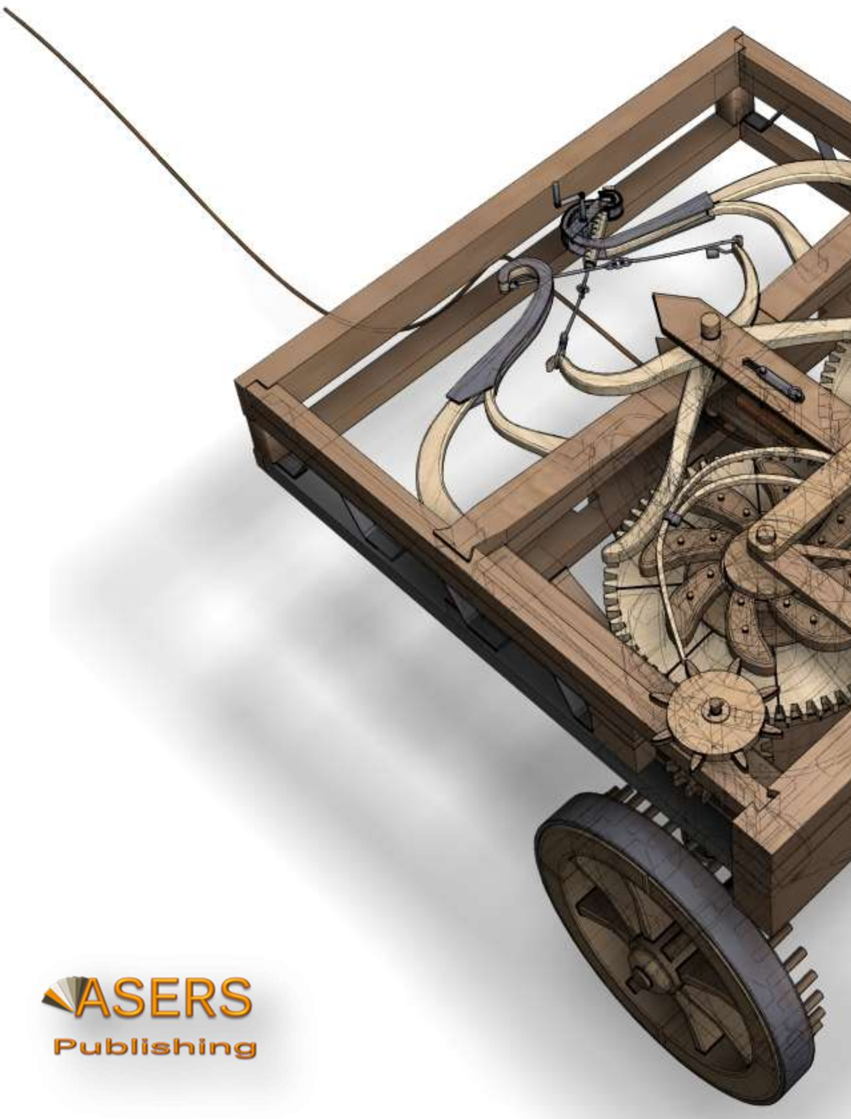
Theoretical and Practical Research in Economic Fields



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A MODEL APPROACH TO UNDERSTANDING MONETARY AGGREGATES GROWTH IN SIERRA LEONE AND IMPLICATIONS FOR POLICY FORMULATION

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Abstract

This study has adopted a model approach to developing an understanding of monetary aggregates (MA) growth in Sierra Leone, which certainly has implications for effective policy formulation by the central bank authority. In pursuance of this, we utilized the Autoregressive Moving Average (ARIMA) model with data spanning 2002M1 to 2021M12 to investigate the out-of-sample projection performance of the disaggregated components that makes up the MA for Sierra Leone – typically in this case Reserve Money (RMA), Currency-in-Circulation (CiC) and Reserve Money (RM). In our evidence from the empirical projection (covering the period 2022M1-2022M12), we observed that RM is projected to grow more than CiC over the observed period. Given RM being the operational target of the Bank of Sierra Leone, we believe that such an outcome is a promising indication particularly in ensuring the bank addresses its core mandates of monitoring price and financial stability. The increased scope of RM in the BSL system is a laudable outcome when it comes to meeting reserve requirements and also managing risks about price and financial stability. The study recommends that the BSL adopt innovation strategies concerned with FinTech and the emergence of the National Switch to effectively manage the MA portfolio in the entire banking system, which will also support the overall growth ambition of the central government.

Keywords: monetary aggregates; financial stability; price stability; growth; Sierra Leone.

JEL Classification: E47; E52; E58.

Introduction

Monetary aggregates by definition provide an indication of monetary stock in a country, which is considered critical to helping central banks monitor their role in supporting stable macroeconomic management, notably price and financial stability (Juhro and Rummel 2022). The process is managed differently by economies around the world depending on the complexity of central banks' monetary operational system. Typically, in a country like Sierra Leone and specific to this study, the process of monetary aggregates is done by computing the end of the monthly stock of components of money, which incorporates Reserve Money (M0), Broad Money (M2), and Currency in Circulation (CiC).

