FINANCIAL INNOVATION AND MONEY DEMAND IN SIERRA LEONE: AN AUTOREGRESSIVE DISTRIBUTIVE LAG APPROACH

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DECLARATION

DECLARATION

I hereby declare that this research paper was entirely written by me and has never been submitted to be awarded a degree or any form of certificate at any institution or examination body.

Signed: ______________ Date: 02/12/2019

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This research paper has been submitted to the School of Economics for examination with my approval as a university supervisor.

Signed: ______________ Date: 02/12/2019

Dr. Owen Nyang'oro

DEDICATION

To my mother and father, I cannot express enough of your contribution. I dedicate this paper to the both of you.

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A special reflection of the many blessings thrown my way during this study, I gave God the glory. The galore of motivation that guided and shaped me throughout difficult and challenging times were ceaseless, and I appreciate everyone who contributed.

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LIST OF ACRONYMS AND ABBREVIATIONS

ACH -	Automated Clearing House
ACP -	Automated Cheque Processing
ADF -	Augmented Dickey-Fuller
ARDL -	Autoregressive Distributed Lag
ATM -	Automated Teller Machine
BSL -	Bank of Sierra Leone
CPI -	Consumer Price Index
ECM -	Error Correction Model
ECT-	Error Correction Term
GDP -	Gross Domestic Product
GSL -	Government of Sierra Leone
Le -	Leones
LPT -	Liquidity Preference Theory
MNO -	Mobile Network Operator
MPC	Monetary Policy Committee
QTM -	Quantity Theory of Money
RTGS -	Real Time Gross Settlement
SMS -	Short Message Service
SSS -	Scriptless Securities Settlement
USD -	United States Dollar
VAR -	Vector Autoregressive
VEC -	Vector Error Correction

ABSTRACT

Economists have long recognized that stability in the money demand function is a precondition for effective monetary policy formation and implementation. In recent decades, many countries have experienced different forms of financial innovations that have one way or the other affected the stability of money demand. Sierra Leone is not exempted, considering the rapid growth of financial innovations in the country over the past years. This study adopts the Autoregressive Distributive Lag method to examine a money demand function for Sierra Leone that includes financial innovation and test its stability for the period 1966 to 2016. The long-run empirical findings indicate that real income, financial innovation and foreign interest rate directly impacts real broad money, whereas the impact of the civil war is negative. Moreover, inflation, financial innovation and foreign interest rate are inversely related to real broad money in the short-run. The short-run findings also confirm the existence of wealth effects. Lastly, the test for parameters stability test points to a stable estimated model, suggesting monetary policy has been effective.

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

The effective formulation and implementation of monetary policy depend heavily on the stability of money demand, specifically in nations where monetary aggregates are targeted (Goldfeld and Sichel, 1990; Sichei and Kamau, 2012). A stable money demand function certifies central banks are more effective in controlling issues like inflation by simply adjusting the money supply (Sriram, 1999; Hamori, 2008). As far as the mid-1970s, empirical studies relied solely on conventional variables like the interest rate and income to analyze this phenomenon (Goldfeld and Sichel, 1990). Following the rapid growth of financial innovations around the world, determinants of money demand are no longer restricted to just these factors (Kasekende and Nikolaidou, 2018). It has been recognized that when financial innovation is not taken into consideration when investigating money demand, findings might suggest instability in the estimated function; hence, rendering monetary policy ineffective (Dunne and Kasekende, 2018). As a result, researchers have included different indicators of financial innovation to conventional money demand functions.

Following several financial modifications coupled with the liberalization of both the exchange and interest rates during the 1980s and 1990s, the financial sector in Sierra Leone has undergone rapid changes mainly attributed to growth in financial innovation. These innovations are outcomes of healthy competition in the financial sector and the growing desire for reducing risk and transaction costs (BSL, 2019). For instance, an addition of ten new banks from the sub-region in the mid-2000s saw the introduction of new financial products such as debit cards, short message service (SMS), automatic teller machines (ATMs), and internet banking which permits online banking transaction and enquiries (Mansaray and Swaray, 2012). These financial products have allowed the usage of electronic payment and at times, act as close substitutes to physical cash. Furthermore, collaboration among banks and mobile telecommunications companies have led to the creation of a mobile Network operator (MNO) services. Table (1.1) shows the performance of ATMs and point of sales (POSs).

Table 1.1: Performance of ATMs and POSs

Year	No. of ATMs	No. of POSs	No. of ATM Transactions	No. of POS Transactions	Value of ATM Transactions	Value of POS Transactions
2013	50	20	437,761	2,456	54.78	7.37
2014	59	72	303,840	5,143	63.01	13.1
2015	69	130	730,803	11,509.00	154.38	25.86
2016	71	150	370,726	23,981	69.53	34.35
2017	43	32	530,342	6,773	102.11	5.69

Source: Bank of Sierra Leone (2017)
Note: Values of transactions are recorded in trillions of Leones

From 2013 to 2016, there was an upward movement in the number of ATM and POS owing to the Bank of Sierra Leone (BSL) agenda for financial inclusion. However, these figures decreased significantly in 2017. In 2015, the total volume of transaction via ATM and POS stood at 730,803.00 and 11,509.00 as compared to 437,761.00 and 2,456.00 recorded in 2013. The value of ATM transactions from 2013 to 2015 increased by 181.84 percent (Le54.78Tn to Le154.38Tn) followed by 54.96 percent fall in 2016 as a result of long term impact from the previous year Ebola Virus Disease outbreak. Further, the transacted value of POS between 2013 to 2016 rose from Le7.37Tn to Le34.35Tn, thereby indicating a 366.06 percent increment. These numbers demonstrate the public acceptance of electronic means of payment.

Other innovations comprise of a modern core banking application (CBA), which boosts the processing of transactions as well as offer the BSL adequate controls of its daily operations (BSL, 2019). The introduction of real time gross settlement system (RTGS) aimed at handling large-value transactions in real time and the clearing of interbank transactions[1] and the launch of the automated clearing house (ACH) system which facilitates the processing of electronic transactions comprising of cheques and direct credits and debits with low value but high volume[2] (World Bank, 2018; BSL, 2019). The incorporation of

[1] Payments that are above Le50,000,000.00 (5483.88 United States Dollars) are considered large value payment.
[2] Low value transactions are the ones valued at Le50,000,000.00 and less.

the automated cheque processing (ACP) compliments the ACH system[3] whereas the scriptless securities settlement (SSS) allows the processing of Government securities such as treasury bills and bonds[4] (World Bank, 2018). Although a national retail payment switch that enables the interoperation of diverse systems like ATM, POS, and mobile money is lacking, a limited number of banks are connected through bilateral arrangements (BSL, 2018). These systems have contributed to the bank financial inclusion agenda and have aided in the improvement of non-cash transactions.

1.1.1 Monetary Policy in Sierra Leone

Like most Central Banks, the BSL has the constitutional mandate of maintaining stable prices-low and stable rate of inflation as well as assisting the central Government's in achieving its economic and development targets (BSL, 2016). To achieve its objectives, the bank has adopted a monetary targeting framework. A monetary policy committee (MPC), which also include the governor of the BSL as a heading member is an authorized committee responsible for formulating, and executing monetary policies in Sierra Leone (Mansaray and Swaray, 2012). By the close of each MPC meeting, a policy statement containing the monetary policy rate (MPR) and other vital information is published on the bank's website followed by a press conference where the bank governor justifies the committee decision (BSL, 2016).

Before 1990, monetary policy was conducted via a system of direct controls, which puts ceilings on interest rates together with boundaries on other activities in the financial market (Mansaray, 2012). For instance, commercial banks were required to retain an explicit credit ceiling to ensure that the bank's supply of money was in line with its targeted levels. Also, the rate of interest on government securities was determined by the central bank, and commercial banks kept 40 percent of their total deposit liabilities as reserve assets at the BSL (Mansaray and Swaray, 2012; Lavally and Nyambe, 2019). Following the Structural Adjustment Program (SAP), the financial system was deregulated as the direct monetary

[3] The ACP system has led to a reduction in the clearing cycle from (T+ 9) to (T + 1).
[4]Following the introduction of the SSS in 2013, open market operation efficiently improved (BSL, 2019).

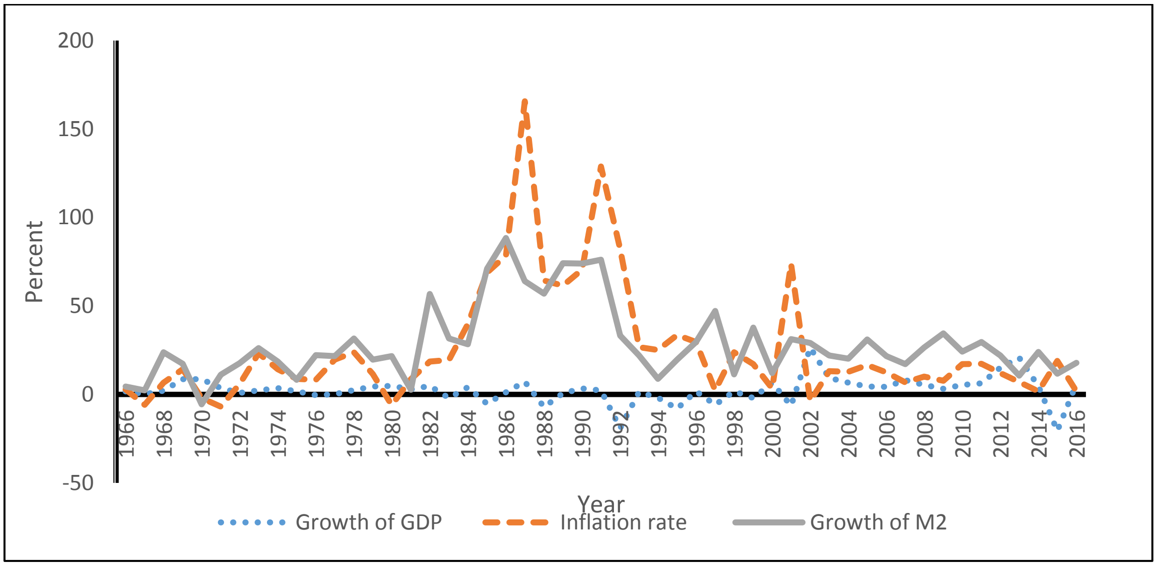
management system was replaced by an indirect monetary management framework (Mansaray, 2012).

