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An empirical investigation of the demand for money

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AN EMPIRICAL INVESTIGATION OF THE DEMAND FOR MONEY

INTRODUCTION

The theory of the demand for money continues to generate lively debate, not only among students of monetary economics but also among highly distinguished and competent economists. A clear dichotomy of views among economists participating in the debate follows the two familiar framework of ecouomic analysis referred to in the literature as the classical and keynesian approaches. The aim of this paper is to conduct an empirical investigation of the demand for money hypothesis. Section one gives a brief summary of the controversy surrounding the theory of the demand for money. The second section specifies the model and data employed in the investigation, while the third section analyses the statistical results. The paper ends with some concluding remarks.

Part I
THE THEORY OF THE DEMAND FOR MONEY[1]

The classical approach is summed up in the quantity theory of money which considers money as barren and held only for transaction purposes. This view of the role of money is suggestive of the dynamic nature of economic processes and consequently, the inadequacy of the comparative static tool of analysis which deals only with equilibrium situations. Under static equilibrium analysis, income receipts and payments obligations are assumed to be perfectly synchronized and hence no one would wish to hold cash balances. The income velocity of circulation would tend to infinity. Modern quantity theorists assert that the demand for cash balances arises from the disparity between receipts and payments coupled with the existence of uncertainty about future transaction needs (precautionary motive for holding money). Both transactions and precautionary demand for money are held to be a function of the level of transactions or income. Thus the quantity theory of the demand for money may be expressed as

$M = kY$, $o < k < 1$

where M represents the nominal stock of money and Y is the nominal value of national income or product (current GNP). The parameter k, the fraction of money income held as cash balances is said to be determined by institutional factors such as payments and transaction patterns and procedures. It is assumed to be stable over time, implying that income velocity of money Y/M is constant. With this assumption the quantity theory turns into a testable hypothesis rather than a definition of velocity.

The classical economists assumes zero interest elasticity of demand for money. Modern classicists (neoclassical economists) represented by their chief spokesman, Milton Friedman, concluded that although the interest sensitivity of the demand for money can be argued in principle, it cannot be empirically demonstrated. Friedman asserted that a stable relationship between income and money balances exists and provides useful basis for policy. Using annual data for the U.S. economy covering the period of 1869-1957, he obtained an income elasticity of demand for money of 1.8.[2]

Keynes expanded the theory of demand for money by adding an asset demand component to the classical transactions demand for cash balances. He called the asset demand for money the speculative motive for holding money. His theory was based on the assumption that liquid assets could be held in two ways only — riskless money and risky bonds. His argument was that it was rational to expect asset holders to choose to hold their financial wealth as money when bond prices appear to be abnormally high (i.e. when interest rates are abnormally low) and therefore seem likely to fall in the near future, and as bonds in the opposite circumstance when interest rates are so high (or when bond prices are so low) that a fall in rates is expected. Thus the asset demand for money varies inversely with the rate of interest.

$$M_i = M_1 (y_i) + M_2 (r), \frac{\Delta M}{\Delta y} > O, \frac{\Delta M}{\Delta r} > O$$

Here M_i = ith individual's total demand for money

M_1 = transactions demand component assumed to be a positive function of income (y_i)

M_2 = the relationship expressing the individuals choice betweeu bonds and money, i.e. asset demand function. It is inversely related to the rate of interest.

From the foregoing it is observed that the important point of departure between the two theories arises from the interest sensitivity of the demand for money. Here lies the root of the monetarists and fiscalists controversy. Following the classical framework of analysis, it could be demonstrated that monetary policy would be powerful in influencing economic activity if the elasticity of demand for money with respect to interest rate is zero, while fiscal policy would be ineffective. This is the claim of the monetarists. On the other hand the fiscalists following the extreme Keynesian tool of analysis which claim infinite interest rate elasticity of demand for money (liquidity trap) concludes that fiscal policy would be highly effective while monetary policy would be a weak tool in controlling the economy. It is not surprising therefore that economists have devoted much time and energy to the empirical investigation of the theory of the demand for money.

[1]Based on an excellent article by Ronald L. Teigen, 'The Demand and Supply of Money' in *Reading in Money, National Income and Stabilisation Policy* 3rd Ed. (Ed. by W.L. Smith & R. Teigen) pp. 68-86.

[2]"The Relative Stability of Monetary Velocity and the Investment Multiplier in the United States, 1897-1958,' Milton Friedman and David Meiselman.