The concept of monetary aggregates is very important in supporting the role of central banks to discharge their core mandates. Therefore, in discharging the role of monetary issuance in an economy, central banks normally ensure that monetary aggregates computation are very well coordinated in supporting the smooth running of economic activities, which also has huge implications for stabilising the financial system, while at the same time ensuring price control system is effectively monitored to address stable economic well-being for citizens. An understanding of monetary growth, which has been explored through various forms of empirical research operations is very essential in ensuring a trade-off or a balance is realised between inflation and economic growth in an economy (Garratt, Koop, Mise and Vahey 2009).

Effective monitoring of Monetary aggregates is considered very important for economies, particularly in a country like Sierra Leone where Reserve Money (RM) is the operational target for effective monetary policy operations (Jabbie and Jackson 2020; Jackson and Jabbie 2019). Monetary aggregates are a very important engine that supports the operation of monetary policy, which also impacts economic activities and employment in the short run and as a means for taming inflationary pressure in the long run (Labonte 2009; Currie 1956). Reserve Money, also referred to as '*high-powered money, base money, and central bank money* typically suggests that its maintenance and monitoring are highly important for a country like Sierra Leone. Given its relevance as the monetary target for a country like Sierra Leone, it also makes it possible for the country to own up to its international commitments, while also anchoring high scope for maintaining stable foreign exchange reserves to support uneventful concerns arising from both internal and external shocks.

It is therefore essential that stable monetary aggregate growth is maintained by the central bank, with good predictive power in a bid to monitor risks to price and financial instability. It is with this focus in mind that this study has carved its impetus to produce a model approach that will help understand the direction of monetary aggregates (specifically Reserve Money as the operational target) in Sierra Leone, which is thought to have implications for effective policy formulation. Sierra Leone is a rich and endowed nation, but equally challenged with a plethora of concerns that include a long battle against civil unrest in the 1990s that almost brought the country to a standstill, and also external shock owing to its weak real sector operations (Jackson, Barrie and Johnson 2021; Jackson and Tamuke 2021; Jackson, Tamuke and Sillah,2021). As stressed by Friedman (1970) from his monetarist view of inflation, *"Inflation is perceived to be everywhere and more so a monetary concern, which is said to be due to an increase in the quantity of money outstripping output*". Therefore, on reflection of Fisher's (1936) version of the Quantity Theory of Money (MV=PT)[1], it is hereby believed that effective control of the money supply (in this case the Reserve Money component of the Monetary Aggregates) will help anchor reasonable level of inflationary pressure, regardless of the low state of real sector operation as currently witnessed in the case with Sierra Leone.

To empirically explore the topic, the researchers have set themselves the onus of answering the highlighted research question: *What is the importance of Monetary Aggregates in addressing effective monetary operations by a central bank?* To address the highlighted research question, the following research objectives are hereby set in place as the milestone to achieving the overall focus of the study: (i) To provide a background understanding of Monetary Aggregates concerning its operational target focus by the Bank of Sierra Leone. (ii) To utilise a univariate ARIMA model to project outlook for Reserve Money (RM) as the operational target. (iii) To proffer sound recommendations, which are consistent with the objective focus of the Bank of Sierra Leone.

The remaining sections of the paper cover the following: Section Two provides an overview of Stylised facts about monetary aggregates in Sierra Leone. Section Three addresses the literature review, divided into two parts (namely theoretical and empirical reviews), while Section Four provides a

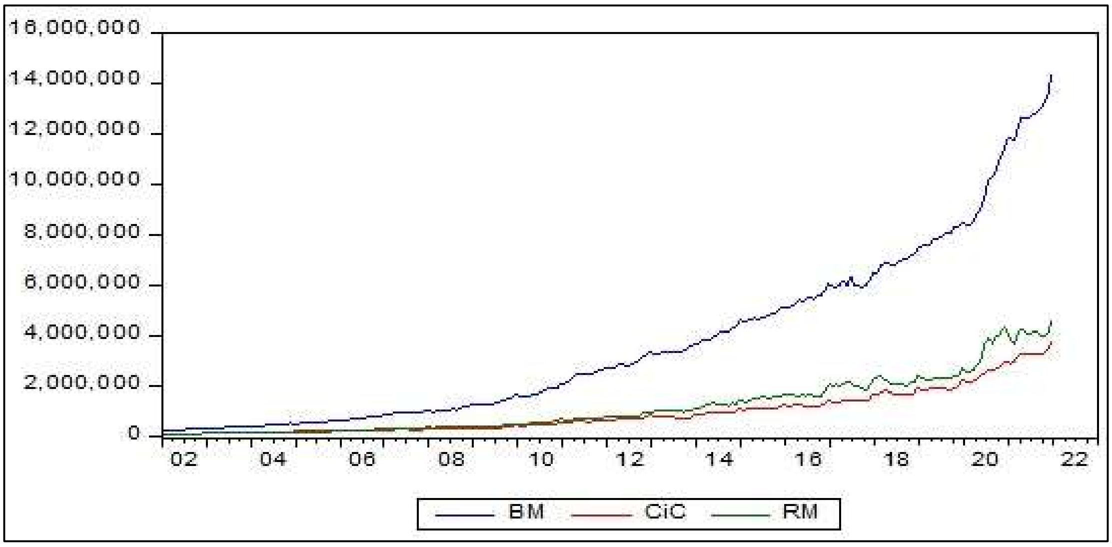
[1] Where: M is Money Supply; V is Velocity of Circulation; P is Price level; and T is Transaction

snapshot of a simplified short-term model to project the outlook of components of the monetary aggregates. Section Five provides an analysis of the results, while Section Six concludes with proffered pointers for effective policy recommendations.