In the system of indirect monetary management, the BSL has three distinct monetary policy targets, namely; operating, intermediate, and final targets. These monetary policy targets are set based on the quantity theory of money equation as the BSL perceives inflation as a monetary phenomenon (Mansaray, 2012). A schematic of the monetary policy framework is shown below:

Policy Instrument → **Operational Target** → **Intermediate Target** → **Ultimate Target**
(**OMO**) (**Reserve Money**) (**Money Supply**) (**Inflation**)

Open market operation (OMO) is used to meet its operational target, which is reserve money. Although OMO alters the reserve money or monetary base, it has a more substantial influence on the money supply (broad money) via the money multiplier effect. Through its intermediate target, the bank achieves its ultimate target. Figure 1.1 shows the performance of key macroeconomic indicators.

Figure 1.1: Trend of Real GDP, Broad Money, and Inflation rate (1980-2018)



Source: IMF and World Bank (2019)

As shown in figure 1.1, there were fluctuations in the annual growth of broad money, GDP, and inflation rate (annual percentage change) based on GDP deflator for the period under study (1966-2016).

The annual growth rate of broad money reached its highest peak of 88.4 percent in 1986, followed by an inflation rate of 165.7 percent in 1987 and a decline in the growth of GDP by 7.08 percent. In the 1990s, the economy of Sierra Leone performed poorly as shown in figure 1.1. The poor performance can be ascribed to the eruption of the civil war in 1990. However, the implementation of several macroeconomic and structural reforms by the Government following the completion of the civil crisis in 2001 significantly improved the macroeconomic environment (Mansaray, 2012). GDP grew by 26.4 percent while inflation stood at -3.9 percent in 2002. Nevertheless, GDP declined by 20.6 percent while the inflation rate was recorded at 18.9 percent in 2015 as a result of the twin shocks of Ebola and fall in the prices of primary exports.

The BSL has employed five exchange rate regimes since 1964, as illustrated in Table 1.2. Before adopting a flexible exchange rate system in the 90s, several regimes were used. The bank currently adopts a managed float regime which permits the market forces to decide the exchange rate. But, the BSL consistently interferes in the financial market to smoothen exchange rate movement.

Table 1.2: Exchange Rate System in Sierra Leone

Period	Exchange Rate Regime
1964-1982	Fixed Exchange Rate Regime
1982-1983	Dual Exchange Regime
1983-1986	Dollar Peg Regime
1986-1990	Dirty Float Regime
1990-Present	Managed Float Regime

Source: Bank of Sierra Leone (2019)

1.2 Statement of the Problem

The stability of the money demand function has received vast attention owing to the vital part it plays in the smooth formation and conduct of monetary policies (Goldfeld and Sichel, 1990; Serletis, 2007; Dunne and Kasekende; 2018). However, empirically testing its stability requires accurate specification of the function, which involves including all relevant variables pertinent to the model and adequately accounting for developments in the financial sector. Empirical studies on this matter, over the past decades, have provided mixed findings, mostly in the case of low-income countries. Findings that have shown instability have been somewhat attributed to factors, such as regulatory changes, financial and monetary reform, or the rapid growth of financial innovations. Not incorporating these innovations could lead to an unstable model and ultimately affect the effective conduct of monetary policy.

Sierra Leone has experienced several innovations in its financial sector over the years, and these have been found to have some implications on money demand. For instance, financial innovation improves the overall efficiency of the financial system, enabling smooth monetary policy operations, but it also complicates the environment in which monetary policy functions (Solans, 2003). The introduction of financial products like debits card, electronic banking, among other products increases money velocity, as well the level of substitution between money and other nonmonetary assets. However, despite these developments in the country, empirical evidence of their impacts on money demand are limited; thus, is unclear if or not the demand for money is stable when financial innovation is considered. As such, the study intends to offer empirical answers to questions in the next section.

1.2 Research Questions

The study tries to answer the following questions:

i. Is the money demand function for Sierra Leone stable?
ii. Is there cointegration between broad monetary aggregate and its determinants?

1.3 Objectives of the Study

The general objective of this paper is to empirically evaluate the demand for broad money function in Sierra Leone and specifically to:

i. Establish the stability of broad money demand function in Sierra Leone.
ii. Examine the existence of cointegration among broad money aggregate and its determinants.
iii. Provide policy implications.

1.5 Significance of the Study

The BSL has a monetary target framework with broad money as its intermediate target in play. For this reason, a stable money demand function is of major concern to policymakers as well as researchers primarily in the presence of financial innovation that has been an increasing characteristic of the Sierra Leonean economy. Stability in the money demand will allow economic policymakers to project money demand then decide the applicable rate of growth of money supply required for the BSL to meet its ultimate target of low and stable inflation.

Previous studies have shown a direct relationship between financial innovation measured by time trend and money demand in Sierra Leone. These studies have also found stability in the money demand model. However, an upward time trend may be a reflection of how monetary policy is being managed and not necessarily financial innovation. Given what has been done, this study will adopt a more robust proxy (proportion of broad money to narrow money) to capture financial innovation. As such, findings will inform policymakers in designing proper monetary policy actions as well as aid researchers in conducting forthcoming studies.

1.6 Organization of the Study

The remaining chapters are arranged in the following ways: chapter two provides a review of literature which comprises of the theoretical and empirical literature reviews and an overview of the literature in general. Chapter three explains the method used for empirical analysis. It includes the empirical model, the data and their sources, and descriptions and definitions of variables. The empirical findings and discussions are reported in chapter four, whereas chapter five summarizes the study, provides conclusion and implications that are policy related.

CHAPTER TWO: LITERATURE REVIEW

2.1. Introduction

Chapter two examine theories and studies that are related to the study. Section one is the theoretical literature which describes the various money demand theories. Next, the empirical literature investigates several studies conducted worldwide. The last section summarizes key findings from the review.

2.2. Theoretical Literature

2.2.1. Quantity Theory of Money

The QTM consists of two versions, the "Fisher's version" linked to Irving Fisher and the "Cambridge version" theorized by some Cambridge economists especially Arthur C. Pigou and Alfred Marshall. These versions explain the starring role of money as a means of exchange. Fisher's version is based on the equation of exchange which relates money stock (M_S) to the price level (P_t), the volume of goods transacted (T), and transactions velocity of money (V_t) as shown:

$$M_S V_t = P_t T \tag{2.1}$$

Equation (2.1) is simply an identity. Fisher (1911) assumed V_t is fixed, and it is subjective by technological factors, nature of the monetary arrangement, among others.

Unlike Fisher's version that is macroeconomic related, Cambridge's version is concerned with the choice-making decision of economic agent. It argues that though money serves as a means of exchange to ease transactions, it has a store-of-value role. In other words, an agent holds a part of his nominal income in the form of money balance. Thus, the aggregate money demanded (M^d) is equivalent to the domestic income (Y), fraction of domestic income (k), and price level as specified below:

$$M^d = kPY \quad (2.2)$$

In the short-run, k will fluctuate when there are variations in the expected returns and yields on other assets (Serletis, 2007).

2.2.2. Liquidity Preference Theory of Money Demand

The theory of liquidity preference (LPT) posited by Keynes (1936) highlight reasons (transaction, precaution, and speculative) why people hold money. Like the QTM, the transaction motive underlines medium of exchange function of money whereas the precautionary reason suggests individual hold money for unforeseen event. The speculative motive is Keynes (1936) major additional to money demand theory. It argues that wealth is held in money and bond. People willingness to purchase the bond is influenced by the interest rate. The real money demand function is illustrated by equation (2.3):

$$M^d = L(Y, i) \quad (2.3)$$

Where M^d is real money, Y represents income, and i is the interest rate. One main implication of the LPT is that individuals anticipate future increase is that when the interest rate falls. To avoid loss, they convert their nonmonetary assets in cash. As a result, the aggregate demand turns out to be perfectly elastic with regards to interest rate, thereby causing a situation referred to as a liquidity trap.

2.2.3. Transactions Theories of Money Demand

Some theories stress the medium-of-exchange function of money. These theories are considered transactions theories. For instance, the Baumol-Tobin model postulated individually by Baumol (1952), and Tobin (1956) put emphasis on the cost and benefit of holding cash. The model suggests as interest rate rise, the holding of cash for transactionary reason decline, thereby increasing transactions cost. It indicates a tradeoff exists between the interest rate given up as a result of holding non-monetary assets and liquidity provided by cash with zero yields. Average money holding is mathematically expressed as follows:

$$A = \sqrt{YF/2r} \quad (2.4)$$

Where A is average money holding, F represents costs of transactions, Y denotes real income (Y), and r is interest rate (r). Equation (2.4) shows that variations in F will cause changes in the average holding of money. However, this model failed to provide justifications of why individuals hold cash.

The shopping time model posited by McCallum and Goodfriend (1987) is another transaction model of money demand. Contrary to the Baumol-Tobin Model, it explicitly explains why money is held by individuals. In this model, although assets with higher pecuniary yields exist, the representative agent is assumed to hold non-interest-bearing money as it enables the agent to transact. As such, trading with money produces considerable savings that a termed shopping time. McCallum and Goodfriend (1987) considered these savings crucial as shopping time cuts leisureliness needed for shopping, thereby reducing utility.

2.2.4. The Precautionary Demand for Money Approach

Following Keynes (1936) argument that people hold money to meet subsequent liability – precautionary motive, Whallen (1966) argued it is only achievable if the due date for repayment is unknown with certainty. Thus, the precautionary demand for cash relates to both expected expenditure and receipts that are unpredictable. People hold onto money because they are uncertain about future payments. When people hold more cash, the cost associated with illiquidity is minimum. At the same time, the more cash held by individuals, the higher the forgone interest. For this reason, individuals find the optimal amount of cash that is needed for precautionary purposes by taking into consideration the costs of interest contrary to the advantages of holding cash. In contrast to the inventory models, the assumption that people are aware and sure about receipts and payments is omitted.

