per cent. This positive coefficient mirrors the effect of wealth as an investment window. Implies, a depreciation of the local currency or an appreciation of the foreign currency means more local currency is used to attract less foreign currency. However, if this increase in the local currency translates into disposal income or wealth, the demand for local currency by households increases and consequently increases the nominal effective exchange rate, so the coefficient becomes positive. This result corroborates with findings from Bahmani-Oskooee & Wang [2] in China and Mansaray & Swaray [26] in Sierra Leone.

Table 6. *Long-Run Coefficient Estimates of the Money Demand Function.*

Variable	Coefficient	Standard Error	t-Statistic	P-value
Dependent variable: Narrow Money (M1)				
LRGDP	2.8642	0.2534	11.3047	0.0000***
TBR	0.0059	0.0061	0.9770	0.3332
USFR	-0.0203	0.0231	-0.8799	0.3830
LEXR	0.3575	0.1742	2.0519	0.0453**
C	-12.9858	2.1909	-5.9271	0.0000
Dependent variable: Broad Money (M2)				
LRGDP	1.2386	0.8473	1.4619	0.1497
TBR	0.0142	0.0163	0.8683	0.3892
USFR	-0.0597	0.0655	-0.9114	0.3662
LEXR	0.4122	0.4233	0.9739	0.3345
C	2.5613	8.1321	0.3150	0.7540

Source: Author's Computation.

Similarly, according to the short-run results in Table 7, both the scale variable and nominal effective exchange rate are significant at the 1 per cent level. This means that a one percentage increase in real output decreases the demand for narrow money by 0.61 per cent while an increase in the nominal effective exchange rate by 1 per cent increases the demand for narrow money by 0.31 per cent in the short-run. Also, the Ebola Virus Disease (EVD) dummy coefficient is negative and significant as expected. The negative coefficient explains the debilitating effect the EVD posed on our economy between 2014 and 2015, as the economy crashed from a positive growth rate of 15.2 per cent to a negative of 20.01 per cent during this period. Most importantly, the coefficient of the lagged error correction term is negative and significant at the 1 per cent level. The coefficient suggests that in the short-run, about 13 per cent of any disequilibrium caused by previous quarters' shocks convergences to long-run equilibrium in the current quarter.

Table 7. *Short-Run Coefficient Estimates of the Money Demand Function (M1).*

Variable	Coefficient	Standard Error	t-Statistic	P-value
D (LRGDP)	-0.6064	0.2092	-2.8991	0.0055***
D (LEXR)	0.3068	0.0849	3.6152	0.0007***
EBOLA_DUM	-0.0622	0.0221	-2.8221	0.0068***
RGDP_DUM	0.0012	0.0515	0.0228	0.9819
ECT (-1)	-0.1270	0.0164	-7.7385	0.0000***
R-squared	0.3335	Mean Dependent Variable		0.0415
Adjusted R-squared	0.2502	S.D. Dependent Variable		0.0349
S.E. of Regression	0.0302	Akaike Info Criterion		-4.0462
Sum Squared Resid	0.0510	Schwarz Criterion		-3.7763
Log Likelihood	137.4781	Hannan-Quinn Criterion		-3.9399
Durbin-Watson Stat	2.0813			

Source: Author's Computation; where (***) & (**) denote significance at the 1% and 5% significance level, respectively.

Accordingly, Table 8 presents the long-run money demand model when M2 is used as dependent variable. According to the short-run results, nominal effective exchange rate is significant with a positive sign but a negative sign with a lagged coefficient at both the 1 per cent and 5 per cent significance level, respectively. This means that a one percentage change in nominal effective exchange rate in the short-run increases the demand for broad money by 0.44 per cent in the current quarter but reduces the demand for broad money by 0.10 per cent in the previous quarter in short-run. Again, the coefficient of the lagged error correction term is negative and significant at the 1 per cent level. The coefficient suggests that in the short-run, about 46 per cent of any disequilibrium caused by the previous quarters' shocks convergences to long-run equilibrium in the current quarter.

4.5. Diagnostics Analysis

The validity and potency of the estimated money demand model is determined by the diagnostic tests. Table 8 presents results of the diagnostic tests conducted on the models. The results show that the model passes normality (except for M2), autocorrelation, heteroscedasticity and Ramsey's tests for functional misspecification, and the latter test, confirms stability of model.

