Demand for Money in Pakistan: an ARDL Approach

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Abstract-The paper estimates the demand for money in Pakistan using Autoregressive Distributed Lag (ARDL) approach to cointegration analysis. The empirical results show that there is a unique cointegrated long-run relationship among M2 monetary aggregate, income, inflation and exchange rate. The income elasticity and inflation coefficients are positive while the exchange rate elasticity is negative. Our results also, after incorporating the CUSUM and CUSUMSQ tests, reveal that the M2 money demand function is stable between 1973 and 2007.

Keywords-Money Demand, ARDL, Stability

Classification: E4, E41

I. INTRODUCTION

Empirically, demand for money estimations are used by monetary authorities as a main apparatus in designing policies to influence real and monetary balances of the economy. Since 1980’s search for the determinants of monetary aggregates such as real GDP, foreign exchange rates and inflation gained importance in the literature. According to Friedman (1956), money demand function assumes that there are a stationary long-run equilibrium relationship between real money balances, real income, and the opportunity cost of holding real balances. The common understanding from the literature is that most of the studies on the demand for money function and its stability using autoregressive distributed lag (ARDL) approach have been paying attention on the advanced and industrialized countries. Not many studies using ARDL cointegration technique for money demand functions have been reported in Asian countries. In Pakistan, considerable effort has been made in estimating money demand functions, see for instance, Akhtar (1974), Mangla (1979), Khan (1980, 1982), Nisar and Aslam (1983), Ahmed and Khan (1990), Hossain (1994), Khan and Ali (1997), Qayyum (1998, 2005) and Zakir (2006). These studies have estimated money demand functions using different cointegration techniques. Some of these studies such as Ahmed and Khan (1990) and Qayyum (2005) have also examined the stability of their estimated money demand functions. In most of the studies the M2 is found to be stable money demand function. However, most of these studies have ignored the time series properties of the relevant variables and therefore may be prone to spurious regression. Further, not a single study has used the Autoregressive distributed lag (ARDL) approach to estimate the money demand function in Pakistan. Present study fills this gap to some extent as it estimates the money demand function and checks its stability in Pakistan using ARDL approach. The rest of the paper is organized as follows. Section 2 shows literature review, section 3 presents the theoretical model. Section 4 provides the estimates of the model along with its interpretation. Final section concludes the paper.

II. LITERATURE REVIEW

Qayyum (2005), estimated the dynamic demand for money (M2) function in Pakistan by employing cointegration analysis and error correction mechanism. The parameters of preferred model were found to be super-exogenous for the relevant class of interventions. It was also found that the rate of inflation is significant determinant of money demand in Pakistan. The analysis reveals that the rates of interest, market rate, and bond yield are important for the long-run money demand performance. Ghatak (2001), applied the autoregressive distributed lag (ARDL) approach to cointegration analysis in estimating the virtual exchange rate (VER) for India. The VER would have prevailed if the unconstrained import demand was equal to the constraint imposed due to foreign exchange rationing and the VER is used to approximate the ‘price’ of rationed foreign exchange reserves. Rao (2009), estimated the demand for money (M1) for 11 Asian countries from 1970 to 2007. This method has advantages of which the most important one is its ability to minimize small sample bias with persistence in the variables. Results show that there is a well defined demand for money for these countries and there are no structural breaks. Renani (2007), estimated the demand for money in Iran using the autoregressive distributed lag (ARDL) approach to cointegration analysis. The empirical results showed that there is a unique cointegrated and stable long-run relationship among M1 monetary aggregate, income, inflation and exchange rate. Study also found that the income elasticity and exchange rate coefficient are positive while the inflation elasticity is negative. After incorporating the CUSUM and CUSUMSQ tests results reveal that the M1 money demand function is stable between 1985 and 2006. Qayyum (1998), concluded that in the long run money demand depends on income, rate of inflation and bond rate. The rate of inflation and rate of interest on deposits emerged as important determinant of money demand in the short run. Moreover dynamic model remains stable through out the study period. Thornton (1996), used cointegration, error correction and the demand for money in Mexico and estimated of the long-run demand for narrow and broad definitions of the Mexican money supply over the period 1980Q1–1994Q1 suggested that a single cointegrating

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relationship exists for real money balances (M1 and M2), a scale variable (real GDP), and the 91-day treasury bill rate. The result from short-run dynamic equations favor M2 as the monetary aggregate to target and suggest that real GDP rather than real private consumption is a more appropriate scale variable in the demand for money function for Mexico. Hwang (2002), showed that there exists a long-run equilibrium relationship between M2 and its determinants, real income and the long-term interest rate, in Korea by using Johansen and Juselius maximum likelihood cointegration method. However, M1 does not have any meaningful cointegration relationships with its determinants. The long-term interest rate is a better proxy than the short-term rate to measure the opportunity cost of holding money. Based on the results, a broad definition of money is a better measure than a narrow definition of money in considering the long-run economic impacts of changes in monetary policy in Korea.