2.2.5. Money as an Asset Approach

A number of economic theories considered money an asset by highlighting its store-of-value role. These theories, widely known as portfolio theories, suggest cash delivers a unique combination of risk and return, ones that are not offered by other assets. Tobin (1958) suggests that as part of a portfolio of assets, people hold cash. Therefore, the risk and returns on money, in addition to other non-monetary assets that individuals can hold though money is available as well as total wealth, are major determinants of money demand. Based on this information, a functional form is expressed below:

$$(M/P)^d = \Psi(W, -r_1, -r_2, -e_\pi) \tag{2.5}$$

Where M is nominal money, P is price level, W denotes wealth, r_1 is the anticipated yield on stock, r_2 denotes expected yield on bonds. e_π represents expected inflation. This approach explains the broad money demand better than it does to narrow money (Mankiw, 2007).

2.2.6. Consumer Demand Theory Approach

It analyzes money demand from the theory of consumer demand perspective. Friedman (1958), along with Barnett (1980), are associated with this approach. Friedman (1956) pointed to the money demand function as the most significant stable function of macroeconomics. Instead of focusing on what drives individuals to hold money, this approach looks at money as any other assets held as part of an economic agent collection of assets. Equation (2.6) is a mathematical representation of Friedman's view:

$$(M/P)^d = f(y, -r_m, -r_2, -r_e, e_\pi) \tag{2.6}$$

Where P, M, r_2 , and e_π are previously defined, and y denotes permanent income. r_m and r_e are expected yields on money and equities, respectively.

2.3 Empirical Literature

Many research works have investigated money demand stability in industrialized and emerging nations. It is expected as stability is required for monetary policy formation and implementation. In this section, a number of the related and relevant empirical literature is reviewed to facilitate comparing and contrasting findings as well as identifying existing gaps.

Muscatelli and Papi (1990) estimated the broad money demand for Italy that incorporates financial innovation. Using the Engle-Granger Two-step method, they found that financial tools that are close alternatives to money, especially the growth of Buoni Ordinari del

Tesoro[5] and Certificati di Credit del Tesoro[6], triggered a reduction in the broad money (M2) demand in the 1970s. The findings also show the use of time trend aimed at measuring financial innovation and monetization is unfitting. However, the inclusion of the innovation term which captured the learning process of economic agent led to an improvement of the model. They also investigated the model over different sample periods using three constancy tests to ensure stability. The findings indicate the period after 1977 performed well in terms of constancy.

Adam (1992) specified a number of single-equation to study the demand for different measures of money in Kenya that covers the period 1973 -1990. By Adopting a quarterly data and Johansen approach, the study found an income elasticity that is around unity for M0 and one that is approximately 1 for other monetary aggregates. The findings revealed narrow money (M1) is stable. A recent study by Kasekende and Nikolaidou (2018) adopted the bounds testing technique to re-examine a money demand function for Kenya that included a specific form of financial innovation popularly known as mpesa (mobile money). A quarterly time-series for 14 years, beginning 2010 was used for analysis purpose. Unlike Adam (1992), they included several measures of financial innovation[7]. The results show mpesa directly impact money demand. Furthermore, the findings indicate the model is stable.

Baba et al. (1992) examined the demand for narrow money (M1) in the United States of America, spanning from 1960 to 1980. They found that the partial adjustment approach and regular corrections made for autocorrelation like the Cochrane–Orcutt technique improper. An application of the Error Correction Model (ECM) shows that, apart from interest rates, inflation significantly influences the demand for M1. The results also show

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[5] Bonds are treasury bills have short maturity (3, 6 or 12 months) without coupons. From 1976 onwards, BOTs aided the Bank of Italy in bridging the maturity range gap as well as insuring the implementation of an efficient control policy given the large and growing budget deficit (Muscatelli et al., 1990).

[6] These are medium-long term bonds with a 7-year maturity, and they provide a floating semi-annual coupon income.

[7] The fraction of the transacted value of mobile money to narrow money, a dummy variable, and fraction of the transacted value of mobile money to gross domestic product.

changes in velocity is explained by the expected returns on long term treasury bond adjusted for risk. Further, they argued that if both financial innovation and its speed are not incorporated in the specification, the estimated model will be unstable. The findings also point to a stable model.

Odularua and Okunrinboye (2009) used the Vector Error Correction (VEC) methodology to study the demand for broad money (M2) in Nigeria. The study found cointegration among all variables. Besides, the elasticity of income is positive, whereas interest rate elasticity is negative. The findings also indicate the relationship between financial innovations measured by the nominal rate on treasury bills and money demand was insignificant. Following similar lines of thought, Kumar et al. (2013) estimated narrow money demand in Nigeria. Two forms of the equation, including, the augmented version were specified for the period 1960-2008. Findings through the Engle-Granger technique shows real income, nominal income, and real M1 are cointegrated. Moreover, the elasticity of income is lower than one. Despite the liberalization and reform in the financial sector, the demand for money was stable.

Mutluer and Barlas (2002) studied the demand for money in Turkey using data recorded quarterly from 1987 to 2001, a period branded by deregulations, financial liberalization, and structural reforms. They measured financial innovation by the following ratios: currency in circulation to M2X[8], M1 to M2X and M2 to M2X. By adopting a VAR model, they found exchange and inflation rates have impacted the broad money demand. Also, the various measures of financial innovation were insignificant.

Todani (2007) adopted a Vector Autoregressive (VAR) model to re-evaluate the demand for money in South Africa from 1980 to 2003. The results indicate income and interest rate spread have positively and negatively impacted money demand. Moreover, the elasticity of income attained was higher than what the quantity theory predicts and higher than what other studies have reported. The author suggests several factors, including the omission of

[8] A measure of broad money which comprises of narrow money, time deposits, and other deposits denominated in foreign monies.

wealth variable and failure to include financial innovation. The recursive test shows stability in the estimated long-run model.

Adam (2009) investigated a cointegrating relationship for non-bank private sector M3 demand in the UK. The specified function included variables such as income, inflation, interest rates, wealth, among others. By applying a monthly time series from 1975:M6 to 1986:M6, the results indicate the standard techniques (For instance, Johansen and Juselius) revealed exactly one cointegrating vector. However, it was shown that two significant vectors existed in the VAR. In spite of financial innovation, the model was sable.

Hafer and Kutan (2003) examined the impact of financial innovation on the Philippines' long-run demand model stability for 18-year, starting in 1980. The results attained by the Johansen technique show that cointegration among narrow money, income, interest rates, and among others is achievable when financial innovation is incorporated in the model. Additionally, at 5 percent confidence level, the demand for real balances is positively impacted by financial innovation. However, the inclusion of M3 failed to produce the same results.

Mannah-Blankson and Belnye (2004) adopted the Johansen method and quarterly data from 1992:Q1 to 2000:Q4 to examine how the development of innovative tools has impacted money demand in Ghana. The authors used the following measures to capture financial innovation: the proportion of M2 to M1 and the volume of cash cards transacted. They reported that income, financial innovation and inflation significantly determine M1 and M2 demand in the long-run and short-run, respectively. The findings further indicate that regardless of the growth in financial innovation, real money balances were stable.

Hye (2009) examined to what extent financial innovation have altered money demand in Pakistan employing the Johansen Maximum Likelihood technique. The study used a quarterly times series that covers the period of 1995Q1 to 2007Q12 and measured financial innovation as a ratio of M1 to M2. Empirical results indicate the presence of four cointegrating vectors; inflation, financial innovation, income, and interest rate. Moreover, financial innovation positively influences the demand for real monetary balances.

Domowitz and Elbadawi (1987) employed the ECM and annual data, which covers 1956-1982 to analyze a money demand function for Sudan. In contrast to other studies, the authors did not incorporate financial innovation. They found income measured by GDP is positively influenced money the long-run money demand, whereas domestic inflation and foreign exchange rate significantly impacted the short-run money demand. The study rejected earlier views that the price and income effects are unusually high. In addition, the estimated model was stable.

Bahmani-Oskooee and Gelan (2009) used the bounds testing technique and a quarterly data which covers 1971Q1-2004Q3 to re-investigated broad money stability for 21 nations in Africa. They estimated two forms of the model; a model with the nominal effective exchange rate and another with the real effective exchange rate. The results show the presence of cointegration among broad money, income, exchange rate, and inflation in all nations. When the nominal effective exchange rate replaced the real exchange rate, the results show the estimated coefficient of exchange was insignificant in most of the countries. The test for stability revealed the model is stable

Arrau et al. (1995) investigated money demand in a number of developing countries. Contrasting to other studies which incorporated specific measures for financial innovation, they included trends like a random walk as proxies. The findings suggest financial innovation meaningfully altered narrow money demand and its variations. Furthermore, the findings indicate that when inflation increases, the price paid for not being innovative is higher. Besides, a country inflation history that is independent of the interest rates, as well as inflation, determines the estimated model.

Dunne and Kasekende (2018) studied the rapid growth of financial innovation and how it has impacted the money demand for 34 nations in Sub- Saharan Africa from 1980 to 2013. By employing panel estimations procedures, they found financial innovation captured by the proportion of M2 to M1 inversely impacted the demand for money demand. Put differently, the rapid development in terms of innovation has led to a movement from assets with higher liquidity assets to those with less liquidity; thus, a reduction in money demand.

However, in spite of the innovative development in the financial sectors of these countries, stability was found.

Kallon (2009) re-analyzed the demand for money in Sierra Leone from 1964 to 2005. Unlike other studies, financial innovation was not included in the function. The long-run findings generated through the Johansen approach indicate the elasticities of all variables have their expected signs. A relatively stable money demand model was found. Bathalomew and Kargbo (2009) adopted the same approach as Kasekende and Nikolaidou (2018) and a quarterly data to test the effect of foreign monetary developments on money demand in Sierra Leone for a period of 25-year. The findings show the presence of a cointegrating relationship. Furthermore, the long-run parameter estimate of exchange rate was negative. Like Kallon (2009), the model was stable

Mansaray and Swaray (2012) investigated the rate at which changes in the financial markets have affected money demand behavior in Sierra Leone using similar methods adopted by Bathalomew and Kargbo (2009) and a time series for 30 years, starting 1981. Empirical findings show real income, real exchange, and interest rate, have directly impacted real money demand in the long-run and short-run. Besides, the study captured the impact of financial innovation during the period of financial liberation with a time trend. The coefficient of financial innovation was positive and significant. Financial liberalization measured by a dummy was positive but insignificant. Despite the development in its financial sector, the money demand function is stable.