Part II
THE MODEL AND DATA

The Model

This paper uses a multiple curvilinear regression model to investigate the function that,

$$M_D = M^O + ky - mr \quad (1)$$

An equilibrium position of $M^S = M_D$ is assumed where

M_D = Demand for money
M^O = Intercept
y = Income
r = Interest rate

and k and m are parameters. The above equation may be written in the non-linear form as $M_D = My^k r^m$ (2)

Taking the log of (2) we have,

$$\log M_D = \log M + k(\log y) + m(\log r) \quad (3)$$

set $\log M_D = z$
$\log M = d$
$\log y = w_2$
$\log r = w_3$

Then produce a linear regression equation of

$$z = d + kw_2 - mw_3 \quad (4)$$

Equation (4) was used to find the least-squares values of the regression co-efficients d, k and m

The double-log transformation was used because they correspond to the assumption of constant elasticity between the dependent and independent variables in the model. The application of linear methods of log of the variables gives a direct estimate of elasticities. The partial regression co-efficient k is interpreted as the percentage change in the value of the demand for money per unit per cent change in the value of y while m refers to the percentage change in the demand for money per one per cent change in the interest rate.

The Data

Quarterly data from the U.S. economy covering the period 1955 to 1975 (both dates inclusive) were used to test the following functions:

$$M_1 = M_0 + ky - mr_1 \quad (1)$$
$$M_1 = M_0 + ky - mr_2 \quad (2)$$
$$M_1 = M_0 + ky - mr_3 \quad (3)$$
$$M_1 = M_0 + ky - mr_1 - mr_2 - mr_3 \quad (4)$$
$$M_2 = M_0 + ky - mr_1 \quad (5)$$
$$M_2 = M_0 + ky - mr_2 \quad (6)$$
$$M_2 = M_0 + ky - mr_3 \quad (7)$$
$$M_2 = M_0 + ky - mr_1 - mr_2 - mr_3 \quad (8)$$
$$\frac{M_1}{P} = M_0 + \frac{ky}{P} - mr_1 \quad (9)$$
$$\frac{M_1}{P} = M_0 + \frac{ky}{P} - mr_2 \quad (10)$$
$$\frac{M_1}{P} = M_0 + \frac{ky}{P} - mr_3 \quad (11)$$
$$\frac{M_1}{P} = M_0 + \frac{ky}{P} - mr_1 - mr_2 - mr_3 \quad (12)$$
$$\frac{M_2}{P} = M_0 + \frac{y}{kp} - mr_1 \quad (13)$$
$$\frac{M_2}{P} = M_0 + \frac{y}{kp} - mr_2 \quad (14)$$
$$\frac{M_2}{P} = M_0 + \frac{y}{kp} - mr_3 \quad (15)$$
$$\frac{M_2}{P} = M_0 + \frac{ky}{kp} - mr_1 - mr_2 - mr_3 \quad (16)$$

Where the variables are as follows:

M_1 = Currency plus demand deposit
M_2 = M_1 plus time deposits at commercial banks
y = GNP at current prices
P = GNP deflator as the price index
r_1 = Interest yield on 3-month Treasury bills
r_2 = Interest yield on 6-month Treasury bills
r_3 = Issue rate of 3-5 years Govt. Securities
$\frac{M_1}{P}$ = Real demand for money using M_1
$\frac{M_2}{P}$ = Real demand for money using M_2
y/p = Real level of GNP
M_0 = Intercept; and k and m, the co-efficients of income and interest rate, respectively.

The data used for gross national product are seasonally adjusted quarterly figures published in the survey of Current Business monthly issues. The price index data are also taken from the same source. The Money Stock figures and interest rates were compiled from various issues of Federal Reserve Monthly Bulletin. The sample made use of 84 observations covering the quarterly positions betweer 1955 first quarter and the last quarter of 1975.

The use of the narrow definition of money (M_1) and the broader definition (M_2) reflects the current debate in monetary economics as to what represents the most appropriate definition of money. Those who emphasize the medium of exchange function of money regard M_1 as the most appropriate but Friedman and many other economists in their theoretical and empirical work use the broader definition, M_2.

