THREE STAGE -LEAST SQUARE ESTIMATES OF NARROW MONEY DEMAND & MONEY SUPPLY IN PAKISTAN

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ABSTRACT: *This paper estimates the demand for money in the Pakistan within a model where the money supply function is also considered simultaneously [1]. The independent variables for the money demand function include a real income, exchange rate and measure of the interest rate. The explanatory variables for the money supply function include the output gap and the inflation gap in addition to an interest rate. The parameters estimated are avoided being biased and inconsistency as well as problem of autocorrelation. The results estimated by (3SLS) technique are more efficient as compared to (2SLS) technique. The results should be helpful for both macroeconomic researcher and policy makers.*

Keywords: Money Demand; Money Supply; 2SLS; 3SLS; Pakistan

1. INTRODUCTION

To study about the relation of money demand and its determinants is a prime issue since the stability of money demand function is helpful to make an effective monetary policy. The money demand function helps to ascertain the liquidity needs of the economy. [2] Noted that the relationship between money demand and its main determinants is very important to build macroeconomic theories, and is very crucial component to conduct monetary policy.

The money stock in an economy is determined by the interaction of forces money demand and money supply. But unfortunately, a lot of empirical work in Pakistan has been done only to pertain the separate estimations of demand and supply functions. The supply side effectiveness on money stock is ignored in these studies.

However money demand and money supply dynamics determines interest rates, which consequently impact a country's monetary policy objectives. Because of the premium placed on stable money demand, adequately estimating it makes it easier for policy makers to predict the impact of monetary policy on various macroeconomic aggregates such as inflation, output and interest rates [3] and [4].

Gross domestic product (GDP), interest rate and other macroeconomic variables are valuable indicators to estimate the money demand function. However quantity of money demand and interest rate are simultaneously obtained through the interaction of money demand and money supply. A single equation method gives unbiased and inconsistent estimates but 3 SLS technique can be a helpful to find efficient estimates. [5] in U. S. A. The purpose of this study is to estimate the money demand and money supply for Pakistan, within the context of simultaneous equation model. In section 2, we specify the model used in this study, and Section 3 presents the description of variables and data. The results and discussion presented in section 4, and conclusion stated in section 5.

2. Model Specification

According to a survey literature, [6] and [7], that the money demand is the function of Interest Rate (R), Real GDP, and Exchange Rate (EX). So the demand for real balances can be written as.

Money demand function:

$$\log(M_t^d) = \alpha_0 + \alpha_1 \log(R_t) + \alpha_2 \log(Y_t) + \alpha_3 \log(EX_t) + u_{1t} \qquad (1)$$

Where,

M^d = Real Demand for Money (M1)
R = Nominal Interest Rate
Y = Real Gross Domestic Product (GDP)
EX = Exchange Rate

In the same way the money supply function can be presented as

Money supply function:

$$\log(M_t^s) = \beta_0 + \beta_1 \log(R_t) + \beta_2 (YG_t) + \beta_3 (IG_t) + u_{2t} \qquad (2)$$

Where, M^s = Real Money Supply (M1)
R = Nominal Interest Rate
YG = Output Gap
IG = Inflation Gap

In equilibrium, we have

$$M^d = M^s \qquad (3)$$

The studies of [8] reveals that by the other things remaining same, the real money demand vary directly with real GDP and inversely to interest rate. The sign of exchange rate depends on whether the wealth affect less or greater. The money supply directly affects the interest rate, the inflation gap, and output gap should be inversely related to money supply.

3. Data & Variable Description

The data used in this study was obtained from the appendixes of International Financial Statistics (IFS) of Pakistan, and World Development Indicators (WDI). The annual data is used, which covered the period from 1961 to 2013 both inclusive, giving the total of 54 observations. The variables used in this study are real money demand (M1) and real money supply (M1), nominal interest rate, real GDP, exchange rate (PAK/USD), inflation gap and output gap.

The Narrow Money (M1) is chosen as real money demand. The real GDP is measured in pak rupees at 2005 prices. The deposit rate is chosen as interest rate. The inflation gap is the difference of actual inflation rate and target inflation rate, the target inflation is 2% per year [9]. The output gap is calculated by percent difference between real GDP and potential GDP, and the potential GDP is calculated by hodrick-prescot filter method. The exchange rate (PAK/USD) is used as the average of one year. All the variables are

expressed in logarithm form except inflation gap and output gap, both of which can be negative.

4. RESULTS & DISCUSSION

It is a strong assumption of least square method that all the independent variables should be exogenous [10]. It is proved by the Hausman test that there is simultaneity problem between interest rate and real money demand. So OLS is not applicable here, because it gives the unbiased and inconsistent results. The order and rank conditions also proved that both the equations (1) and (2) are over identified. So we will apply Two Stage-Least Square (2SLS) method to estimate the model.