2.4 Overview of Literature

Financial innovation lessens the costs of transaction and improves efficiency. On the other hand, it also causes volatility in money demand, thereby, weakening monetary policy effectiveness in some cases. For these reasons, researchers have acknowledged the need to re-visit the money demand functions in response to recent dynamics in several financial sectors led by the speedy development of financial innovations.

From the studies reviewed, several time series methods, especially the Johansen and ARDL approach, have been adopted to examine money demand that incorporates financial innovation for industrial and emerging economies. Given the complexities in directly measuring financial innovation, researchers have developed many proxies, including, the proportion of broad money to narrow money, dummy variable, the proportion of the transacted value of mobile money to narrow money, a stochastic trend, and so on. These studies have found mixed results especially with respect to how financial innovation affect money demand. Some studies have shown that financial innovation positively impacts money demand, whereas others have found a negative relationship. In addition, the majority of the studies reported a stable money demand functions, whereas a limited number failed to conduct a test for stability. These mixed results can be, to some extent, be attributed to different countries specific effects.

While it is true that there is a tendency for financial innovation to disturb money demand and its stability, most countries specific studies with respect to Sierra Leone have ignored financial innovation with the exception of few studies which incorporated a time trend to capture its impact. However, this measure is general and does not account for potential sources of financial innovation. By specification a money demand function that includes financial innovation measured by a proportion of M2 to M1 and using a more recent annual time-series data in addition to an ARDL approach, this study will fill the gap. Therefore, in Sierra Leone, where a monetary targeting framework is in use, stability in the money demand function ensures policy geared towards changes in money supply has a predictable effect on vital economic indicators like output, interest rate and prices. Therefore, the findings of this study will guide policymakers in making sounds decisions relevant to monetary policy.

CHAPTER THREE: METHODOLOGY

3.0 Introduction

There have been several methods adopted to analyze money demand and its stability in many low and high-income economies. In this chapter, the paper expounds on the method to be employed in assessing Sierra Leone's money demand function. The data source and variables to be used in the analysis are also presented.

3.1 Theoretical Framework

Serletis (2007) emphasized the work of McCallum and Goodfriend (1987) by considering a small economy with numerous identical, infinite-lived representative individuals. At time t, the representative agent, who could be the household head has preferences that can be expressed as:

$$U(C_t, L_t) = \sum_{t=0}^{\infty} \theta^t U(C_t, L_t) \tag{3.1}$$

Where C represents the individual's consumption, L denotes leisure and the rate at which the $U(C_t, L_t)$ is discounted denoted by θ . The utility function obeys the concavity assumptions: $U_i(C_t, L_t) > 0$ and $U_{ii}(C_t, L_t) < 0$, where $i = 1,2$. Though assets with higher yields exist, the agent holds money as it enables the agent to transact. The length of shopping time is assumed to have a direct relationship with the number of goods and services consumed, but at a particular consumption level, money balances in real term is inversely related to shopping time. As more time is given to shopping, less time is left for leisure. By extension, leisure is assumed to have an inverse relationship with consumption, as well as a direct relationship with real money balances. This relationship is presented in a functional form as follow:

$$L_t = \varphi(C_t, m_t), \qquad \text{where } \varphi_1 < 0 \text{ and } \varphi_2 > 0, \tag{3.2}$$

Where the nominal money divided by the general price level gives the real money balances ($m_t = M_t/P_t$). A production function said to be linearly homogenous in both physical capital and labor is assessable to the household. Labor supplied is assumed perfectly inelastic so that the production function is specified as:

$$y_t = f(k_t) \tag{3.3}$$

Where y_t is production and k_t denotes capital stock at time t. $f(\cdot)$ satisfy the following assumptions: concavity, $y_t{}' = \infty$ if $k_t = 0$, and $y_t{}' = 0$ if $k_t = \infty$. Exclusive of money and capital, the household have access to bonds from the government. The household can purchase a bond for $1/(1 + R_t)$ where R_t denotes expected yield on bonds in nominal terms at time t. The bond purchased can be converted into money or cash at period $t + 1$. The household's optimization problem can be expressed as:

$$C_t + k_{t+1} - k_t + (1 + \pi_t)m_{t+1} - m_t + \frac{b_{t+1}}{1+r_t} - b_t = f(k_t) + v_t \tag{3.4}$$

Where m_t denotes real cash holding, b_t is bond holding, π_t is inflation, with $\pi_t = (P_{t+1} - P_t)/P_t$, and v_t represents the lump-sum transfers (net of taxes) from the government in real term[9].

A Lagrangian function that incorporates the preferences function of equation (3.1) where equation (3.2) is substituted for l_t and the budget constraint of equation (3.4) is maximized over a set of choice variables (See McCallum and Goodfriend (1987); Serletis, 2007). Then, a portfolio-balance relationship between the real balances which relates the household demand to its optimal consumption as well as the nominal interest rate is formed from the optimality condition as shown below:

$$M_t/P_t = \emptyset(C_t, R_t) \tag{3.5}$$

From equation (3.5), it is not known whether C_t and R_t are positively and negatively related to M_t/P_t. To complete the model, it is assumed that $\emptyset(\cdot)$ comprises partial derivatives and

[9] $b_{t+1}/(1 + r_t) - b_t$ represents the difference in real bonds held between period t and t +1. To be more precise, it can be represented by $\frac{\frac{B_{t+1}}{1+R_t} - B_t}{P_t} = \frac{B_{t+1}}{(1+R_t)} - b_t = \frac{1+\pi_t}{1+R_t} b_{t+1} - b_t = \frac{b_{t+1}}{1+r_t} - b_t$

$\emptyset_1 > 0$ whereas $\emptyset_2 < 0$ is given to complete the model (Serletis, 2007). Since equation (3.5) is a demand model for the household, consumption represents the transactions or scale variable. However, the demand for real monetary aggregates in any country is an aggregation of money demanded by household, firms, and government. Therefore, this model can as well be used to explain a firm's demand for money and that of government. Although the variable measuring the opportunity cost would be the same as the one written above, the transactions variable would not be consumption. The rigorous process of aggregating is, however, avoided when consumption c_t is replaced with GDP or GNP denoted by Y_t. Assuming $m_t = M_t/P_t = RM_t$, the aggregate demand for money is presented as follow:

$$RM_t = \emptyset(Y_t, R_t) \quad (3.6)$$

3.2 Empirical Model Specification

Following the theoretical framework of this study, the conventional money demand function improved by the real exchange rate and foreign interest rates, financial innovation and inflation is specified as:

$$RM_t = \emptyset(Y_t, R_t, FINO_t, RER_t, F_t) \quad (3.7)$$

Where RM_t denotes real broad money, Y_t represents real GDP. R_t is the rate of inflation rate, $FINO_t$ symbolizes financial innovation, RER_t and F_t represents real exchange rate and foreign interest rate, respectively. By transforming expression (3.8) into log-linear form to reduce the errors and variances, we form an empirical model is formed as shown by equation (3.9).

$$LRM_t = \beta_0 + \beta_1 LY_t + \beta_2 R_t + \beta_3 LRER_t + \beta_4 FINO_t + \mu_t \quad (3.8)$$

$$t = 1, 2, \dots, T$$

Where all variables initially defined are the same, L represents the natural logarithm, β_0 denotes the constant, β_i $(i = 1, 2, \dots, 4)$ are coefficients, and μ_t represents the error term.

Real Broad Money (**RM**): Comprises of M1 and quasi money in trillions of Leones deflated by Consumer Price Index (CPI). Following Kallon (2009), Mansaray and Swaray (2012), and Dunne and Kasekende (2018), real broad money is the preferred monetary aggregate. For the objectives of this study, it is measured in natural logarithm.

Real GDP (**LY**): The total market value of all commodities produced annually in Sierra Leone. Mannah-Blankson and Belnye (2004), Mansaray and Swaray (2012), Kasekende and Nikolaidou (2018), among others have used real GDP is a proxy for income and captures volume of economic activities. The elasticity of the volume of economic activities and real money balances is expected to be positive. It is also measured in natural logarithm.

Inflation (R): Captured by the implicit GDP deflator, it indicates the rate of price change in Sierra Leone. As theory predicts, the opportunity cost variable negatively affects money demand. The motivation for using inflation rate is because most emerging economies like Sierra Leone are characterized by financial markets that are not well-developed and lack of comprehensive data on interest rates (Sriram, 1999).

Financial Innovation (FINO): FINO is the creation of new technological advances in the financial market that increases money velocity. For this study, the measure of financial innovation is obtained using a ratio of M2 to M1. It is expected to positively or negatively affect money demand.

Real Exchange Rate (LRER): It measures the real value of the Leones against United States Dollars (USD). The RER is obtained when nominal exchange rate is deflated by CPI. The estimate of LRER elasticity is subject to the presence of either wealth or substitution effect. In the case of a wealth effect, it is expected to be positive, whereas a negative elasticity indicates a substitution effect. For this study, RER is measured in natural logarithmic form.

Foreign Interest Rate (F): F is the expected returns on the United States 91-day treasury bill. McKinnon (1983) argued that foreign interest rates would most likely influence money demand because foreign assets become more attractive relative to domestic assets when F increases, causing a decrease in domestic currency demand.

War (W): A dummy which accounts for the impact of the civil crisis from 1991 to 2003.

3.3 Pre-estimation Tests

A required number of pre-estimation tests will be conducted. It ensures the variables are reliable for estimating the money demand model and its stability. These tests are a normality test, unit root test, and test for cointegration.