Part III
ANALYSIS OF THE STATISTICAL RESULTS

The estimates from the first set of eight equations using nominal values of income and money stock are presented first as follows:

$$M_1 = 1.49566 + 0.51206y - 0.06302r$$
$$(27.62184) \quad (-3.65165)^*$$
$$(\ 0.01854) \quad (\ 0.01726)^{**} \quad (1)$$
$$R^2 = 0.9620;\ F = 1024.8586$$

$$M_1 = 1.54769 + 0.50415y - 0.05948r_2$$
$$(26.20701) \quad (-2.99584) \quad (2)$$
$$(\ 0.01931) \quad (\ 0.01985)$$
$$R^2 = 0.9601;\ F = 975.6506$$

$$M_1 = 1.61301 + 0.49338y - 0.05130r_3 \quad (3)$$
$$(17.82314) \quad (-1.49366)^*$$
$$(0.02768) \quad (0.03435)^{**}$$
$$R^2 = 0.9569;\ F = 899.4160$$

$$M_1 = 1.67948 + 0.46399y - 0.12372r_1 + 0.13837r_3 \quad (4)$$
$$(17.76852) \quad (-4.23707) \quad (2.53479)$$
$$(0.02611) \quad (0.02920) \quad (0.05459)$$
$$R^2 = 0.9648;\ F = 730.9690$$

$$M_2 = 0.86895 + 0.66868y - 0.06804r \quad (5)$$
$$(33.16905) \quad (-3.62543)$$
$$(0.02016) \quad (0.01877)$$
$$R^2 = 0.9744;\ F = 1538.9290$$

$$M_2 = 0.89173 + 0.66706y - 0.07264r_2 \quad (6)$$
$$(32.27391) \quad (-3.41816)$$
$$(0.02067) \quad (0.02125)$$
$$R^2 = 0.9740;\ F = 1514.6589$$

$$M_2 = 0.88618 + 0.67288y - 0.08821r \quad (7)$$
$$(22.85463) \quad (-2.41449)$$
$$(0.02944) \quad (0.03653)$$
$$R^2 = 0.9722;\ F = 1416.3571$$

$$M_2 = 0.93433 + 0.65160y - 0.08961r_1 + 0.04917r_3 \quad (8)$$
$$(22.16382) \quad (-2.72599) \quad (0.80014)$$
$$(0.02940) \quad (0.03287) \quad (0.06146)$$
$$R^2 = 0.9746;\ F = 1021.2776$$

* = t values ** = std. error of regression co-efficients

The following conclusions may be drawn from the above results. Equations (1) through (3) conform with the expectation of the theory that the demand for money is positively correlated with income and negatively correlated with interest rate. Their regression co-efficients are significant and correctly signed. Each of the equations have a significantly high R^2 and large F values.

2 — Equation (*1*) is the best as demonstrated by its highest R^2 (0.962), largest F (1024.8586) and computed t values of the regression co-efficients.

3 — Equation (4) included the short-and long-term interest rates in order to test what improvement that could make to the explained variation in M_1 by increasing the number of independent variables. The resulting R^2 (0.9648) is slightly higher than that of equation (1) but the r_3 co-efficient is wrongly signed. This perverse result may be attributable to the problem of multicolinearity. An F test to determine whether the co-efficient of determination of (4) is significantly different from that of (1) proved only a very slight superiority for equation (4) at 95 per cent confidence limit.

4 — Among the next sub-group of equations ((5) through (7)), equation (5) gives the best result for the same reasons that equation (1) performed best in the sub-group discussed earlier.

5 — A comparison of the two best equations specified above shows that equation (5) performed better than equation (1). The only difference between the two equations is in the definition of money used. Since equation (5) uses M_2, this is an important indication that this is the better definition when nominal variables are used for this kind of statistical experiment.

6 — Another interesting result from equations (5) through (7) is that the interest rate co-efficient of the demand for money improves as we move from the short to the long-term interest rate.

7 — The attempt in equation (8) to increase the explanatory power of the regression model failed to yield any significantly different result as demonstrated by the F test carried out between (8) and (5) —— $F = 0.554 < 3.9$ at 95 per cent confidence limit, with 2 and 80 degrees of freedom.