1. Stylised Facts about Monetary Aggregates in Sierra Leone

Figure 1 above illustrates a succinct historical outlook of monetary aggregate components for Sierra Leone within the period 2002M1 to 2021M12 – this includes indicators like Reserve Money (RM) as the operational target for Sierra Leone, Broad Money (BM), and Currency in Circulation (CiC). Given the nature of the Sierra Leone economy, which is currently managed as a highly cash-based system, it is apparent to infer those monetary aggregates and particularly CiC could potentially manifest some level of risks to the system, particularly when it is shown to be higher than the monetary base or simply put, reserve money. In general, several studies have also shown that a high level of informality in the entire economy of Sierra Leone is exposing the system to pumping more money into circulation (CiC), which also poses risk to the entire financial system's stability (Jackson, 2020; Jackson and Jabbie, 2019). An expanded CiC in itself has the capability of inducing inflationary pressure on an economy, which as shown has become a concern for Sierra Leone, in addition to the fact that the country's real sector is currently not very well functional to support a healthy domestic economy.

Figure 1. Monetary Aggregates for RM, BM, and CiC



Source: EVIEWS Output

Given the above trajectory of the historical position of monetary aggregates in the Sierra Leone economy, there is certainly a need for the move towards the redenomination of the Leone currency and also backed by the emerging launch of a National Switch, which will help to monitor cash usage in the domestic economy, while also increasing surveillance of illegal financial transactions – an implied disincentive to foreign investments. As seen, Broad Money (BM) component in the Monetary Aggregates is high, which is the totality of all forms of money in the financial system – this includes items like notes and coins and other operational deposits held in the central bank and also savings at commercial banks or other depository corporations. More surprisingly, BM also incorporates Treasury Bills securities, which makes it quite obvious as the highest component when compared to the other components that make up the monetary aggregates.

2. Literature Review

This section explores the literature on monetary aggregates, with attention focused on the theory of money and empirical works already produced over the past decade in a bid to develop our approach to carving the methodology and outcome for this study.

2.1. Theoretical Review

Theoretically, the concept of Monetary Aggregates (MA) is considered very important, both in terms of its economic linkage and also the role it plays in addressing both price and financial stability in a county. Since the 1980s, advocates of MA have been faced with a deterioration in the traditional relationship between money and financial innovation, while the consequential impact on the velocity of money is fully explained on account of the associated relationship with the highlighted factors (Estrella and Mishkin 1996). As emphasized by the authors, changes in the velocity of money could be explained in part by regime shifts in policies and also through financial innovations introduced more recently with the emergence of systems like FinTech and the National Switch platform. As utilised by many economies around the world, and particularly in terms of its operational anchor for monetary policy, the use of MA could be assessed as an informational source in effecting sound policy formulation and also in signaling central banks' intention to monitor their core objectives of maintaining price and financial stability, and for some central banks anchoring nominal income growth (ibid).

The relevance of MA is growing with prominence given its relationship with economic growth in a country (Labonte 2009). As already identified, the conduct of monetary policy decisions is very critical to addressing economy-wide confidence in MA as a tool for stabilising prospects for growth and economic well-being. Money supply, a component in the MA needs to be monitored and central banks are considered very critical in ensuring the components are effectively managed through the adoption of firm policy measures in a bid to affirm confidence in a financial system. Effective management of MA normally helps central banks to anchor sound monetary policy and financial stability targets, which are considered very important to ensure inflationary pressure is contained. For instance, an uncontrolled level of CiC may result in inflationary pressure and as highlighted by Estrella and Mishkin (1996), the use of a firm policy stance backed by innovative measures is also considered helpful in reducing risks of instability to an economy.

2.2. Empirical Review

Elgar, Jones & Nilsson (2006) investigated out-of-sample forecasting performance for different monetary aggregates in four models that include real output growth, inflation, interest rate, and the nominal money growth during the period 1992 to 2004. The model uses vector autoregressive (VAR) and regime-switching (RS) VAR models. The authors also made use of Divisia and monetary aggregates like M1, M2M, M2, and M3. There was not enough evidence to prove that any of the methods (aggregation method or level of aggregation) impact the forecast performance of the models, particularly when it comes to inflation and output growth. The VAR model outcome when utilised with monetary aggregates made very little improvement on the RMSE when compared to the VAR models that did not incorporate money growth. The outcome also proved that RS-VAR models show improvement in one-quarter forecasts when equated to the VAR models, but also performed worse when the inflation forecast is done for four-quarters periods.