Table 8. *Short-Run Coefficient Estimates of the Money Demand Function (M2).*

Variable	Coefficient	Standard Error	t-Statistic	P-value
D (LRGDP)	-0.2776	0.1178	-2.3566	0.0222**
D (LEXR)	0.4388	0.0989	4.4372	0.0000***
D (LEXR (-2))	0.2346	0.0950	2.4707	0.0167**
EBOLA_DUM	0.0139	0.0126	1.0999	0.2763
ECT (-1)	-0.0458	0.0049	-9.3061	0.0000***
R-squared	0.3553	Mean Dependent Variable		0.0484
Adjusted R-squared	0.2886	S.D. Dependent Variable		0.0352
S.E. of Regression	0.0296	Akaike Info Criterion		-4.0974
Sum Squared Resid	0.0510	Schwarz Criterion		-3.8632
Log Likelihood	140.1651	Hannan-Quinn Criterion		-4.0050
Durbin-Watson Stat	1.9548			

Source: Author's Computation; where (***) & (**) denote significance at the 1% and 5% significance level, respectively.

Table 9. *Diagnostic Test Results.*

Diagnostic Test Type		Dependent: M1		Dependent: M2	
		Test-stat.	P-value	Test-stat.	P-value
Normality	Jarque-Bera	0.2340	0.8896	9.1671	0.0102
Serial Correlation	Breusch-Godfrey	0.7213	0.4912	1.0240	0.3664
Heteroscedasticity	Breusch-Pagan-Godfrey	1.2618	0.2697	0.6403	0.7861
Stability	Ramsey Reset	1.5683	0.2187	1.9122	0.0614

Source: Author's Computation.

4.6. Parameter Stability Test

The stability of the money demand function and the money multiplier is crucial in assessing the efficacy of monetary policy, and is well documented in the extant literature [2, 3]. Some studies have used the cumulative sum of squares residuals (CUSUM) or the cumulative sum of squares recursive residuals (CUSUMSQ) or a combination of both [2, 16, 25]. Hence, to establish the stability of the estimated money demand function, the current study relies on the CUSUM, CUSUMSQ [5] and the Ramsey Reset diagnostic test. Figures 3 and 4 present plots of the parameter stability test results when M1 is the dependent variable.

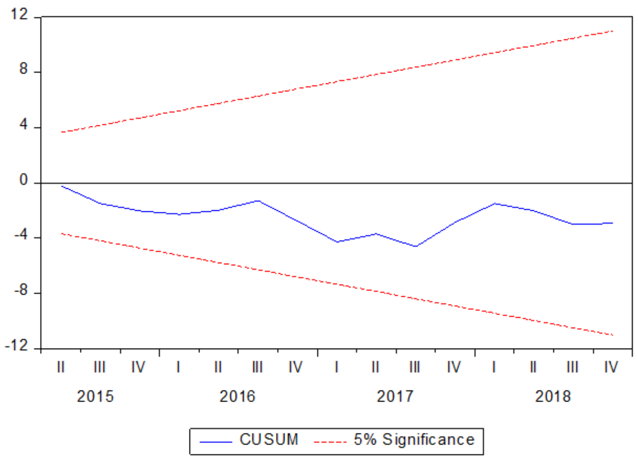


Figure 3. *Plot of Cumulative Sum of Recursive Residuals (CUSUM) for the Money Demand Function (M1).*

The plot of the CUSUM and CUSUMSQ indicate that the statistics lie within the critical bounds, indicating stability of the model. One crucial advantage of the cumulative sum of recursive residuals (CUSUM) and the cumulative sum of squares recursive residuals based tests is that, both do not necessarily require the specification of the break points before estimating them. They do, rather make use of the recursive residuals that are based on the first N observations. However, the major difference between the CUSUM and CUSUMSQ based test is that, the former only accounts for instability that occurs in the intercept only instead of the entire estimated coefficients, whereas, the latter accounts for instability in the intercept of the entire estimated coefficient during the review period [25]. Hence, it is concluded that the money demand function with respect to the narrow definition in the case of Sierra Leone is generally stable based on the CUSUM and CUSUMSQ plots presented in Figures 3 and 4.

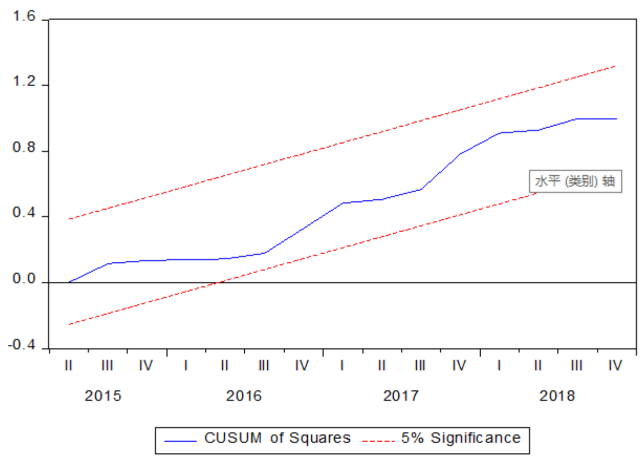


Figure 4. *Plot of Cumulative Sum of Squares Recursive Residuals (CUSUMSQ) for the Money Demand Function (M1).*

Again, the stability of the money demand has been established using the CUSUM and CUSUM plots. Figures 5 and 6 present graphs of the parameter stability test results. The plots of the CUSUM and CUSUMSQ indicate that the statistics lies within the critical bounds, indicating stability of the model.