3.3.1 Normality Test

In a situation where the error terms are not normal, the testing of the hypothesis is not achievable. Furthermore, it leads to inaccurate and unreliable conclusions about the reality. As a result, a normality test is done to tell if or not the series is normally distributed (Wooldridge, 2012). Hence, this study employs the Shapiro-Wilk (SW) test. According to Yap and Sim (2011), the SW displays some unique power properties that are suitable for both asymmetric and symmetric distributions. It also works well when the sample size is less than 50 ($n < 50$).

3.3.2 Unit Root Tests in the Absence of Structural Break

Unlike other approaches, the adoption of the ARDL approach does not necessarily need a pretest for stationarity (Pesaran et al., 2001). However, this study will incorporate a unit root to ensure the variables specified in this study are integrated of orders greater than 1. It is intended to sidestep problems associated with spurious regression and misleading conclusions. The study, therefore, adopts the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) unit root tests.

The ADF test includes the addition of lagged differences on the dependent variable to cater for autocorrelation (Wooldridge, 2012). The number of lagged values to include is empirically determined (Gujarati and Porter, 2009). It ensures that there are sufficient lagged differences so that the residuals are not serially correlated, thus, obtaining unbiased estimates. The ideal ADF test model, including a time trend, is as follows:

$$\Delta y_t = \alpha + \beta y_{t-1} + \Gamma t + \sum_{j=1}^{k} \chi_{t-j} + v_t \tag{3.9}$$

Where α denote the intercept, Γt represents the time trend, χ indicates the lag differences, k denotes the sum of lags that is included to make sure the disturbance term denoted by v_t is white noise. k is determined through the various selection criteria used to obtain the maximum lag length, which includes the Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC). The null hypothesis states the variable is integrated of order one or higher order while the alternate, assumes less than one order of integration. In instances where the unit root is detected, the study differenced appropriately until the series became stationary (Gujarati and Porter, 2009).

Due to the potential problem of heteroscedasticity and serial correlation, the study further used the PP unit root test coined by Phillips and Perron (1988) to ensure the efficient conclusion of the order of integration of the variables. Unlike the ADF, this test does not assume homoscedasticity, but correct for the presence of heteroscedasticity and serial correlation through a non-parametric approach. It is also easier since it does not involve the inclusion of a lag length (Gujarati & Porter, 2009). The representation is shown in equation 3.10

$$y_t = \alpha + \theta y_{t-1} + u_t \qquad (3.10)$$

Where α denote the intercept and/or time trend, θ symbolizes parameter estimate of the lag term, whereas u_t symbolizes white noise.

3.3.3 Unit Root Tests in the Presence of Structural Breaks

In time series analysis, structural break arises when there is an unanticipated shift in one or more variables. Pahlavani (2005) asserted that the occurrence of structural breaks in many time series is attributed to several factors such as economic crises, policy changes, institutional arrangements, and shifts in the regime. When structural changes exist in the series but are not accounted for in the specification of the model, the result may be inexact. For this reason, most time-series studies include a test for a structural break. However, the tests for unit root does not account for possible structural breaks (Ling et al., 2013). The study adopts the Bai and Perron (2003) unit root tests for structural breaks. The test is best known for identifying multiple structural changes as well as being applicable for pure structural break models and partial ones (Bai and Perron, 2003). The null hypothesis suggests the existence of a γ breakpoint whereas the alternative indicates the presence of γ + 1 breakpoint; where γ = 0,…,n. In equation form, the Bai and Perron (BP) test is given as:

$$y_t = x_t'\beta + z_t{}'\Upsilon_j + \nu_t \qquad (3.11)$$

Where the dependent variable (y_t) is a linear combination of the regressors (β and Υ_j) with both time-invariant coefficients (x_t), time-variant coefficients (z_t) and the error term (ν_t).

3.4 Cointegration Test and Estimation Method

The ARDL approach, otherwise known as the bounds testing approach, was utilized to check if the variables are cointegrated. This approach has many merits when compared with other methods (Pesaran and Pesaran, 1997). First, it is superior when the sample size of the study is small. Second, a long-run relationship can be tested even if the series is nonstationary. Third, it includes appropriate lags which solve both the problem of serial correlation and multicollinearity. Fourth, it addresses the issue of endogeneity. The ARDL approach in equation (3.8) is expressed below:

$$\Delta LRM_{t_t} = \beta_0 + \sum_{i=1}^{n}\beta_{1i}\Delta LRM_{t_{t-i}} + \sum_{i=1}^{n}\beta_{2i}\Delta LY_{t-i} + \sum_{i=1}^{n}\beta_{3i}\,\Delta R_{t-i} + \sum_{i=1}^{n}\beta_{4i}\,\Delta RER_{t-i} + \sum_{i=1}^{n}\beta_{5i}\,\Delta FINO_{t-i} + \sum_{i=1}^{n}\beta_{6i}\,\Delta F_{t-i} + \gamma_1 LRM_{t_{t-1}} + \gamma_2 LY_{t-1} + \gamma_3 R_{t-1} + \gamma_4 RER_{t-1} + \gamma_5 FINO_{t-1} + \gamma_6 F_{t-1} + \alpha_1 W + \mu_t \qquad (3.12)$$

From equation (3.11), Δ represents the first difference operator; β_{ij} and γ_{ij} are the short-run and long-run parameter estimates. An application of the ARDL approach to cointegration procedure consists of two steps, as indicated in Pesaran and Pesaran (1997). First, the study checks for the presence of cointegrated variables in the model ($H_0 =$ absence of cointegration), using the F-test for joint significance of the lagged variables. Pesaran and Pesaran (1997) suggested two sets of critical values, the upper and the lower critical bound which relies on the assumption that the series is I(1) and/or I(0). However, these values are obtained via large sample sizes of quite a lot of observations. So, it cannot be used to dictate cointegration in this study with less than 60 observations. Kripfganz and Schneider (2018) proposed critical values for any sample size will be used for analysis purpose. For simplicity, the study presents below a table of the various conclusions based on the bound test:

Table 3.1: Decision Table

F-Statistics	Conclusion
Exceed the upper critical bound value	Cointegration
Below the lower critical bound value	No Cointegration
Between lower and upper critical bound values	Inconclusive

Source: Pesaran and Pesaran (1997), Narayan (2005), and Kripfganz and Schneider (2018)

Once cointegration is recognized, the second step is to identify the optimal lag length using a suitable selection criterion. Then, the selected long-run ARDL model was assessed using the Ordinary Least Square estimator while the lagged variables in equation (3.12) is replaced by ECT_{t-1} and the error correction model specified as equation (3.13) is estimated.

$$\Delta \mathrm{LRM}_{t_t} = \beta_0 + \sum_{i=1}^{n} \beta_{1i} \Delta \mathrm{LRM}_{t_{t-i}} + \sum_{i=1}^{n} \beta_{2i} \Delta \mathrm{LY}_{t-i} + \sum_{i=1}^{n} \beta_{3i} \Delta \mathrm{R}_{t-i} + \sum_{i=1}^{n} \beta_{4i} \Delta \mathrm{RER}_{t-i} + \sum_{i=1}^{n} \beta_{5i} \Delta \mathrm{FINO}_{t-i} + \sum_{i=1}^{n} \beta_{6i} \Delta \mathrm{F}_{t-i} + \alpha_1 \mathrm{W} + \Phi \mathrm{ECT}_{t-1} + \mu_t \quad (3.13)$$

Where Φ denote the speed at which the coefficients adjust and ECT_{t-1} denotes the error correction term which shows the rate at which the regressand returns to its equilibrium state after a change in other regressors. A negative and significant Φ suggests there is cointegration.

The stability of the model is tested by two graphical tests, CUSUM and CUSUMQ put forward by Brown et al. (1975). These tests have null hypotheses that are not rejected when the plots of the tests are within the specified boundary. It implies the model has stable parameters. If it lies outside the boundary, the parameters are said to be unstable. Therefore, the model cannot be used for forecasting purposes.

3.5 Post-estimation Test

A model in which the results of post estimation tests are inconsistent suggests that the results from the estimation are unreliable. For this reason, this study underwent a series of post estimation test to ensure model validity. These tests comprise of Breusch Godfrey

Lagrange Multiplier test for residual autocorrelation, the Breusch-Pagan for heteroscedasticity as well as Shapiro-Wilk test for residuals normality.

3.6 Data Source

The study utilizes an annual time series data collected available in the World Development Indicators and International Financial Statistics databases. The series include M1, M2, CPI, GDP, inflation, rate of exchange, and foreign interest rate. It covers 1966-2018 due to the availability of important variables. Inflation, foreign and exchange rates are measured in percentage, whereas broad money and GDP are recorded in Leones.

CHAPTER FOUR: EMPIRICAL FINDINGS AND DISCUSSIONS

4.0 Introduction

Chapter four reports the results in graphical and tabular forms. These results are explained in seven sections. The first section describes the data, while section two discusses pre-estimation tests. In the third section, the selection of optimal lag for the model is described. Section four presents the results of the bounds test, which explains an estimation of the ECM in section five. The findings on diagnostic tests are presented in the last sections.