Garratt *et al.* (2009) carried out an empirical study by exploring real-time prediction with UK Monetary Aggregates in the presence of model uncertainty. It was perceived that the demise of the U.K.'s monetary targeting regime in the 1980s was to be blamed on the fluctuating predictive relationships between broad money and inflation and real output growth. The paper particularly investigated predictive relationships for indicators like inflation and output growth by using both real-time and heavily revised data. The authors made use of a large set of recursively estimated vector autoregressive (VAR) and vector error correction (VECM) models – the models are thought to differ in terms of their lag length and the number of cointegrating relationships. They also made use of Bayesian model averaging (BMA) to establish real-time issues that monetary policymakers faced in the presence of model uncertainty. In-sample prediction of money fluctuated in the 1980s on account of data revisions in the presence of model uncertainty – it was proven that the feature is more seeming with real-time data, while heavily revised data was said to be incomprehensible with the observed fluctuations. On the other hand, Out-of-Sample predictive evaluations seldom advocate that money matters for either inflation or real output. The study finally concludes that both data revisions and model uncertainty contribute to an obstacle to the U.K.'s monetary targeting regime.

Bošnjak, Novak & Krišto (2018), produced an empirical study to explore the determinants of Croatian current account dynamics with the use of a monetary and absorption approach. The study made use of the Non-linear Auto-Regression Distributed Lag (NARDL) approach, incorporating nonlinear and asymmetric relationships for the Croatian current account and other determining factors. The study utilised quarterly data ranging from 2000Q1 to 2017Q2 and revealed that the Croatian current account with the framework of both monetary and absorption systems. Variables used as determinants to assess the Croatian current account include "*Domestic demand, real exchange rate index, loans to the private sector and monetary aggregates M4*". The outcome shows that monetary aggregates M4 are found to provide the chief explanatory power of the other monetary variables used. The main findings of the paper recommend the need for fiscal policy among many other measures while calming down constraints about liquidity constraints exporters as considered necessary to obtain external balance.

Dinh (2019) made use of the ARIMA model to forecast domestic credit growth in China and Vietnam. The model was then fitted using time series data, with two motives in mind; notably, to develop an understanding of the data used and also to forecast future point series. The specific model used is based on the best fit for Vietnam as ARIMA (2,3,1) and that of China, which ARIMA (2,3,5). The sample data used for analysis ranged from 1996 to 2017 and statistical significance was proven for the fitted sample. The out-of-sample forecast was done for one year. The outcome shows that both Vietnamese and Chinese purported as open economies possess domestic credit that greatly contributes to economic growth. The results are generally consistent with the central bank's approach to formulating effective policy that impacts domestic credit growth and GDP for the two countries.

Shaibu and Osamwonyi (2020) utilise Autoregressive Integrated Moving Average (ARIMA) model that was developed by Box-Jenkins (1976) for money demand in Nigeria, with quarterly data from 1986 to 2018. The study made use of correlogram, specifically Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) under the first-order difference of money demand series in a bid to identify and estimate a parsimonious ARIMA model. The ARIMA (3, 1, 2) model was identified as the best model with the criteria of identification, selection, parameter estimation, diagnostic checking, and forecast evaluation. The outcome from the results suggested that its adequacy was based on the Ljung-Box Q-statistic, considered most efficient in the forecasting of demand for money based on the RMSE and MAE values. Statistical significance was found to be found for lagged values of money demand in explaining actual broad money demand in Nigeria during the observed estimation period. The outcome also shows that inferences from previous values of money demand also affect present values of money demand. To achieve the stable and sustained function of Broad Money in Nigeria, the study recommends that the monetary authority should manifest a high level of transparency in monetary policy formulation, presentation, implementation, and control.

Srinivasan & Arora (2020) empirically tested to see if the addition of monetary aggregates with inflation forecasting models contributes toward enhancing forecast outcomes or not. The estimates were done using the P-star model and Divisia M2, Divisia M3, simple sum M2, and simple sum M3 together with Phillips curve and ARIMA models to forecast inflation for India from the period April 1994 to December 2016. The outcome shows the inflation forecastability of the Divisia monetary aggregate model and m1onetary aggregates to be the same. Even though Divisia was considered to fit better than the simple sum from 1993 to 2013, Divisia's model outcome seems not to explain the behaviour of inflation after the year 2013. The final takehome for policy recommendations is that reliance on Divisia alone may not help in producing reliable conclusions for policy formulation - it is, therefore, suggested its use is done together with the ARIMA model for consistent inefficient policy formulation.

Given the above-mentioned review of the theoretical and empirical literature, it is obvious to note the relevance placed on MA in monitoring the stability of a financial system and inflationary pressures. The addition to knowledge acquisition for this study is its niche in disaggregating the identified monetary aggregates for Sierra Leone (Reserve Money, Currency in Circulation, and Broad Money) to understand their projected outlook, which is critical to anchoring a stable domestic economy.

3. Theoretical Framework and Model Specification

The model utilizes the previous past movement of variable(s), particularly Reserve Money (RM) as the operational target in predicting future values/events. This is a time series model, with data spanning from 2002M1 to 2021M12. Reliability of the outcome is focused on the out-of-sample forecast performance of the series (Stock and Watson 2003; Jackson 2018; Jackson, Tamuke and Sillah 2018). Times series models in particular are normally expressed in Autoregressive Moving Average (ARMA) form (Slutsky 1927 and Wold 1938), which is simplified in the following equation statements:

$$Y_t = e_t - \theta_1 e_{t-1} - \theta_2 e_{t-2} - \theta_3 e_{t-3} - \ldots\ldots\ldots - \theta_q e_{t-q} \qquad 3.1$$

The above series is referred to as a moving average of order **q**, with the nomenclature MA**(q)**; where Y_t is the original series and e_t as error term in the series. As presented by Pankratz (1983), the autoregressive process of the moving average series can be expressed as:

$$Y_t = \varphi_1 Y_{t-1} + \varphi_2 Y_{t-2} + \varphi_3 Y_{t-3} + \ldots\ldots\ldots\ldots + \varphi_p Y_{t-p} + e_t \qquad 3.2$$

It is assumed that t, is independent of $Y_{t-1}, Y_{t-2}, Y_{t-3}, \ldots Y_{t-q}$.

