Demand for Money in Sri Lanka: ARDL Approach to Co-integration

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Abstract—This paper investigates the long run money demand function for Sri Lanka using error correction version of autoregressive distributed lag (ARDL) approach while giving special attention to the effect of international financial crisis on money demand. Findings of the paper emphasized that M1 money demand in Sri Lanka is highly co-integrated with the real income; real exchange rate and short term domestic and foreign interest rates. It is also found that short-run causality (in Granger sense) runs from both foreign interest rate and financial crisis variable to M1, emphasizing that both variables have a significant impact on money demand in Sri Lanka in the short-run. However, financial crisis did not show significance in the long-run as was expected. To the end, the overall test results show that Sri Lanka was able to maintain a stable money demand function despite the economic uncertainty arises due to international financial crisis.

Keywords—Autoregressive Distributed Lag (ARDL) Model, Co-integration, Causality, Demand for Money, Error Correction Method (ECM)

I. INTRODUCTION

The importance of money demand has become a prominent research topic in economics in recent years due to its role in monetary policy formulation. There can be seen a wide array of literature on the demand for money, however, the focus of them is varied in accordance with time span, choice of variables and motives of money demand. The majority has emphasized that wealth and permanent income affect for money demand [1]-[5]. Contrary to the view, [6] has argued that current income affects for money demand rather than permanent income, as people demand money mostly for transaction purpose. However, in addition to those fundamental determinants, new findings on the determinants of money demand have appeared in recent literature. According to them, real exchange, exchange rate fluctuations, inflation and interest rate spread are also can have a considerable impact on the demand for money [7]-[17].

Regional wise studies which cover especially the South Asian region, have emphasized that real per capita income, interest rate, foreign interest rate and financial innovations are the most influential determinants of money demand than real exchange rate [16], [17]-[20].

Studies on money demand relating to Sri Lanka however are limited in number [21]-[23]. As mentioned in their studies, real income, nominal interest rate, short-term foreign interest rate and real effective exchange rate are the major determinants of money demand in Sri Lanka.

As a whole, the literature provides useful information about determinants of long-run money demand function and their interrelationships. However, due to country specific characteristics and time difference, the money demand and its determinants could be altered and therefore it is difficult to draw a general conclusion on it.

The objective of the present paper is twofold. First, it is set to investigate the determinants of long-run money demand function in Sri Lanka during the post liberalization period while examining the influence of current global financial crisis on it. Second, it examined whether Sri Lankan financial institutions would be able to maintain a stable money demand relationship during financial crisis.

Considering Sri Lanka, it has started implementing of financial liberalization policies in 1977 as a part of economy wide policy reform process. After 1977, together with the emergence of external links, Sri Lanka had been able to develop market economic condition within the country and engage in international market transactions. However, in comparison to the other Asian counterparts, financial markets in Sri Lanka; especially money and foreign exchange markets have somewhat lagged behind. The liquidity shortage and lack of financial depth in financial institutions are central to this problem [24]. Due to this condition, still the bulk of money market transactions are based on overnight basis and market is mainly driven by trade related flows. On the other hand, due to the presence of capital control and heavy government intervention, Sri Lanka could not gain full financial market benefits from the liberalization. At present, both M1 and M2 aggregates in Sri Lanka are 432.7 and 2192.6 billion rupees respectively [25]. Money supply is still at 35.06, as a percentage of GDP [25]. Moreover, the open economic environment sometimes make Sri Lanka vulnerable for external shocks including trade shocks and international financial and currency crises. So far, Sri Lanka has
experienced two financial crises i.e. Asian financial crisis and the current global financial crisis. It seems that monetary authority in Sri Lanka is therefore handling policy instruments carefully.

In this setting, it is noteworthy to investigate the behavior of money demand in Sri Lanka considering its importance in monetary policy decision making.

To achieve the above mentioned objectives, this paper utilized both co-integration and causality tests. To test the co-integration, the autoregressive distributed lag (ARDL) approach of [26] is employed and the error correction version of the same model is used to investigate the short-run dynamics of the money demand function in Sri Lanka. In addition, the study tested the existence of causality among variables using Granger causality test. Hence, this study is somewhat different from previous studies relating to Sri Lanka [21], [22].

The paper is organized as follows. Section II is used to describe the model specification of the empirical analysis and the section III describe the theoretical and empirical framework of ARDL approach of co-integration. Section IV explains data and the sources of data. Section V reports results of the empirical test and the section VI gives possible conclusions based on the findings of the study.