III. METHODOLOGY

This section models the linkages between money demand and its determinants using regression analysis. Here the hypothesis is that there is long run cointegration relationship between monetary aggregates and its determinants. In order to be consistent with previous studies, we use a conventional money demand function. In what follows we estimated the following model:

\[ \ln M_t = \beta_1 + \beta_2 \ln Y_t + \beta_3 \ln \text{INF}_t + \beta_4 \text{ER}_t + \nu_t \]

where \( M_t \) is money demand (M1 or M2), \( Y_t \) is real income, \( \text{INF}_t \) is inflation rate and \( \text{ER}_t \) is exchange rate. While \( \nu_t \) is the stochastic disturbance term such that \( \nu_t \sim N(0, \sigma^2) \). From the literature on transaction demand for money the sign of \( \beta_2 \) is expected to be positive. The sign of \( \beta_3 \) could be positive or negative. It is positive because when there is increase in inflation real value of money will decrease so people will need more money in hand to fulfill their needs. The sign of \( \beta_3 \) is negative if people decrease demand for money due to high inflation. Finally, the sign of \( \beta_4 \) may be positive or negative. Arango and Nadiri (1981) argue that the decrease in exchange rate or the depreciation of domestic currency (or appreciation of foreign currency) will increase the value of foreign assets or securities held by the domestic residents. If the residents perceived that there is increase in their wealth after depreciation of domestic currency they will increase their demand for domestic currency. In this case \( \beta_4 \) turns out to be positive. In turn, Bahmani-Oskooee and Pourheydarian (1990) argue that when a currency depreciates, there could be expectation for further depreciation. This could instigate public to increase the holdings of foreign currency by drawing down to the domestic holdings. In this case \( \beta_4 \) turns out to be negative. To find long run cointegration among the variables it is necessary to check the stationarity properties of the variables. To hold cointegration all variables should be of the same order of integration. If all variables are not of same order of integration then we have to rely on Autoregressive Distributed Lag (ARDL) approach of Pesaran and Shin (1995), which was further elaborate by Pesaren et al. (2001). This method has also the advantage that it does not require unit root pre-testing. This approach is suitable for our money demand model because we have stationary variables like inflation along with non stationary variable like money demand (M1 or M2). The error correction version of the ARDL model of equation 1 is as follows. From equation (2) we can check long run cointegration among the variables of money demand model. In this case the null hypothesis (H0) is defined as \( \alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = 0 \) against the alternative hypothesis (H1) that at least one of \( \alpha \) is not equal to zero, by means of F-test. Pesaran et al. (2001) have tabulated two sets of appropriate critical values. One set is calculated when all variables are integrated of order one and another set of appropriate critical values when the variables are integrated of order zero. So these two sets of critical values cover all the possible classification of variables either they are integrated of order zero or one or even fractionally integrated. If the calculated value of F-statistics lies above the upper level of the band then the null hypothesis is rejected. It shows that there is cointegration. If the value of F-statistics lies below the lower level of the band then the null hypothesis cannot be rejected, which indicate that there is lack of cointegration. If the value of F-statistics falls within the band the results are inconclusive.

IV. MODEL ESTIMATION

The paper uses annual time series data for the period 1973 to 2007 to check long run cointegration among the variables of money demand model. Following Schwarz criterion lag length 1 is found to be optimal. Thus, we impose 1 lag on each first differenced variable in equation 2. The results of the F-test for cointegration are reported in Table 1. For M1 equation the calculated F-statistics (3.07) is less then upper critical value (4.35) therefore null hypothesis of no cointegration is accepted at 5 per cent level. It indicates the absence of cointegration among the variables of M1 money demand model. In turn, for M2 the calculated F statistics (5.93) is greater then upper critical value (4.35) therefore null hypothesis of no cointegration is rejected at 5 per cent level. It shows existence of long run cointegration among M2, income, inflation rate and exchange rate. Although the results do not show long run cointegration among the

We have applied ADF unit root test to check stationarity of the variables. The results show that some variables are stationary at levels and some are stationary at first differences. The results of ADF test are not reported here to conserve space. However, they are available from authors on request.
variables of M1 money demand function, for comparison purpose the results for both M1 and M2 will be provided in the subsequent sections.

\[
\Delta \ln M_t = \beta_1 + \sum_{i=1}^{n} \beta_{2i} \Delta \ln M_{t-1} + \sum_{i=1}^{n} \beta_{3i} \Delta \ln Y_{t-1} + \sum_{i=1}^{n} \beta_{4i} \Delta \ln INF_{t-1} + \sum_{i=1}^{n} \beta_{5i} \Delta \ln ER_{t-1} + \alpha_1 \ln M_{t-1} + \alpha_2 \ln Y_{t-1} + \alpha_3 \ln INF_{t-1} + \alpha_4 \ln ER_{t-1} + \nu_t
\]  

(2)

### Table 1: F-Statistic for Testing the Existence of Long-run Cointegration: (1971 – 2007)

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Order of Lag</th>
<th>F-statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>1</td>
<td>F (3, 24) = 3.074</td>
</tr>
<tr>
<td>M2</td>
<td>1</td>
<td>F (3, 24) = 5.931*</td>
</tr>
</tbody>
</table>

Notes: The relevant critical value bounds are given in Table CI (iii) (with an unrestricted intercept and no trend) in Pesaran et al. (2001). With four regressors the critical value bounds are 3.23 – 4.35 at the 5% significance level.
* denotes that F-statistic falls above the 5% upper bound.