The model is based on the Box-Jenkins Autoregressive Integrated Moving Average (ARIMA) format and it is a generalised form of the non-stationary ARMA model that represents the form ARMA(p,q):

$$Y_t = \varphi_1 Y_{t-1} + \varphi 2 Y_{t-2} + \varphi_3 Y_{t-3} + \ldots + \varphi_p Y_{t-p} + e_t - \boldsymbol{\theta_1 e_{t-1}} - \boldsymbol{\theta_2 e_{t-2}} \ldots\ldots - \boldsymbol{\theta_p e_{t-p}} \qquad 3.3$$

Where, Y_t is the original series, for every t.

We assume that is independent of $\mathbf{Y_{t-1}, Y_{t-2}, Y_{t-3}, \ldots, Y_{t-p}}$.

Based on Hamjah (2014: 170-171 (Jackson 2021; Jackson 2018; Jackson and Tamuke 2018), the procedure for this study is based on the undermentioned procedure:

- Check normality assumption, which makes use of the “Jarque-Bera” test, typically perceived to measure the goodness of fit.
- Check to make sure that is no evidence of autocorrelation with the residuals.
- Ensure features like Autocorrelation Function [ACF] and Partial Autocorrelation Function [PAC] are utilised to discover of Stationarity situation.
- Use of Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) for model selection criterion.

More simplistically, this study, and particularly the program codes as shown in Appendix 1 are created in EVIEWS, with attention focused on the above procedure(s) to evaluate outcomes from the ARIMA model. This takes into consideration steps connected with unit roots, which are integrated within the codes, stability outcome as identified in the best model, and identification of AIC, Durbin-Watson, and R^2 values. These are required to produce the projection for Reserve Money (in short, the monetary base) and other components of the MA (See Table 1).

4. Discussion of Empirical Results

Based on the automated codes as shown in Appendix 4, each index has been modelled to reproduce its unique feature by incorporating constant, lag structure(s), first difference, and seasonal adjustment[s], as documented in similar research estimation outcomes (Jackson 2021; Jackson and Tamuke 2020). Specific to this research paper, the univariate Box-Jenkins model examined the characteristics of each component’s projection process, with a unique best estimation output as shown in Table 1. The equations for the estimation were derived through an automated process by selecting the best three models through several iterated processes (see Appendix 1 for the complete codes).

Appendix 2 shows descriptive statistics of Monetary Aggregates for Sierra Leone as extracted for the study period. Technically, the summary statistics for the mean provide indicative information about the average of the series, while the median provides an expression of the median value in the series after ordering them in order of size or magnitude. Both minimum and maximum values indicate the lowest and highest of the monetary aggregate series during the observed period. Standard deviation in the series shows the level of dispersion or spread of the series and the Skewness is indicative of the symmetry of the distribution of all the series around the mean value. The Kurtosis value, which is 3.64 indicates that the distribution has a fatter tail. The Jarque-Bera value indicates the goodness-of-fit as to whether the data sample possesses skewness and kurtosis. The distribution in Appendix 2 indicates that the hypothesis of normal distribution at 1% and 5% significant levels is rejected, which means that the distribution is not normal.

Equally, we also provided in Appendix 3 the correlogram (otherwise known as the Autocorrelation Function) of the residuals. Supposedly, this makes it relevant to check the randomness of the data set – in other words, it explains how to well the present value of the series is related to previous or past values. In this situation, movements around the residual plot show that the data set is not random. The model's stability was also determined through the AR root value, indicated as 0.80 and backed by the AIC and Schwarz criterion values, which eventually determine its best feature for projecting the out-of-sample range in determining components of the monetary aggregates, which depicts the action of efficient monetary policy formulation that is consistent with the Bank of Sierra Leone's (BSL's) mandate – in this case, ensuring price and financial stability are consistently monitored.