II. MODEL SPECIFICATION

The money demand function for Sri Lanka is specified in a partial log form and it can be illustrated as follows.

\[ \ln M_1 = a + bR + c \ln Y + dFI + x \ln RER + gD_1 + \varepsilon \] \tag{1}

Where, M1 is real money stock, IR is one year fixed deposit rate which is used as opportunity cost Variable, Y is real GDP which represent the scale variable, FI is US commercial paper rate and RER is real exchange rate. D1 is a dummy variable for financial crisis. In the dummy variable D1 = 1 represents the presence of financial crisis and D1 = 0 represents period without financial crisis. The term \( \varepsilon \) represents the error term.

To calculate the Real exchange rate, (2) is used following the related literature [19], [20]. It can be illustrated as follows.

\[ RER = \frac{P^f}{P^d} \] \tag{2}

Where, RER represent the real exchange rate and \( e \) represent the nominal exchange rate. \( P^f \) and \( P^d \) represent foreign prices (US Dollar used in this study as it is the main currency use for trade) and domestic prices respectively. It should be noted here that this study used the official exchange rate (SL rupee per US dollars) in Sri Lanka as a nominal exchange rate. However, some studies utilized multilateral real exchange rate index to represent the real exchange rate [17]-[21]. On the other hand, nominal exchange rate is also used for the estimation of money demand function in some other studies [17].

III. ARDL APPROACH

The above illustrated model (1) is estimated using ARDL approach of [26]. The significance of using this approach is, it can be used disregarding whether the underline variables are purely \( I(0) \), \( I(1) \) or mutually co-integrated. On the other hand, it suggests that once the order of ARDL has been recognized, the model can be tested by using the OLS (ordinary least square) technique. The basic theory of ARDL approach can be illustrated as follows:

\[ \Delta z = \mu + \alpha t + \beta \Delta z_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta m_{t-i} + \sum_{i=1}^{p} \delta_i \Delta X_{t-i} + \epsilon \] \tag{3}

Where, \( z \) is the vector of both \( x \) and \( m \). \( m \) is the dependent variable. According to this study, it is M1 money stock. \( x \) represents the vector matrix of a set of explanatory variables i.e., real GDP, short term domestic and foreign interest rate, real exchange rate and dummy variable which represents financial crisis. \( t \) is a time or trend variable. According to [26], \( m \) (dependent variable) must be \( I(1) \) variable, but the \( x \) (independent) can be either \( I(0) \) or \( I(1) \).

Based on the above theory, the study incorporated the short-run adjustment mechanism in estimating the long-run money demand function for Sri Lanka. It can be presented as follows.

\[ \Delta \ln M_1 = a + \sum_{i=1}^{p} \beta_i \Delta \ln M_{1-i} + \sum_{i=1}^{p} \gamma_i \Delta R_{1-i} + \sum_{i=1}^{p} \delta_i \Delta Y_{1-i} + \sum_{i=1}^{p} \mu_i \Delta F_{1-i} + \sum_{i=1}^{p} \omega_i \Delta RER_{1-i} + \sum_{i=1}^{q} \tau_i \Delta D_{1-i} + \varepsilon \] \tag{4}

In the above model, the short-run effect can be measured by the coefficient of first difference variables (\( \beta, \delta, \gamma, \phi, \mu, \omega \)) while the long-run effect can be inferred by the estimates of \( \rho_1 to \rho_5 \) which are normalized on \( \rho_0 \). Then the null hypothesis \( H_0 \) which says that no co-integrated relationships among variable is tested against the alternative hypothesis \( H_1 \) which emphasized that co-integration relationship exist among variables in the model.

\( H_0 : \rho_1 = \rho_2 = \rho_3 = \rho_4 = \rho_5 = 0 \)

\( H_1 : \rho_1 \neq 0, \rho_2 \neq 0, \rho_3 \neq 0, \rho_4 \neq 0, \rho_5 \neq 0 \)

It is expected that the coefficient of \( Y \) is positive while IR negative if it is consistent with the theories of money demand.
Coefficient of other variables could be positive or negative depending on the situation.