Having established long run cointegration among the variables of M2 money demand function the results of the long-run coefficients of equation 1 are reported in Table 2. According to this table the income elasticity is 1.13 which is highly significant as reflected by a t-statistic of 8.98. The inflation rate elasticity is positive (0.513) and significantly supports our theoretical expectations. The coefficient of exchange rate is negative. It shows that depreciation of domestic currency decreases the demand for domestic currency, thereby supporting the view that domestic currency is expected to depreciate further, the argument provided in the previous section. To remove autocorrelation from the model MA (1) process is applied. The value of Durbin Watson (DW) is closed to desired value of 2, which indicates the absence of autocorrelation problem. High values of R square and adjusted R square indicate that the model fits the data well. The table also reports the results for M1 monetary aggregates. The results show that M1 is equally important monetary aggregate as M2 in terms of formulating monetary policy.

### Table 2: Long-Run Coefficient Estimates and Diagnostics

<table>
<thead>
<tr>
<th>Dependent Variables</th>
<th>M2 Aggregates</th>
<th>M1 Aggregates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-2.228</td>
<td>-5.005</td>
</tr>
<tr>
<td></td>
<td>(-2.315)*</td>
<td>(-4.667)*</td>
</tr>
<tr>
<td>Income</td>
<td>1.131</td>
<td>1.521</td>
</tr>
<tr>
<td></td>
<td>(8.989)*</td>
<td>(10.937)*</td>
</tr>
<tr>
<td>Inflation</td>
<td>0.513</td>
<td>0.610</td>
</tr>
<tr>
<td></td>
<td>(1.684)**</td>
<td>(1.339)</td>
</tr>
<tr>
<td>Exchange Rate</td>
<td>-0.008</td>
<td>-0.525</td>
</tr>
<tr>
<td></td>
<td>(-0.083)</td>
<td>(-4.817)*</td>
</tr>
<tr>
<td>MA(1)</td>
<td>0.982</td>
<td>0.519</td>
</tr>
<tr>
<td></td>
<td>(57.503)*</td>
<td>(3.031)*</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.993</td>
<td>0.983</td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>0.992</td>
<td>0.981</td>
</tr>
<tr>
<td>Durbin-Watson stat</td>
<td>1.936</td>
<td>1.904</td>
</tr>
<tr>
<td>No. of Observations</td>
<td>35</td>
<td>35</td>
</tr>
</tbody>
</table>

Note: Values in parentheses denote underlying student-t values. The t statistics significant at 5% and 10% levels of significance are indicated by * and ** respectively.
Since the existence of a stable and predictable relationship between the demand for money and its determinants is considered a necessary condition for the formulation of monetary policy strategies based on intermediate monetary targeting, the stability of the long-run coefficients is checked. As pointed by Laidler (1993) and noted by Bahmani-Oskooee (2001), some of the problems of instability could stem from inadequate modeling of the short-run dynamics characterizing departures from the long-run relationship. Hence, it is expedient to incorporate the short run dynamics for constancy of long run parameters. In view of this we apply the CUSUM and CUSUMSQ tests proposed by Brown et al. (1975). The CUSUM test is based on the cumulative sum of recursive residuals based on the first set of \( n \) observations. It is updated recursively and is plotted against the break points. If the plot of CUSUM statistic stays within 5% significance level\(^2\), then estimated coefficients are said to be stable. Similar procedure is used to carry out the CUSUMSQ test that is based on the squared recursive residuals. A graphical presentation of these two tests is provided in Figures 1 to 4.

\(^2\) That is portrayed by two straight lines whose equations are given in Brown et al. (1975, Section 2.3).

V. CONCLUSIONS

In this paper, money demand function has been estimated in Pakistan using ARDL approach to cointegration analysis using time series data for the period 1973 to 2007. The results show that income and inflation variables are positively associated with money demand while exchange rate negatively affects money demand. The negative effect of exchange rate on money demand supports our theoretical expectation that as domestic currency depreciates, the demand for domestic currency declines, thereby supporting...
the view that domestic currency is likely to depreciate further. Following recent trends in cointegration analysis, this paper demonstrates that cointegration does not imply stability. By incorporating CUSUM and CUSUMSQ tests into cointegration analysis, it is revealed that CUSUM statistics for monetary aggregates (for both M2 and M1) cross the critical value lines, indicating instability in money demand functions. However, the plot of CUSUMSQ statistics (for both M2 and M1) do not cross the critical value lines, therefore, we are safe to conclude that (both M2 and M1) money demand functions are stable. Thus, it is also concluded that M1 equally important monetary aggregate in terms of formulating monetary policy and central banks control as does M2 monetary aggregate.

VI. REFERENCES