Table 1. Model 3 (Best Model Outcome)

Dependent Variable: D(RM_3)
Method: ARMA Maximum Likelihood (BFGS)
Included observations: 239
Convergence achieved after 52 iterations

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.014630	0.000253	57.93917	0.0000
AR(1)	0.826794	0.041421	19.96092	0.0000
MA(1)	0.974588	0.74696	17.028779	0.043771
SIGMASQ	0.002357	0.002053	1.148127	0.2521
R-squared	0.087579	Mean dependent var		0.015108
Adjusted R-squared	0.075931	S.D. dependent var		0.050935
S.E. of regression	0.048963	Akaike info criterion		-3.165679
Sum squared resid	0.563379	Schwarz criterion		-3.107496
Log-likelihood	382.2987	Hannan-Quinn criter.		-3.142233
F-statistic	7.518812	Durbin-Watson stat		2.096848
Prob(F-statistic)	0.000080			
Inverted AR Roots	.83			
Inverted MA Roots	0.92			

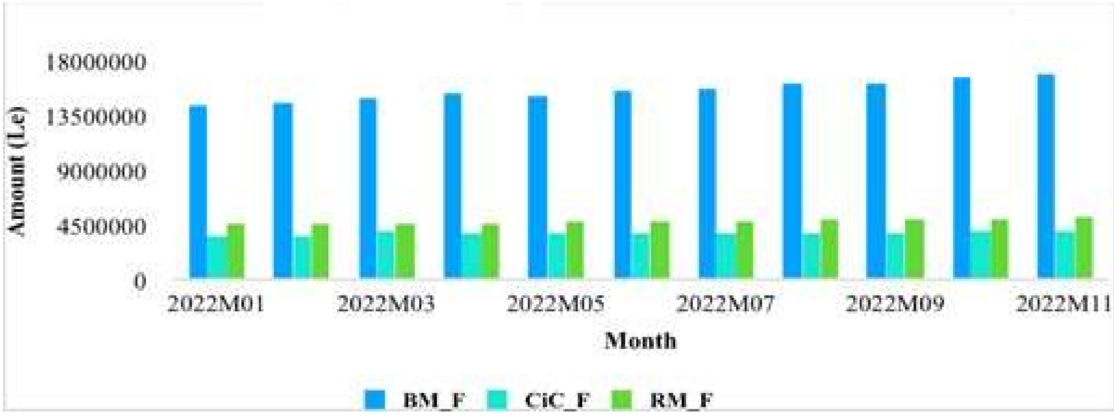
Source: EVIEWS Output

As we know from theory, failure to stabilise Monetary Aggregates in the system, with difficulty in curtailing CiC to a low level can also catalyse inflationary risk in the domestic economy. Consistent with the BSL mandates, and in particular identifying an operational target of building a good Reserve Money buffer, can also add pressure to financial instability, which in itself could instigate inflationary pressure.

For this study, the best ARIMA model as depicted in Table 1 has produced an out-of-sample projection (2022M1-2022M12) for all of the Monetary Aggregates (Reserve Money, Broad Money, and Currency-in-Circulation). Please note that there are several models, but the automated system provided us with the three best models, Model 1 as shown in Table 1 above is considered the best based on the properties (RMSE, Durbin-Watson, AR/MA Root Values) that are provided Appendix 1. This is the best model outcome when compared to the Models 1 and 2 as shown in Appendix 1, which also have the lowest Durbin Watson (indicating the absence of autocorrelation) and Root Mean Square Error (RSME) value – this, therefore, indicates that it is well fit to be chosen as the model for the forecast outcome.

Figure 2 below shows the actual position of all projected MA components. Broad Money (BM) is projected to be the highest, which is normal as it encompasses all of the components that make up the indicators of MA in an economy. Reserve Money (RM) typically considered the operational target for the BSL is also projected to rise during the cause of the year, which is well in place to surpass Currency-in-Circulation (CiC). Consistent with the BSL's mandate of maintaining single-digit inflation, a low projection will allow the financial system to be effectively balanced assuming other conditions are held constant.

Figure 2. Graph Showing Monetary Aggregates Projection



Source: EVIEWS Estimation Output

Conclusion and Recommendations

In conclusion, this study has brought to the fore, the importance of applying the STIF / univariate ARIMA model to project disaggregated components of Monetary Aggregates as applied to Sierra Leone. This is an innovative approach, which can also be combined with other econometric models to anchor effective monetary policy decision-making, aimed at achieving a single-digit inflation target. The use of an ARIMA model has made it possible for policymakers to become proactive in their approach to monitoring risks to the financial system, while at the same time preventing anything that may instigate inflationary pressures. Given the independent role of the central bank in providing policy advice to the government, the outcome of this research has paved the way to ensure effective advice is provided to capacitate the real sector, which will motivate high scope for generating revenue from PAYE and other forms of tax revenues - typically linked with the notion of reducing government borrowing normally channelled through the money market or Treasury Bills auction l.

The advantage of this study and particularly the methodology of ARIMA is its predictive power of evoking salient means of inspiring the central bank authority to continuously monitor price and financial stability. With the planned launch of the National Switch and the redenomination exercise, it is possible that the authority could be inclined to introduce financial innovation approaches (notably FinTech and electronic payment systems) to reduce people's perpetual habit of carrying huge sums of money around. In a nutshell, people also can divert their attention towards the high usage of automated/electronic means of settling payments. Future studies of this nature could benefit from extensive use of a combination of macroeconomic variables to effectively influence the monetary policy approach in monitoring the dynamics of monetary aggregates needed to effectively address the BSL's core objectives.

