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The Demand for Money in a Simultaneous-Equation Framework

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Abstract

This paper estimates the demand for money in the U.S. within a model where the money supply function is also considered simultaneously. The explanatory variables for the money demand function include a measure of the interest rate, real income and the exchange 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 for the two equations avoid being biased or inconsistent. The results should be useful to both macroeconomic researchers and policy makers.

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1. Introduction

A good estimate of the demand for money is a valuable indicator of the GDP and other macroeconomic variables. As a result this topic has been a subject of extensive research. Monetary policymakers need to know whether there will be sufficient money supply to meet the needs of households and businesses. A more precise forecast of the demand for money provides the policymakers with a reliable tool for tracking and predicting interest rates. A number of influential papers (Chow, 1966; Klein, 1977; Saving 1971; Goldfeld, Duesenberry and Poole, 1973; Gordon, 1984; Arango and Nadiri, 1981; Judd and Scadding, 1982; and Fair, 1987) have led to a better understanding of the demand for money. Recent empirical studies have investigated the demand for money related to unit root tests, cointegration tests, the stability of money demand, shift in the velocity of money and the impact of stock prices and other factors on money demand. To our knowledge, all empirical studies employed a single equation method to estimate the parameters of the money demand function. However, we know from theory that the quantity of money demanded and the market interest rate are simultaneously determined through the interaction of money demand and money supply. If a single equation method is used to estimate the money demand function, it implicitly assumes that the money supply function is completely inelastic with respect to the interest rate. This may not be realistic since financial institutions are likely to provide more credit in the money creation process if the interest rate is higher. Monetary easing leading to more money supply or monetary tightening resulting in less money supply is also expected to be influenced by the inflation gap and the output gap. Consequently, a single equation method of estimation will provide parameters that would be biased and inconsistent.

The purpose of this paper, therefore, is to estimate the demand for money in the U.S. within the context of a simultaneous-equation model that also incorporates the money supply function. In section 2, we specify the model used in the study. The empirical results are presented in section 3, and conclusions are stated in section 4.

2. The Model

A survey of the literature[1] indicates that the demand for money primarily depends on the interest rate, real income or wealth and the exchange rate. The demand for real balances may be specified as:

$$MD = f(R, Y, EX) \qquad (1)$$
$$\quad - \; + \; ?$$

where

MD = demand for real balances,
R = a representative interest rate,
Y = real income, and
EX = nominal effective exchange rate (NEER).

The money supply function may be represented as:

$$MS = h(R, YG, IG) \quad (2)$$
$$+ \quad - \quad -$$

where

MS = real money supply,
YG = output gap, and
IG = inflation gap.

In equilibrium, we have:

$$MD = MS. \quad (3)$$

Ceteris paribus, the demand for money is expected to vary inversely with the interest rate and directly with real income. The sign of the nominal effective exchange rate is negative (positive) if the wealth effect is greater (less) than the substitution effect (Arango and Nadiri, 1981; Bahmani-Oskooee and Hafez, 2005). The supply of money is expected to vary directly with the interest rate. Policy makers are expected to tighten the money supply if the actual GDP is growing faster than the potential GDP. Thus, the money supply should vary inversely with the GDP gap. Similarly there should be a tightening of the money supply if the actual inflation rate is higher than a target inflation rate of 2 percent per year. In other words, the money supply should be inversely related to the inflation gap.

3. The Results

Quarterly data from 1974:Q4 to 2010:Q2 were used to estimate the parameters of the equations. Except for potential output, other data were obtained from the *International Financial Statistics*. Seasonally adjusted real M2 is chosen to represent real money balances. Real GDP is measured in billions at 2005 price. The T-bill rate is used to represent the interest rate. Following Taylor (1993), the average inflation rate for the last four quarters is selected to represent the inflation rate. Potential output was obtained from the Federal Reserve Bank of St. Louis. The output gap is measured by the percent difference between real GDP and potential output. The inflation gap is the difference between the actual inflation rate and the target inflation rate of 2% per year or 0.5% per quarter (Taylor, 1999; Hilsenrath, 2011). Except for the output gap and the inflation gap, both of which could be negative, the other variables are expressed in the logarithmic scale.

Each of the variables was tested to determine whether there is a unit root. Based on the augmented Dickey- Fuller (ADF) unit root test and a 1% level of significance, the results show that M, Y and YG have unit roots with or without a trend, and therefore are not stationary in level. All the variables were stationary in first difference. An ADF test on the regression residuals shows that the equations were stationary and cointegrated at the 5% level of significance.

Equations (1) and (2) were estimated simultaneously using a three stage least squares (3SLS) procedure. The estimates for equation (1) are reported in Table 1. The results show that all the estimated coefficients have the expected signs and are significant at the 1% level. The relatively high value of the adjusted R^2 indicates that the three independent variables used may explain

Table I. 3SLS estimation of log(Real Money Demand) in the U.S.

Variable	Coefficient
Constant	2.875 (10.55)**
Log(Interest Rate)	-0.044 (-4.78)**
Log(Real GDP)	0.684 (18.09)**
Log(Nominal Effective Exchange Rate)	-0.116 (-4.49)**
Adjusted R^2	0 .939
RMSE	0.053
Sample size	142

Table II. 3SLS Estimation of log(Real Money Supply) in the U.S.

Variable	Coefficient
Log(Interest Rate)	4.819 (15.02)**
Output Gap	-1.410 (-2.67)**
Inflation Gap	-0.856 (-5.69)**
Adjusted R^2	0.721
RMSE	4.494
Sample size	142

Notes:
The figures in the parentheses are t-statistics
** denotes significance at the .01 level
RMSE is the root mean squared error.

nearly 94 percent of the variation of real money demand. A one percent rise in the interest rate will result in a 0.04 percent decline in the quantity of real money demanded and conversely. The influence of the income (GDP) is stronger. If the real GDP rises by one percent, the quantity of real money demanded will increase by 0.68 percent, while the reverse will be true when GDP declines. A one percent change in the nominal effective exchange rate for the dollar inversely affects real money demand by 0.12 percent.

Table 2 presents the estimates for real money supply. As shown, all the coefficients are significant at the 1% level and have the expected signs. Approximately 72.1% of the variation in real money supply can be explained by the three right-hand side variables. Real money supply is positively associated with the interest rate and negatively influenced by the output gap and the inflation gap. The estimated parameter values suggest that real money supply is more sensitive to the output gap than the inflation gap.

3. Conclusion

The demand for money has been a topic of central interest in the literature. The parameters of the money demand function are usually estimated by a single equation method, which are likely to be biased and inconsistent. In this paper we presented a simple system of equations representing money demand and supply relationships. These two equations were estimated simultaneously using the 3SLS technique. Our results show that it is possible to specify the demand for money using only a few variables. The estimated parameters would be unbiased and consistent. These results should have important implications for conducting macroeconomic policies since the quantity of money demanded is a useful predictor of GDP and other macroeconomic variables.

Footnotes

1. See, for example, Fair (1987) and Laidler (1997), Bahmani-Oskooee and Hafez (2005), Hoffman, Rasche and Tieslau (1995), and Bahmani and Kutan (2010).

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