To measure the speed of adjustment with short-run dynamics, the model can be rewritten including the error correction term (\(ECT_{t-1}\)). It can be illustrated as follows.

\[
\Delta \ln M_{1, t} = \alpha + \sum_{i=1}^{4} \beta_i \Delta \ln M_{1, t-i} + \sum_{i=0}^{3} \delta_i \Delta R_{E, t-i} + \sum_{i=0}^{3} \gamma_i \Delta \ln Y_{t-i}
+ \sum_{i=0}^{4} \phi_i \Delta F_{I, t-i} + \sum_{i=0}^{4} \mu_i \Delta \ln RER_{t-i} + \sum_{i=0}^{4} \omega_i D_{1, i} + ECT_{t-1} + \epsilon_t \ldots \ldots (5)
\]

IV. DATA

Annual data from 1978 to 2010 was utilized here for the estimation incorporating the period of financial liberalization. The conversion of nominal variables into real variables is made using both GDP deflator (2002 = 100) and consumer price index (CPI- 1952 = 100 and 2002 = 100) for Sri Lanka and US CPI (1995 = 100) was used for the US data. All data were obtained from International Financial Statistic Yearbooks, World development indicators (online database) and some annual reports of the Central Bank of Sri Lanka in various years since 1978.

V. RESULTS

Before testing the above two models, unit root tests were conducted to check the presence of unit root in variables. The results of the unit root test are presented in Table I.

<table>
<thead>
<tr>
<th>M1</th>
<th>Level</th>
<th>ADF</th>
<th>PP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>-2.349109</td>
<td>-5.311202***</td>
<td>-0.027306</td>
</tr>
<tr>
<td>IR</td>
<td>-2.086499</td>
<td>-3.859975*</td>
<td>-1.500795</td>
</tr>
<tr>
<td>Y</td>
<td>1.239985</td>
<td>-3.439853*</td>
<td>1.089891</td>
</tr>
<tr>
<td>FI</td>
<td>-0.984111</td>
<td>-6.143069***</td>
<td>-2.153623</td>
</tr>
<tr>
<td>RER</td>
<td>-0.417383</td>
<td>-6.900791***</td>
<td>-2.320804</td>
</tr>
<tr>
<td>D1</td>
<td>-1.738118</td>
<td>-5.444021***</td>
<td>-1.933531</td>
</tr>
</tbody>
</table>

**,**,**,** indicates significant at 10%, 5% and 1% significance level respectively (ADF = -2.981038, PP = -2.963776).

(Source: author constructed based on statistical outputs)

It is shown that all variables are stationary only at their first difference. Therefore, co-integration test was carried out using (3), to check whether they have a meaningful co-integrating relationships exist in the long-run. The results of the co-integration test are shown in the Table II. It should be noted here that, the optimum lag length is taken as two for the estimation based on the lag length selection criteria and only first lag length results were reported.

The co-integration test results show the presence of co-integration among IR, Y, FI and RER can be seen in the estimated long-run money demand function for M1. Thus, they are consistent with the previous literature of [21]-[22] which has emphasized that M1 in Sri Lanka is highly co-integrated with interest rate, real GDP, real exchange rate and foreign interest rate. The significant negative coefficient of real exchange rate in this study is also consistent with the argument of [7] which emphasized that depreciation of the domestic currency increases the value of residential foreign assets and therefore increase the demand for domestic currency.

However, real GDP seems to be insignificant in the short run. Although it is contrary to the macroeconomic theories, this kind of situation could arise due to the improvement of other non cash payment system such as credit and debit cards. Recently credit card holders are increasing in Sri Lanka due to reduction in credit cards was 862340, consisting 61320 of local card holders and 801020 of global card holders at the end of December, 2011 [25]. On the other hand, introduction of Sri Lanka interbank payment system (SLIPS) also persuades people less cash demand in the short-run. This condition might be affected for negative sign for real GDP in the short-run. However, further empirical investigations are necessary in this regard.
the long-run. Two reasons can be given to confirm this finding. First, Sri Lanka did not expose much to the subprime mortgage market and therefore did not suffer much in liquidity shortage. Second, when US subprime crisis started, monetary authority of Sri Lanka tighten the policies and hence minimized its impact of financial sector. The impact of financial crisis were mainly to the export sector in Sri Lanka, hence it affected to the trade balance.

The diagnostic tests also confirm the results of the estimation. The joint significant F statistic is 9.42896 which is significant in all three cases which introduced by [26]. The F statistics (at 5% significance level) with six variable (k = 6) are 3.247, 3.646 and 4.088 in the case I, II, and III respectively. In addition, LM test shows that there is no serial correlations exist and the residuals are normally distributed. The error correction term which is replaced for the linear combination of the partial lagged differenced variables, is also obtained a significant coefficient in both sign and magnitude (-0.84) and hence it further supports co-integration showing 84% of adjustment towards the long run equilibrium. Test of parameter stability, the (CUSUM and CUSUM of Squares tests) which was introduced by [28] have shown that M1 money demand function is stable in both cases.