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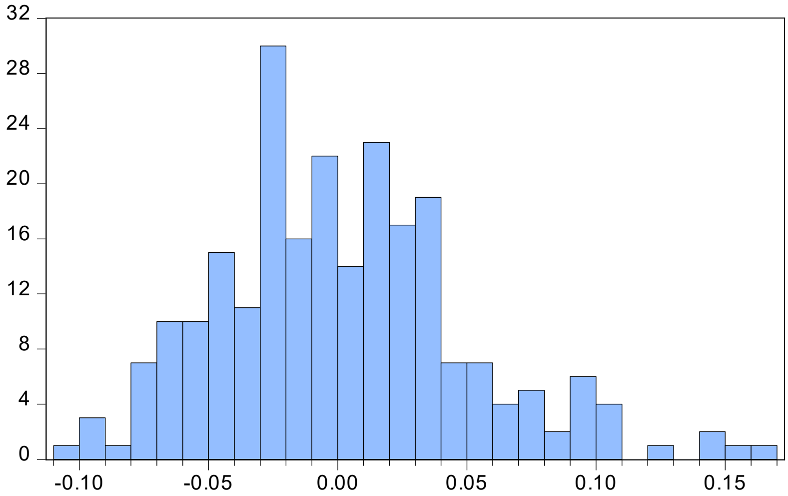
APPENDICES

Appendix 1. Best Model Outlook

Component	Best Model	Durbin-Watson	MAE	RMSE	Stability Condition
Monetary Aggregate Model	Model 1	2.15	5.64	13.76	AR<1 MA>1
	Model 2	2.13	5.21	11.05	AR<1 MA>1
	Model 3	2.09	5.22	11.23	AR<1 MA<1

Source: EVIEWS Output

Appendix 2: Statistical Analysis of Output



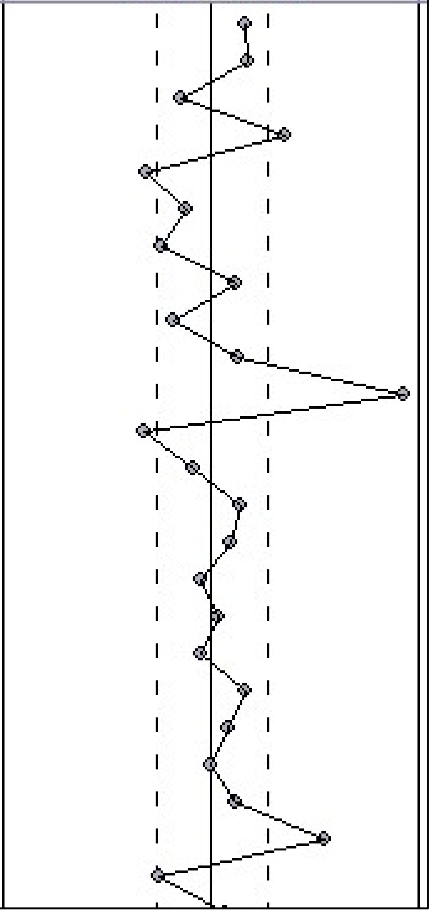
Series: Residuals
Sample 2002M02 2021M12
Observations 239

Mean	0.001452
Median	-0.003280
Maximum	0.169601
Minimum	-0.101928
Std. Dev.	0.048632
Skewness	0.643867
Kurtosis	3.642134
Jarque-Bera	20.61969
Probability	0.000033

Source: EVIEWS Output

Appendix 3. Correlogram of Residuals

obs	Actual	Fitted	Residual	Residual Plot
2002M02	0.04689	0.01606	0.03083	
2002M03	0.04457	0.01317	0.03140	
2002M04	-0.01908	0.00819	-0.02728	
2002M05	0.08045	0.01537	0.06508	
2002M06	-0.05441	0.00426	-0.05867	
2002M07	-0.00924	0.01358	-0.02282	
2002M08	-0.02897	0.01568	-0.04465	
2002M09	0.04266	0.02251	0.02015	
2002M10	-0.01656	0.01730	-0.03386	
2002M11	0.04504	0.02240	0.02264	
2002M12	0.19137	0.02177	0.16960	
2003M01	-0.06677	-0.00625	-0.06052	
2003M02	-0.00948	0.00615	-0.01563	
2003M03	0.03514	0.01051	0.02463	
2003M04	0.02414	0.00779	0.01635	
2003M05	-0.00431	0.00626	-0.01057	
2003M06	0.01556	0.00946	0.00610	
2003M07	-0.00023	0.00924	-0.00946	
2003M08	0.04228	0.01217	0.03011	
2003M09	0.02304	0.00814	0.01490	
2003M10	0.00576	0.00691	-0.00116	
2003M11	0.03113	0.00878	0.02235	
2003M12	0.10869	0.00781	0.10088	
2004M01	-0.05401	-0.00766	-0.04635	