4.1 Descriptive Statistics

Section one provides a description of the series. This consist of the mean, standard deviation, minimum, minimum, kurtosis, and skewness. The summary statistics of the series are reported in Table 4.1

Table 4.1: Summary Statistics

Variable	Obs.	Mean	Max	Min	Std. Dev.	Skewness	Kurtosis
LM	51	27.716	29.042	26.744	0.598	0.374	2.578
LY	51	29.512	30.524	28.7	0.464	0.297	2.537
R	51	25.72	165.677	-6.929	33.884	2.216	8.329
FINO	51	1.614	2.313	1.18	0.293	0.942	3.044
LRER	51	8.758	9.827	8.142	0.538	0.862	2.261
F	51	4.873	14.03	0.03	3.235	0.361	3.075

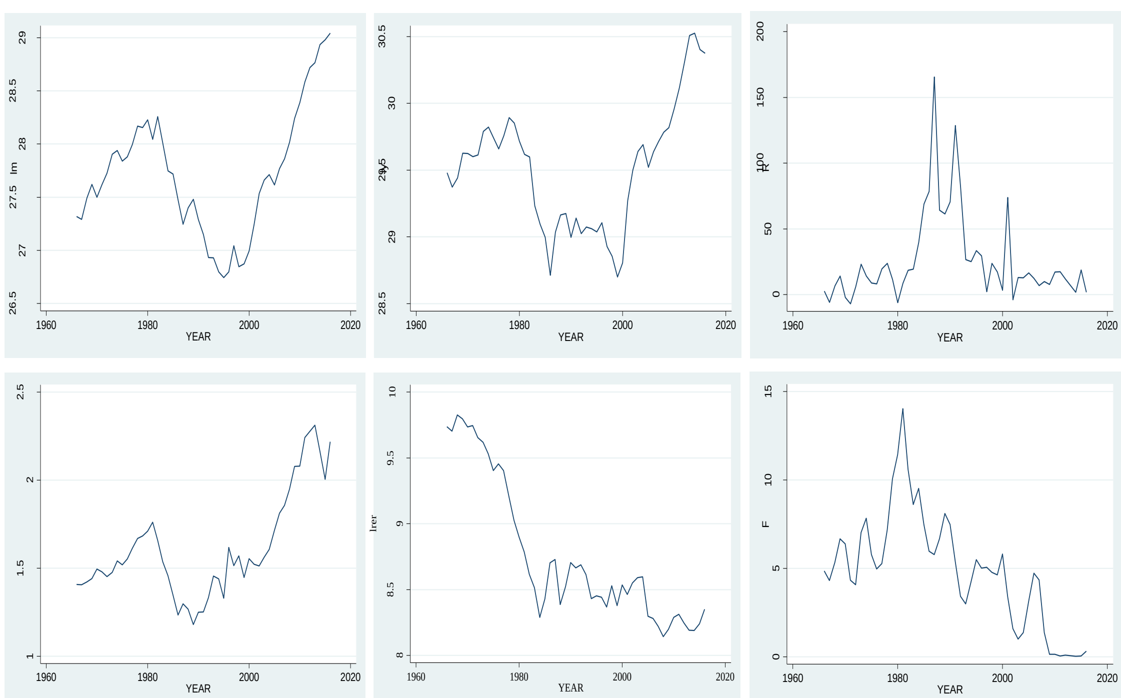
From table 4.1, the average value of LM is 27.716 and a standard deviation of 0.598. A standard deviation of 0.58 shows that the yearly values of the series are distributed close to the mean, thus making the mean a good representation of the series. Further, the lowest and highest values of LM are 26.744 and 29.042. LY has a mean of 29.512 and a standard deviation of 0.464 for 51 years, while its minimum value is 28.700 and its maximum value is 30.524. FINO, the variable of interest, has an average value of 1.614 and a standard deviation of 0.293. Besides, both minimum and maximum values are recorded at 1.18 and 2.313. In addition, the mean and standard deviation of foreign interest rate (F) are 4.84 and 3.235 while its minimum and maximum values are 0.030 and 14.030.

Table 4.1 also point out that the variables are positively skewed or have right-skewed distributions. Although a normally distributed series has a skewness of 0 as well as a kurtosis of 3, some series have values that are approximately 0 and 3. LM, LY, and LRER have kurtoses that are less than 3 while R, FINO, and F are leptokurtic, suggesting that the tails of their curves are flatter than the normal distribution as their kurtoses are greater than 3.

4.1.1 Graphical Analysis of the Data

In time series analysis, graphs are one of the most potent tools in data assessment as it shows the trends of the variables. These trends provide a hint of whether or not the variables have unit root and or structural breaks. The two-way plots of all variables are shown in figure 4.1.

Figure 4.1: Two-way Line Plots of the Variables



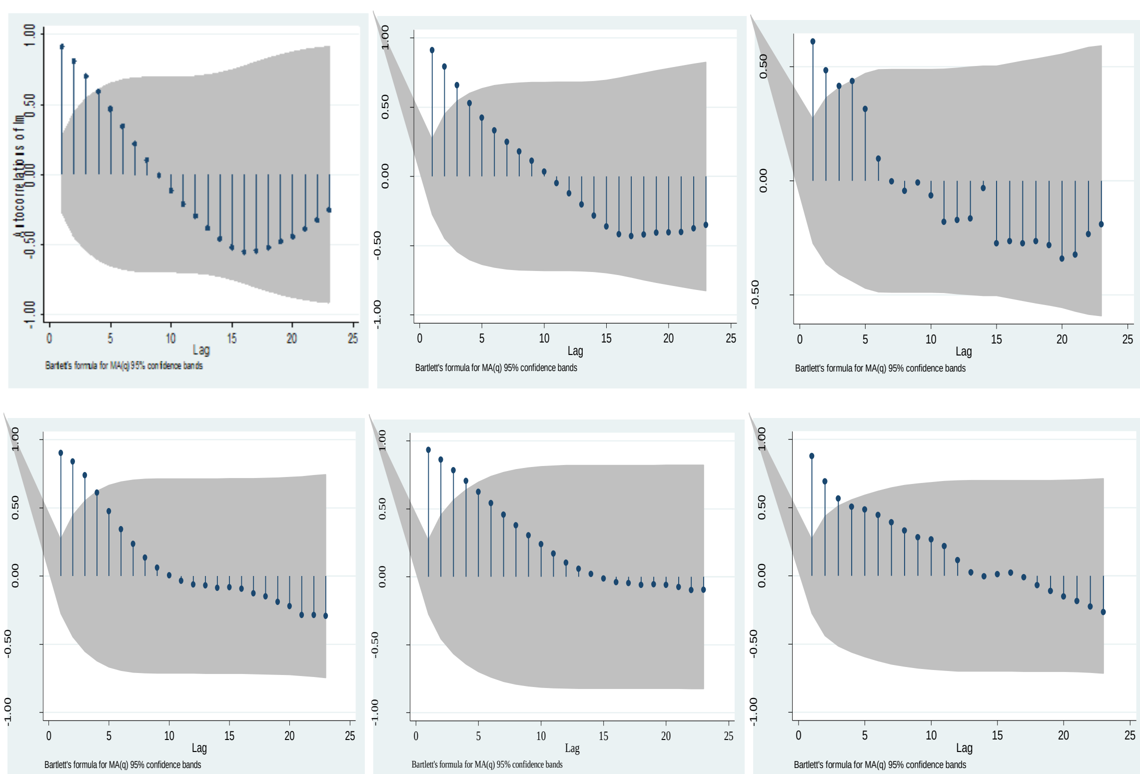
As shown by figure 4.1, LM had an upward trend from 1967 to 1974 with an exclusion of a minor fall in 1970. It was followed by a decade of inconsistency between 1975 and 1985. From 2005 to 2016, the trend of LM shows a skyward movement attributable to the BSL use of expansionary monetary policy. Figure 4.1 also indicate fluctuations in the trend of

LY from 1966 to 2005. However, there is an increasing trend from 2006 to 2015, with a slight decline in 2016. The trend of financial innovation (FINO) shows an upward movement from 1966 to 1981 with some minor declines in 1971, 1972, and 1975, followed by a period of instabilities from 1982 to 2002 which includes the period of the civil war (1991-2003). Then again, an upward trend exists for the period 2003-2013. Except for some disturbances, the trend of LRER is downward sloped as depicted above while the two-way plot of foreign interest rate, F, shows fluctuations.

4.1.2 Correlogram/Autocorrelation Plot

Also called the autocorrelation plot, a correlogram is the plot of the sample autocorrelations at various time lags. The correlogram is one of the essential visual tools for detecting autocorrelation. It also ensures the randomness or seasonality of the data. For instance, there is a high likelihood of autocorrelation if a series shows a seasonal pattern. Figure 4.2 depicts the autocorrelation plots of all variables in level forms while autocorrelation plots at first difference are reported in appendix 1A.

Figure 4.2: Autocorrelation Plots



From figure 4.2, the vertical scale is the autocorrelation coefficient, while the horizontal scale represents the time lag. The grey shaded area on each graph denotes the 95 percent confidence band which tell whether the correlation is statistically significant. Each dot signifies the autocorrelations between a lagged variable and original variable (logged variable). Figure 4.2 shows the presence of autocorrelation and trends among the variables. Thus, chances of non-stationarity of the series are high. The bound test to cointegration takes care of such problem by incorporating lag differences for each variable.

4.1.3 Normality Test Results

The normality of a series indicate that the series follows a normal distribution; thus, its statistical properties, including, its mean, mode, median, and the like are the same. To determine whether or not our series are normally distributed, the study performed the original Shapiro and Wilk (1965) Wald Test. The following hypotheses are given:

H_0: p >0.05: Normal Distribution

H_a: p <0.05: Non-normal Distribution

Table 4.2: Shapiro-Wilk Normality Test Result

Variable	Obs.	Wald statistic	V(covariance matrix)	z-statistic	p-value	Conclusion
LM	51	0.968	1.548	0.933	0.175	Normal
LY	51	0.96	1.899	1.37	0.085	Normal
R	51	0.738	12.505	5.394	0.000	Non-normal
FINO	51	0.901	2.851	4.745	0.013	Non-normal
LRER	51	0.839	7.705	4.36	0.000	Non-normal
F	51	0.954	2.183	1.667	0.000	Non-normal

Table 4.2 displays LM and LY have probability values that are greater than 0.05. Therefore, the study does not reject the null hypothesis, signifying that both variables have normal distributions. In contrast, R, FINO, LRER and F are not normal, as revealed in table 4.2. However, non-normality of variables is not a major problem. The major issue arises when the distribution of the residuals is not normal.

4.2 Unit Root Test in the Absence of Structural Break Results

The ADF and PP tests were used to ascertain whether or not the variables are non-stationary. The outcomes are reported in table 4.3.