Before we apply the (2SLS) method to find out the results, the Augmented Dickey-Fuller (ADF) test of unit root shows that all the variables in the model are not stationary at level but all of these were stationary at 1st difference using 1% level of significance. So it is revealed that all the variables are I (1). Now it becomes compulsory for us to check whether there is long run relationship between the variables or not, for this purpose we use Engle Granger Co-Integration test. The results showed that all the variables are co-integrated to each other at 5% level of significance.

Now equations (1) and (2) are estimated simultaneously by Two Stage-Least Square (2SLS) method, and the results of equation (1) are reported in table: 1. The results shown given below indicates that all the coefficients have expected signs, the Real GDP and Interest Rate are significant at 1% and 5% level of significance respectively, but Exchange rate is insignificant. A relatively high adjusted R^2 value indicates that three right hand side variables in money demand equation (1) may explain 98.22% variation in Real Money Demand. A one percent increase in Interest Rate, the quantity of Real Money Demand decrease by 0.2347% and conversely. If the Real GDP increase one percent, the quantity of Real Money Demand will also rise 1.166% and reverse will be true if Real GDP decline. A one percent change in Exchange Rate, the Real Money Demand inversely changes by 0.08%, but it has insignificant effect.

Table. 1: Money Demand Function, 2SLS Estimates)

Variables	Coefficients	t-stat	p-values
Constant	-4.440	-1.885	0.065
Log(Interest Rate)	-0.234	-2.12*	0.0392
Log(Real GDP)	1.166	10.6**	0.000
Log(PAK/USD)	-0.082	-0.793	0.4313
Adj (R^2)	0.9822		

Note: ** show significant at 0.01, & * denotes significant at 0.05 level

Dependent variable is log of real money demand (M1)

Table: 2 represent the results of money supply function equation (2). In the estimated money supply function adjusted R^2 = 0.97, it means 97% variation can be explained in real money supply by three right hand side variables nominal interest rate, inflation gap, and output gap. We can see from the above table that all the coefficients are significant at 1 percent level of significance, and have expected signs. The real money supply is positively associated with interest rate and negatively impacted by output gap and inflation gap. One thing is notable here that the coefficient of output gap is larger. So we can say that the real money supply is more sensitive to output gap as compared to interest rate and inflation gap.

Table: 2. Money Supply Function, 2SLS Estimates)

Variables	Coefficients	t-stat	p-values
Constant	17.010	111.652**	0.000
Log(Interest Rate)	2.8523	37.77**	0.000
Output Gap	-4.3823	-16.22**	0.000
Inflation Gap	-0.0846	-18.05**	0.000
Adj (R^2)	0.97		

Note: ** show significant at 0.01, & * denotes significant at 0.05 level, Dependent variable is log of real money supply (M1)

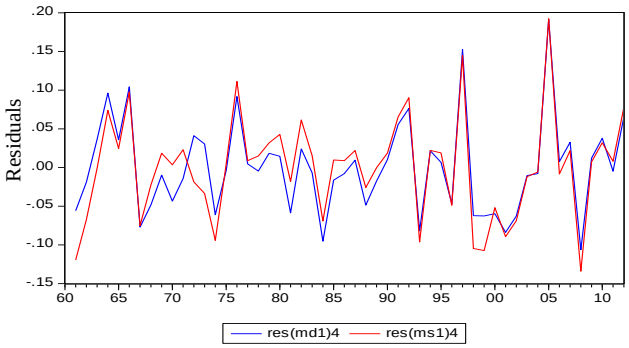

Figure: 1. (2SLS) Graph of Correlation b/w two residuals

Here figure: 1 shown above is revealing that residuals of money demand (M1) and money supply (M1) are highly correlated to each other. So we can say that, the results obtained by (2SLS) technique are unbiased, and consistent but not efficient. To make our results efficient we estimated our results by Seemingly Unrelated Regression (SUR) Model, which is also known as 3rd stage.

Now both the equations of our model money demand and money supply were estimated simultaneously using Three Stage-Least Square (3SLS) technique. The estimated results obtained of real money demand are reported in table: 3. If we examine the results 2SLS and 3SLS for money demand function, there is lot of difference between both the techniques results. Coefficients obtained from 2SLS are comparatively higher than the coefficient calculated by 3SLS method. But one thing is notable here that the variable exchange rate (PAK/USD), which was insignificant in (2SLS), estimates now it becomes significant in (3SLS), estimates. However all the coefficients have expected signs, which is not surprising for us? The real money demand is negatively affected by interest rate, but exchange rate (PAK/USD) and real GDP have positive effect on real money demand (M1). The coefficient of interest rate is -0.4064, if one percent increase in interest rate the real money demand decrease by 0.4064 percent and conversely will happened same. A one percent change in real GDP the demand for money in response will increase by 0.5067% and reverse will happened if real GDP decline. The coefficient of exchange rate (PAK/USD) is 0.5408 which is significant. Here exchange rate has positive effect on money demand, it means

a one percent increase in exchange rate the real money demand increase by 0.54%. From the table given below it is clear that interest rate, GDP, and exchange rate are highly significant even at 1% level of significance.