The income elasticity is 0.42, shows positive and smaller than unity. This is also similar to the previous findings relating to Sri Lanka [21, [22].

Beyond the test of co-integration, causality test (Granger causality test) is also carried out to find the direction of short-run causality among variables. The results of the causality test are shown in Table III.

### RESULTS OF THE SHORT RUN GRANGER CAUSALITY TEST

<table>
<thead>
<tr>
<th>Dep.V</th>
<th>ΔlnM1</th>
<th>ΔIR</th>
<th>ΔlnY</th>
<th>ΔFI</th>
<th>ΔlnRER</th>
<th>ΔD1</th>
</tr>
</thead>
<tbody>
<tr>
<td>lnM1</td>
<td>-</td>
<td>0.2072</td>
<td>0.3284</td>
<td>0.8054</td>
<td>0.824</td>
<td>0.658</td>
</tr>
<tr>
<td>ΔIR</td>
<td>1.9694</td>
<td>-</td>
<td>0.2124</td>
<td>2.257</td>
<td>0.6796</td>
<td>0.2184</td>
</tr>
<tr>
<td>ΔlnY</td>
<td>2.4602</td>
<td>0.2499</td>
<td>-</td>
<td>1.7584</td>
<td>0.7384</td>
<td>0.0948</td>
</tr>
<tr>
<td>ΔFI</td>
<td>11.063</td>
<td>0.701</td>
<td>0.0740</td>
<td>-</td>
<td>2.6344</td>
<td>1.3888</td>
</tr>
<tr>
<td>ΔlnRER</td>
<td>1.8167</td>
<td>2.6878</td>
<td>0.0338</td>
<td>0.124</td>
<td>-</td>
<td>0.1042</td>
</tr>
<tr>
<td>ΔD1</td>
<td>2.889*</td>
<td>0.6169</td>
<td>0.5536</td>
<td>0.1272</td>
<td>0.0989</td>
<td>-</td>
</tr>
</tbody>
</table>

* ** *** shows 10%, 5% and 1% level of significance respectively.
* All values are given in F statistics in the table.
* The value of F statistics (k = 6) are, 3.247 (case I), 3.646 (case II), 4.088 (case III) at 5% level of significance.
* Top horizontal raw shows dependent variables.

(Caption: Author constructed based on statistical output)

Causality test results indicate that short-run causality is running from both FI and D1 to M1 demand for money. This implies that, foreign interest rate and financial crisis have impact to domestic money demand function in Sri Lanka in the short-run. Other than that, no specific causality link has shown in the estimated results. Also the sign of reverse causation could not be found between variables in the model.

### VI. CONCLUSION

The prime objective of this paper was to examine the long-run money demand function in Sri Lanka while emphasizing the influence current international financial crisis on it. In this regards, time series data starting from 1978 to 2010 were utilized incorporating the period of financial liberalization in Sri Lanka. The autoregressive distributed lag (ARDL) approach is employed as the main estimation technique to test the presence of co-integration among variables which are assumed to be the determinants of money demand in Sri Lanka.

In addition, Granger causality test also used to find the causality links among variables.

The findings are consistency with previous findings related to Sri Lanka and also they are consistency with macroeconomic theories. First, M1 money demand is co-integrated with real GDP, real exchange rate, and short term domestic and foreign interest rates. Therefore, these variables can be taken as determinants of M1 money demand in Sri Lanka. Second, it shows that both short term foreign interest rate and financial crisis have causal links with M1 in the short-run. Therefore, these two variables can be taken as good predictors of short-run money demand.

Since the paper gave a special attention to the global financial crisis, the results of the estimation confirm that financial crisis can have an influence on money demand in Sri Lanka in the short-run. This condition could be more important for monetary policy makers to control the supply of money during a financial crisis to avoid systemic banking crises and the volatility in the money market.

In addition, all three variables i.e. real exchange rate, foreign interest rate and financial crisis variables provide a clue for monetary authority and the government that external factors should be taken into account when formulating future monetary policies in the country.

APPENDIX I

![CUSUM test for M1](image-url)
Fig. 2 CUSUM of Square test for M1

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REFERENCE