The next procedure was to test the last eight sets of equations (9) to (16) which yielded the following statistical results. These equations use real variables of money stock and gross national product as mentioned earlier.

$$\frac{M_1}{p} = -1.70400 + 1.63128\frac{y}{p} - 0.46308r_1 \quad (9)$$
$$(4.35035) \quad (-15.09371)$$
$$(0.37498) \quad (0.03068)$$
$$R^2 = 0.7391;\ F = 114.7399$$

$$\frac{M_1}{p} = -1.82966 + 1.93050\frac{y}{p} - 0.52461r_2 \quad (10)$$
$$(5.13729) \quad (-15.44869)$$
$$(0.37578) \quad (0.03396)$$
$$R^2 = 0.748;\ F = 120.1899$$

$$\frac{M_1}{p} = -1.76506 + 2.22793\frac{y}{p} - 0.68758r_3 \quad (11)$$
$$(8.14112) \quad (-23.03816)$$
$$(0.27366) \quad (0.02985)$$
$$R^2 = 0.8683;\ F = 267.0222$$

$$\frac{M_1}{p} = -1.7502 + 2.26353\frac{y}{p} - 0.7770r_3 + 0.06965r_1 \quad (12)$$
$$(8.22523) \quad (-8.99375) \quad (1.10373)$$
$$(0.27519) \quad (0.08640) \quad (0.06311)$$
$$R^2 = 0.8703;\ F = 178.8981$$

$$\frac{M_2}{p} = -1.08629 + 1.15198\frac{y}{p} - 0.33134r_1 \quad (13)$$
$$(4.13633) \quad (-14.54083)$$
$$(0.027850) \quad (0.02279)$$
$$R^2 = 0.7246;\ F = 106.5627$$

$$\frac{M_2}{p} = -1.17269 + 1.36624\frac{y}{p} - 0.37540r_2 \quad (14)$$
$$(4.89029) \quad (-14.86942)$$
$$(0.27938) \quad (0.02525)$$
$$R^2 = 0.7334;\ F = 111.4225$$

$$\frac{M_2}{p} = 1.12053 + 1.56570\frac{y}{p} - 0.48858r_3 \quad (15)$$
$$(7.17062) \quad (20.517776)$$
$$(0.21835) \quad (0.02381)$$
$$R^2 = 0.8396;\ F = 211.9393$$

$$\frac{M_2}{p} = 1.11408 + 1.58119\frac{y}{p} - 0.52754r_3 + 0.03032r_1 \quad (16)$$
$$(7.16314) \quad (-7.61173) \quad (0.59889)$$
$$(0.22074) \quad (0.06931) \quad (0.05062)$$
$$R^2 = 0.8403;\ F = 140.2926$$

Following the same pattern of analysis as with the first set of equations the following conclusions may be drawn:

1 — Among the three equations using $\frac{M_1}{p}$ but varying the term of the interest rate, i.e. (9) through (11), equation (11) gives the best results with highest R^2 and t values.

2 — The regression co-efficients carry the expected signs and improve as we move from short to long-term interest rates.

3 — Equation (12) increased the number of explanatory variables but the F test carried out to demonstrate its superiority to equation (11) proved insignificant, $F = 1.2188$ 3.10 at 95% confidence level.

4 — The final sub-group of three equations using $\frac{M_2}{P}$ definition of money, (13) through (15), again shows (15) as the best of the three, thus proving the superiority of r_3 over

r_1 in three sub-group of equations as was the case in the sub-group considered just before this.

5 — A comparison of the two best equations in the two sub-groups show equation (11) as the better one and hence the superiority of M_1 definition of money in the set of equations considered in this section.

6 — Finally, it may be observed that equation (16) did not prove to be significantly different from (15) in spite of the increase in the explanatory variables. It also suffers from multicolliniarity as equations (12), (8) and (4).

Conclusion:

1 — The overall conclusion that may be drawn from this exercise is that the relation postulated by Keynes that the demand for money is a positive function of income and a negative function of interest rate has been proved. The evidence, however, does not support his extreme case of infinite elasticity of demand for money with respect to interest rate implied in his liguidity trap formulation of the liquidity preference theory. It is also proved that the variation in income is the most important explanation of the variation in the demand for money as emphasized by the classical economists, but their zero interest sensitivity assumption is refuted.

2 — One major problem which the exercise throws up for further research, is the imprecision of the elasticity co-efficients. To the extent that different researchers use different definitions of money or varying interest rate structure in their demand for money functions, to that extent will their results be different. It also matters whether real or nominal values of the relevant economic variables are used. These issues remain largely unresolved by monetary economists.

3 — However, in terms of policy implications, the most important result of the exercise arising from the fact that the interest elasticity of demand for money is neither zero nor infinite, is the plausibility of employing a fiscal-monetary policy mix in regulating economic activity. It proved the futility of extreme fiscalism and monetarism which claimed, respectively, that fiscal policy is the effective policy tool of demand management (fiscalists) and monetary policy is the only powerful tool (monetarists).

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