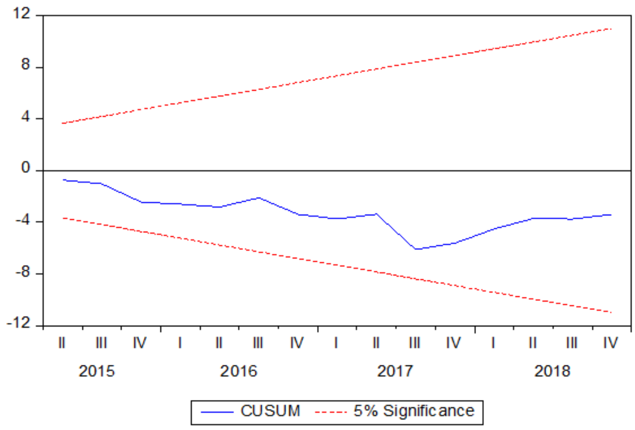


Figure 5. *Plot of Cumulative Sum of Recursive Residuals (CUSUM) for the Money Demand Function (M2).*

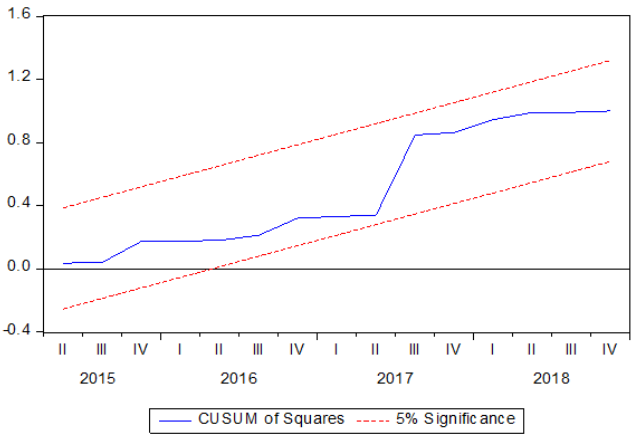


Figure 6. *Plot of Cumulative Sum of Squares Recursive Residuals (CUSUMSQ) for the Money Demand Function (M2).*

5. Conclusion and Policy Implications

The study is empirical examined the stability of the money demand function in Sierra Leone using quarterly data for the 2002 to 2018. Two separate models comprising the narrow and broad money definition as intermediate targets were estimated using the ARDL technique of cointegration. Unit root test with structural break was conducted using Perron [22] approach in addition to the traditional ADF and PP tests to account for structural breaks and regime shifts in the data set. The ARDL estimates established long-run relations among the variables and the stability of the money demand function using the CUSUM and CUSUMSQ plots. In particular, the study revealed high income elasticity of money demand in line with economic theory for high cash based economies. In other words, the high income elasticity of the money demand model sends a signal that the country is highly cash based and with the existence of a robust shadow economy, it is apparent that the central bank faces a daunting task in mopping up excess liquidity in the banking sector in a bid to control inflation in the country. This result corroborates with the findings from Kallon [11]. Similarly, the nominal effective exchange rate was also found to be positive and statistically significant. The short-run coefficient estimates were both negative and significance as expected, confirming cointegrating relationship among the variables. The coefficients indicate that any shock emanating from the previous quarters can be corrected by 13 per cent for M1 and 46 per cent for M2, respectively.

Based on the outcomes of the study, the following recommendations are brought to the attention of the authorities. First, the estimated money demand model indicates a high income elasticity of money demand with a coefficient in excess of 2.5 per cent. This demonstrates that the country is highly cash based. So any efforts by the central bank to effectively mop up excess liquidity in the banking system in a bid to control inflation will be futile given that the underground economy is well developed with a lot of shadow economic activities. This means that the central bank should move from targeting broad money to a much narrower target of money or currency in circulation. Importantly, the monetary aggregate targeting framework, that is based on the stability of the money demand function could be undermine with financial innovation and deregulation.

In terms of future direction of study, it is argued in the literature that the stability of the money demand function becomes questionable with the advent of financial innovation and deregulation. In this vein, given that the country is currently applying efforts to develop the financial sector through the rolling out of the payment system platform, mobile and internet banking system, it is palpable that in the future, the monetary aggregate targeting framework should not be appropriate for the conduct of monetary policy. Hence, the Bank of Sierra Leone authorities should start thinking about an alternative monetary policy framework such as inflation targeting or a hybrid of both monetary aggregate targeting and inflation targeting (inflation targeting lite) framework.

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