Table 4.3: Unit Root Tests Results

	ADF Test Statistics		PP Test Statistics		
Variable	**Constant**	**Constant and Trend**	**Constant**	**Constant and Trend**	**Conclusion**
LM	-0.398	-0.544	-0.139	-0.375	I(1)
DLM	-2.716***	-3.052***	-5.277*	-5.384*	
LY	-0.932	-1.07	-0.759	-0.982	I(1)
DLY	-3.658*	-3.985**	-5.288**	-5.308*	
R	-2.525	-2.499	-3.243**	-3.189**	I(0)
FINO	0.15	0.944	-0.298	-1.218	I(1)
DFINO	-4.235*	-4.340*	-7.063*	-7.122*	
RER	-1.711	-1.497	-1.704	-1.373	I(1)
DRER	-5.321*	-5.616*	-6.451*	-6.577*	
F	-0.921	-2.277	-1.416	-2.576	I(1)
DF	-4.833*	-5.012*	-4.946*	-4.945*	

Note: ***p-value<0.10, **p-value<0.05, *p-value<0.01

Table 4.3 reveals that the ADF test for all variables at levels is nonstationary. The PP test results were used to make a conclusion because of its strength in taking care of breaks. All variables are nonstationary at levels excluding R. Nevertheless, when the variables are first differenced, stationarity is achieved. Therefore, LM, LY, LFINO, REER, and F are I(1) series while R is I(0). The non-stationarity of the series gives a hint of the presence of cointegration. On this account, the Pesaran, Shin and Smith (2001) ARDL Bounds test to cointegration was used to test if the series are cointegrated (findings are shown in section 4.6).

The traditional ADF and PP tests are ineffectual in detecting unit root when there are structural breaks among the series. However, the problem is resolved by testing for stationary where there are structural breaks. The study employed the Bai and Perron unit root test that is widely known for identifying multiple breaks. Table 4.4 indicates the test outcome.

Table 4.4: Bai and Perron Structural Break Test

Variable	Optimal Breakpoint	Scaled F-statistics	Critical Value**
LM2	1973, 1986, 1993, 2002, 2010	13.787*	12.5
LY	1983, 2002, 2010	95.051*	11.14
R	NA	NA	NA
FINO	2006	143.354*	8.58
LRER	1973, 1980, 2005	26.674*	11.14
F	1979, 1986, 2008	21.814*	11.14

Note: * indicates H_0 is rejected at a 5% level; ** implies Bai-Perron critical values.

The results indicate several structural breaks ranging from 1973 to 2010. These breaks are results of the long civil war as well as some minor economic instabilities. The study introduced a dummy (W) to account for the war, which is most likely to have a significant impact on the series. The variable takes on a value of 0 before the occurrence of the civil war and 1 otherwise.

4.3. Optimal Lag Length Selection Criteria

In econometric analysis, choosing a proper lag length is essential. If the selected number of lags are too many, it increases the probability of multicollinearity and forecast error. It also reduces the degree of freedom. On the contrary, the inclusion of insufficient lags leads to misspecification of the model (Gujarati and Porter, 2009). Given these reasons, the selection process is done through the use of information criteria like AIC and SIC. The result is shown in Table 4.5.

Table 4.5: Optimal Lag Selection Criteria

Lag	LL	LR	FPE	AIC	SIC	HQ
0	-361.482	NA	0.015	15.68	15.956	15.784
1	-87.088	455.377	1.06E-06	6.089	8.293*	6.918
2	-21.568	89.218	6.05E-07	5.386	9.519	6.941
3	22.872	47.277	1.09E-06	5.58	11.642	7.861
4	134.459	85.47*	1.85e-07*	2.917*	10.908	5.924*

Note: * indicates the lag length chosen by a criterion

As shown in table 4.5, the appropriate number of lag to be used with respect to SIC is 1, whereas the AIC selected a lag of 4. However, the AIC is more robust when the series are recorded annually (Gujarati and Porter, 2009). For this reason, it is adopted for this purpose of this study.

4.4 Cointegration Test Results

The PP test result displays a combination of stationary and non-stationary series; making it suitable for bounds test for cointegration to be carried out. When cointegration is identified, the long-run coefficients and short-run dynamic model, which include the error correction Term (ECT) are generated. Conversely, the short-run model is estimated when there is no long-run equilibrating relationship. Table 4.6 reveals the findings of the bounds test. The upper and lower critical bound values are obtained from Kripfganz and Schneider (2018)[10]. Appendix 1B and 1C reports the basic ARDL model and selected criteria graph.

Table 4.6: Bounds Test Results

Test	Statistic	Critical Values					
		10%		5%		1%	
		UB	LB	UB	LB	UB	LB
F-test	9.949	2.258	3.666	2.713	4.313	3.8	5.848
t-test	-6.759	-2.437	-3.906	-2.806	-4.354	-3.553	-5.262

From table 4.6, F-statistic of 9.949 is larger than the upper bound (UB) value at all significance levels; the study rejects the null hypothesis. As such, the series are said to be cointegrated. The study then moves to generate the long-run parameter estimates and ECM.

[10] Unlike Narayan (2005) which gives upper and lower bond values for studies with sample sizes which are range from 30 to 80 in increments of 5, Kripfganz and Schneider (2018) offers a more realistic critical values for all samples and regressors.

Table 4.7: Long-run Coefficient Estimates

Variable	Coefficient	t-statistic	p-value
LY	0.927	7.26	0.000
R	0.0002	0.14	0.890
FINO	0.871	3.7	0.001
LRER	-0.078	-0.97	0.342
F	0.061	4.82	0.000
W	-0.239	-3.07	0.005

Table 4.8: Short-run Coefficient Estimates (2,0,1,3,1,3,2)

Variable	Coefficient	t-statistic	p-value
C	-0.393	-0.17	0.865
D(LM(-1))	0.207	1.74	0.093
D(R)	-0.002	-2.54	0.017
D(FINO)	-0.712	-3.4	0.002
D(FINO(-1))	-0.219	-1	0.324
D(FINO(-2))	-0.779	-4.3	0
D(LRER)	0.48	3.16	0.004
D(F)	-0.04	-3.3	0.003
D(F(-1))	-0.021	-1.73	0.095
D(F(-2))	-0.033	-2.89	0.007
D(W)	0.108	1.31	0.201
D(W(-1))	-0.102	-1.16	0.257
CointEq(-1)/ ECT	**-0.7**	**-6.76**	**0**
Number of obs.	47	Sample	1970-2016
R^2	0.827	Log likelihood	63.187
Adj. R^2	0.715	Root MSE	0.082

Table 4.7 and 4.8 presents the findings of the long-run and short-run parameter estimates. The income elasticity is positive and statistically significant at 1 percent level in the long-run. It implies that when real income is increased by 1 percent, real broad money balance grows by 0.927 percent. The positive elasticity is in line with the transaction theory and

conformed to studies by Bathalomew and Kargbo (2009), Kallon (2009), and Mansaray and Swaray (2012) on Sierra Leone.

The long-run inflation elasticity is positive but not significant. In the short-run, inflation is inversely related to real broad. For instance, people in developing countries like Sierra Leone hold less cash when the rate of inflation is high because of rising prices. However, the impact of inflation is relatively low. The negative elasticity agrees with the works of Bathalomew and Kargbo (2009) and Mansaray and Swaray (2012)

Financial innovation, the variable of interest, has a direct long-run elasticity which is statistically significant at 1 percent, which contradicts the findings of Arrau et al. (1995). The finding is in agreement with the assertions of Mannah-Blankson and Belyne (2004), and Kasekende and Nikolaidou (2018). However, in the short-run, financial innovation has an inverse impact on money demand at a 5 percent level of significance. This means the development of innovative means of payment such as debit cards, internet banking, among others, means individuals substitute more liquid assets for those with less liquidity. Hence, there is a reduction in the demand for real money. Besides, a statistically significant coefficient of FINO was found for the 2nd lagged period.

Table 4.6 shows an inverse elasticity of real exchange rate and cash held, however, not statistically significant in the long-run but positive and significant in the short-run at 5 percent. This implies that the appraisal of assets portfolio by holders of wealth hinges on local currency. As the value of the currency depreciates, it increases the value of the local currency in foreign assets held by wealth holders. Those who perceived the depreciation as a means to increase wealth have a tendency to allot a portion of their foreign assets to local assets which include broad money local in order to retain a fixed proportion of wealth invested in local currency. The result is in agreement with Dunne and Kasekende (2018) and Bathalomew and Kargbo (2009) but refutes Mansaray and Swaray (2012) findings of the negative coefficient.

The short-run elasticity of the foreign interest rate is inverse and significant at 5 percent level. The findings back the capital mobility (indirect currency substitution) literature which suggests a rise in the expected returns on foreign interest assets such as the 91-day treasury bill has the tendency to tempt domestic residents to invest in foreign assets. As a result, there is a reduction in the demand for cash balance. Nevertheless, foreign interest rate exerts a direct but significant impact on money demand in the long-run. As more domestic residents demand foreign assets, the foreign interest rate falls in the long-run, thereby leading to a rise in the demand for domestic currency. The positive coefficient of foreign interest rate supports the findings of Kallon (2009) and Mansaray and Swaray (2012) on Sierra Leone. Foreign interest rate is also significant in both the first and second lagged periods.

The coefficient of W is negatively significant at 5 percent in the long-run, which is in agreement with the findings of Bathalomew and Kargbo (2009) and Mansaray and Swaray (2012). A 1 percent increase in war prompts a reduction in real broad money by 0.239 percent. During the periods of the civil war in Sierra Leone, there was little money could buy due to the scarcity of major commodities. For this reason, the desire for holding cash becomes low. Opposing to the long-run findings, the short-run impact of the war is positive and statistically not significant.

The ECT which capture the speed of adjustment is negative as predicted. An adjustment coefficient of 0.715 indicates that approximately 71.5 percent of the disequilibrium triggered by previous years' errors converges back to equilibrium within a year. Moreover, the speed at which the short-run converges back to the long-run is fast and significant at a 1 percent level, indicating the presence of cointegration.

4.5 Post Estimation Tests

When the findings of the post estimation tests are inconsistent, predictions based on its estimates are unreliable. To validity that the parameter estimates are consistent for forecasting, some post estimation tests were conducted. These tests comprise of residuals normality test, test for heteroscedasticity, and residuals serial correlation test. The findings are demonstrated in Table 4.8.