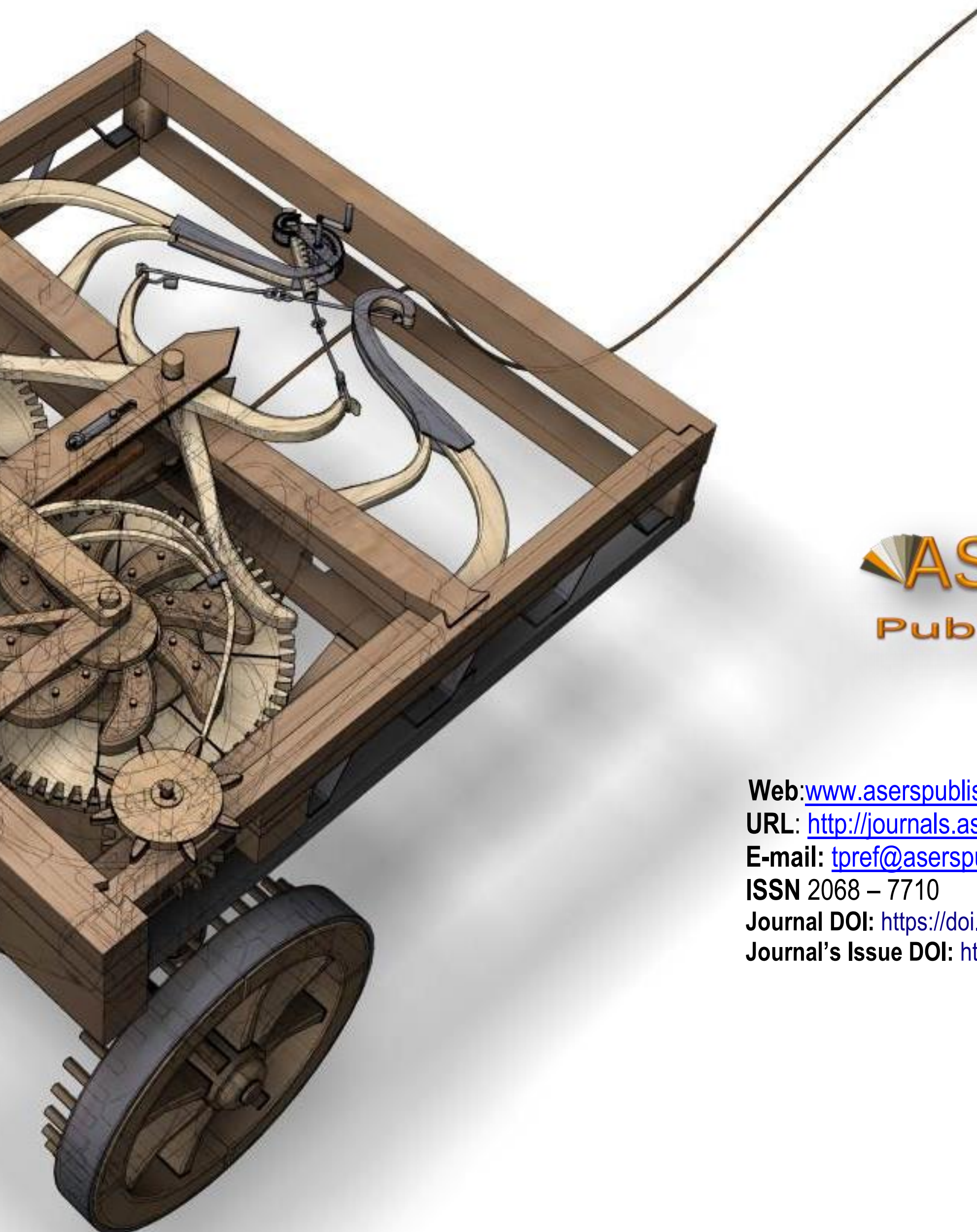
Source: EVIEWS Output

APPENDIX 4

```
'Eviews Version 10 code: ARMA selection

'Code for selecting optimal lag lengths for ARMA models

smpl @all 'Set sample period
scalar n1=@obs(rm) 'Number of observations of RM data
scalar components = 3 'Number of RM components, including aggregate index
scalar maxar = 11
scalar maxma = 11

'Rename series
series rm_1 = bm
series rm_2 = cic
series rm_3 = rm

'Seasonally adjust data
for !i = 1 to components
rm_!i.x12(mode=m) rm_!i
next

'For each component produce ARMA(a,m) with varying orders
for !i = 1 to components
   for !a = 1 to maxar '12
      for !m = 1 to maxma '12

      smpl 2002m1 2022m1+n1-1
      equation arma_!i_!a_!m.ls d(rm_!i_sa) c ar(1 to !a) ma(1 to !m)

      next
   next
next

'Identify the ARMA for each component with the optimal AR and MA orders according to the Akaike
Information Criterion.  Change to @schwarz or @hq for Schwarz and Hannan-Quinn criteria.
for !i = 1 to components
!mininfocrit = 9999
   for !a = 1 to  maxar '12
      for !m = 1 to maxma '12

      if arma_!i_!a_!m.@aic<!mininfocrit then
      !besta = !a
      !bestm = !m
      !mininfocrit = arma_!i_!a_!m.@aic
      endif
      next
   next

'Save the equation with the best order structure
smpl 2002m1 2022m1+n1-1
equation arma_best_!i.ls d(rm_!i) c ar(1 to !besta) ma(1 to !bestm)

smpl 2002m1+n1 2022
arma_best_!i.forecast rm_forecast_!i
```

```
next

'Show best ARMA models for selected components
for !i = 3 to 3
show arma_best_!i
next

show exp(rm_forecast_3)/exp(rm_forecast_3(-12))*100-100
show exp(cic_forecast_2)/exp(cic_forecast_2(-12))*100-100
show exp(bm_forecast_1)/exp(bm_forecast_1(-12))*100-100
'
```

ASERS



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