Table: 3. Money Demand Function, 3SLS estimates)

Variables	Coefficients	t-stat	p-values
Constant	9.791	6.1**	0.000
Log(interest rate)	-0.40	-7.3**	0.000
Log(real GDP)	0.507	6.8**	0.000
Log(PAK/USD)	0.540	7.6**	0.000
Adj R^2	0.99		

Note: ** show significant at 0.01, &* denotes significant at 0.05 level. Dependent variable is log of real money demand (M1).

99 percent change can be measured by three right-hand side variables in real money demand (M1).

Dependent variable is log of real money supply (M1)

The adjusted R^2 calculated by 2SLS is little bit low as computed from 3SLS technique. Table: 4. presents the estimates for real money supply function. These estimates were obtained by 3SLS procedure. As shown in the table, all the coefficients are significant at 1% level of significance and have expected signs. Approximately 98% variation in real money supply may be explained by three right-hand side variables. The real money supply is positively affected by interest rate, if one percent increases in interest rate the real money supply will be increased 2.92%, and if one percent decreases in interest rate the real money supply will also decrease by 2.92%. We can see here that interest rate is more sensitive with money supply as compared to money demand. The other variables inflation gap and output gap are negatively influenced by real money supply, but the output gap has greater effect on respondent variable as compared to inflation gap. The coefficient of output gap is -3.89 means the real money supply will decline 3.89% if one unit increase in output gap, and results will be reverse if one unit increase in output gap. Inflation gap also has the same effect as output gap, but inflation gap has lower effect than output gap on real money supply.

Table: 4. Money Supply Function, (3SLS Estimates)
Note: ** show significant at 0.01, & * denotes significant at 0.05 level.

Variables	Coefficients	t-stat	p-values
Constant	16.884	149.85**	0.0000
Log(interest rate)	2.9180	52.180**	0.0000
Output gap	-3.8945	-18.51**	0.0000
Inflation gap	-0.0898	-25.61**	0.0000
Adj (R^2)	0.98		

Now if we compare the 2SLS results output for real money supply reported in table: 2 with the 3SLS estimates for real money supply reported in the above table: 4. Adjusted R^2 computed by 2SLS is 0.97, which is lower than adjusted R^2 calculated from 3SLS technique because of including the residuals as regressor in the money supply equation. If we see the coefficients of all the variables, there is too much difference of both techniques coefficients except the output gap coefficient which is approximately same computed by 2SLS and 3SLS.

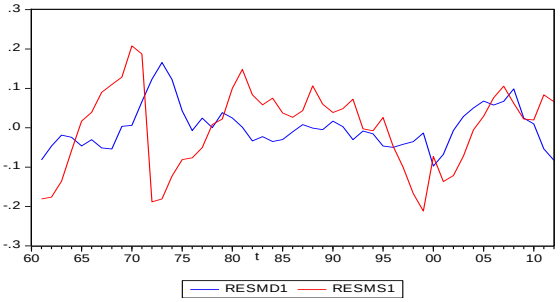

Figure: 2- (3SLS) Graph of correlation b/w two

The figure: 2 above clearly showing that both the residuals have no more relation. Residuals obtained from money demand (M1) equation approximately constant around zero value. But the residuals obtained by money supply (M1) equation have fluctuations; means the correlation between two error terms has been removed. So it is clear evidence that estimates calculated by three stage least square (3SLS) procedure are more efficient as compared to obtained by two stage least (2SLS) square procedure.

5. CONCLUSION & RECOMMENDATIONS

The money demand function has been a topic of continuing research. Usually parameters of the money demand function are estimated by a single equation method which is likely to be biased and inconsistent. In this study we present a simple system of equations representing money demand and supply relationships in Pakistan. The two stage-least square (2SLS) and three stage-least square (3SLS) techniques were used in estimating the equations simultaneously. There may be number of policy implications. First, in estimati e money demand function, the money supply function should not be treated as exogenous or assumed to be unaffected by the interest rate. Second, a change in monetary policy regarding the interest rate with the aim of controlling inflation is expected to affect real money supply. Third, while the inflation gap is a major argument in the money supply function, the output gap could also be a significant tool for monetary policy. Finally, a consistent and unbiased estimate of the quantity of money demand is a useful indicator of GDP.

These results suggest that State Bank of Pakistan would reduce money supply, if inflation gap and output gap increase.

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