Table: 4.9 Results of Diagnostic Tests

Test	Test Statistic	P-value	Null Hypothesis
Heteroscedasticity	Chi2(1) = 1.12	0.291	Constant Variance
Serial Correlation	Chi2(1) = 0.075	0.784	No serial Correlation
Normality	z = -0.106	0.542	Normal Distribution

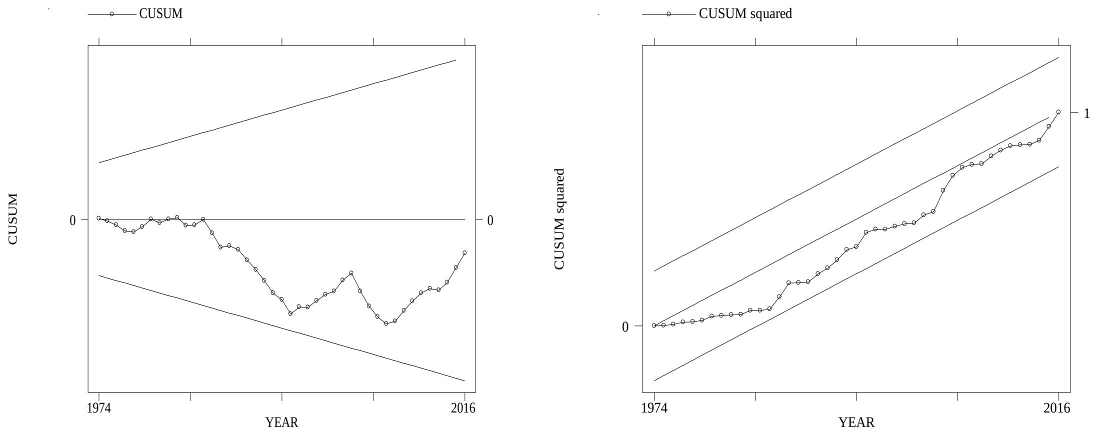
The study conducted the Shapiro-Wilk residual normality test to evaluate if the residuals of the estimated model have a normal distribution. As shown in table 4.9, the probability value is higher than the 5 percent level. The study fails to reject the null hypothesis, suggesting normal distribution. This normality is an indication that the result can be used for policy purpose.

A serial correlation of the residual and presence of heterscedacity point to an inherent flaw in the estimated model. The outcome of the Breusch-Godfrey test shows the residuals of the estimated model not autocorrelated as evident by the p-value of 0.784. Also, the Breusch-Pagan-Godfrey test confirms the residuals are homoscedastic.

4.6 Model Stability Test Results

The stability of the estimated model is significant for validating the reliability of forecasts. To investigate the stability of the coefficient estimates, the study conducted two graphical tests, CUSUM and CUSUMSQ. When the cumulative sum or cumulative sum of square falls within the specified boundary, the model is considered stable. However, instability exists when found outside of the boundary. Figure 4.3 reveals the results of the tests.

Figure 4.3: CUSUM and CUSUMQ Tests for Stability Results



The plot lies within the specified critical lines for both tests. It is evident that the real money demand model for Sierra Leone is stable for the period of the study. Hence, the parameter estimates are useable and can be used for forecast or policy inferences.

CHAPTER FIVE: SUMMARY, CONCLUSION AND POLICY IMPLICATIONS

5.0 Introduction

Chapter five comprises of summary of the study and provision of policy inferences. Additionally, it includes limitations and suggestions for future studies. The chapter is subdivided into five sections which are discussed as follow.

5.1 Summary

The study employed an Autoregressive Distributive Lag approach to investigate a money demand function for Sierra Leone that included financial innovation from 1966 to 2016. To be more specific, the study aimed at establishing a cointegrating relationship in a specified money demand function and testing its stability. The theoretical foundation is based on the Shopping-Time model, which provides a clear explanation for the transactions facilitating services offered by money.

To achieve the secondary objective of the study, the bounds test for cointegration was adopted. A conclusion was made on the basis of the Kripfganz and Schneider (2018) critical values which covers all sample sizes since the Pesaran, Shin and Smith (2001) critical values are biased for smaller sample studies. The results recognized the presence of cointegration. Prior to the test for cointegration, pre-estimation tests were conducted to confirm the time series characteristics of the dataset. These tests included correlogram, SW test for normality, ADF and PP tests for unit root, and Bai and Perron multiple breaks test.

A cointegrating relationship supports an investigation of the short and long-run parameter estimates. Real income, financial innovation, plus foreign interest rate positively impacts the long-run real broad money while war has an inverse effect. Results from the short-run model indicate that inflation, financial innovation and foreign interest rate have an indirect impact on broad money demand. Also, the coefficient estimate of the real exchange rate indicates wealth effects exists in the short-run. The ECT indicates when the variables are adjusting, they are converging in the direction of their long-run equilibrium values at 71.5 percent.

A number of diagnostic tests were carried out to make sure the findings are reliable for forecasting. Findings generated from these tests indicates that the residual of the estimated model has a normal distribution and is free from autocorrelation. The residual is also homoscedastic, thereby suggesting the variance of the residual is constant. Two graphical tests (CUSUM and CUSUMSQ) established the estimated model is stable.

5.2 Conclusion

From the study's finding, it is evident financial innovation has an impact on real money balances; an inverse effect in short-run and a direct impact in the long-run. Nevertheless, with regards to the overall stability of the money demand function, financial innovation does affect it owing to the fact stability was still achieved even with the inclusion of financial innovation. This study, therefore, confirms the assertion of the studies which found stability even the presence of financial innovation.

Also, it is established from this study that there exists a long-run equilibrating relationship among the factors that determine the demand for broad monetary money. It implies that in the long-run factors such as real income, proxy by real GDP, foreign interest rate, financial innovation and the structural break variable (war) influence the amount of money demanded by the general public.

5.3 Policy Implications

The study provides the following policy implications based on the findings:

- The adoption of a monetary targeting framework for ensuring prices are stable is still feasible as the development of innovative instruments has not altered the stability of the money demand function in Sierra Leone. However, a consistent analysis of the money demand function is required as financial innovation is an incessant process.
- A statistical significance foreign interest rate in the long-run and short-run point to the existence of capital mobility effects. Therefore, it hints that any shock that is externally generated will have an impact on the steadiness of money demand.

5.4 Limitation of the Study

As a result of incomplete data on the 91-day treasury bill, the rate of inflation was used as an alternative for an interest rate which may not capture the real impact of the opportunity cost variable. Initially, the study also intended to use several proxies of financial innovation. However, the unavailability of key indicators led to the inclusion of the single measure.

5.5 Areas for Further Research

An analysis of the stability of the money demand model is a broad area in macroeconomics. Though this study has established the main variables that impact the demand for broad money in Sierra Leone, it is necessary to conduct other studies using other proxies of financial innovation. These studies can exclusively focus on individual financial innovations like mobile money, and the volume of ATM transactions as the impacts may vary across financial sectors.

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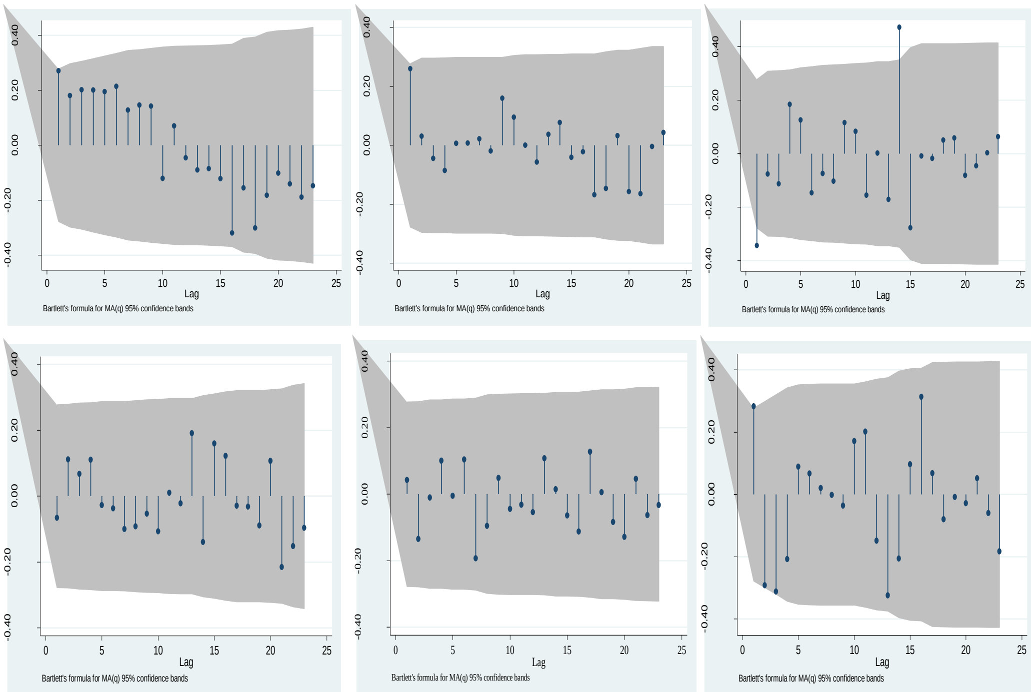
Appendix 1A: Autocorrelation Plots for Variables at First Difference



Appendix 1B: Basic ARDL Model

Variable	Coefficient	t-statistic	p-value
LM(-1)	0.506	3.600	0.001
LM(-2)	-0.207	-1.740	0.093
LY	0.650	5.970	0.000
R	-0.002	-2.360	0.026
R(-1)	0.002	2.540	0.017
FINO	-0.102	-0.680	0.503
FINO(-1)	0.493	2.270	0.031
FINO(-2)	-0.560	-2.330	0.027
FINO(-3)	0.779	4.300	0.000
LRER	0.425	2.680	0.012
LRER(-1)	-0.480	-3.160	0.004
F	0.003	0.280	0.781
F(-1)	0.018	1.060	0.300
F(-2)	-0.012	-0.660	0.512
F(-3)	0.033	2.890	0.007
W	-0.059	-0.820	0.417
W(-1)	-0.210	-2.210	0.035
W(-2)	0.102	1.160	0.257
C	-0.393	-0.170	0.865
No. of obs	47.000	R-squared	0.989
F(18, 28)	143.640	Adj R-squared	0.982

Prob > F	0.000	Log likelihood	63.187
Root MSE	0.081		

Appendix 1C: Akaike Information Criteria Graph for Models