appendix 2 to chapter 22

Empirical Evidence on the Demand for Money

Tobin Mean-Variance Model

Tobin's mean-variance analysis of money demand is just an application of the basic ideas in the theory of portfolio choice. Tobin assumes that the utility that people derive from their assets is positively related to the expected return on their portfolio of assets and is negatively related to the riskiness of this portfolio as represented by the variance (or standard deviation) of its returns. This framework implies that an individual has indifference curves that can be drawn as in Figure 1. Notice that these indifference curves slope upward because an individual is willing to accept more risk if offered a higher expected return. In addition, as we go to higher indifference curves, utility is higher, because for the same level of risk, the expected return is higher.

Tobin looks at the choice of holding money, which earns a certain zero return, or bonds, whose return can be stated as:

$$R_B = i + g$$

where i = interest rate on the bond
g = capital gain

[1]James Tobin, "Liquidity Preference and Monetary Policy," *Review of Economics and Statistics* 29 (1947): 124–131.

[2]A problem with Tobin's procedure is that idle balances are not really distinguishable from transactions balances. As the Baumol-Tobin model of transactions demand for money makes clear, transactions balances will be related to both income and interest rates, just like idle balances.

[3]See David E. W. Laidler, *The Demand for Money: Theories and Evidence,* 4th ed. (New York: HarperCollins, 1993). Only one major study has found that the demand for money is insensitive to interest rates: Milton Friedman, "The Demand for Money: Some Theoretical and Empirical Results," *Journal of Political Economy* 67 (1959): 327–351. He concluded that the demand for money is not sensitive to interest-rate movements, but as later work by David Laidler (using the same data as Friedman) demonstrated, Friedman used a faulty statistical procedure that biased his results: David E. W. Laidler, "The Rate of Interest and the Demand for Money: Some Empirical Evidence," *Journal of Political Economy* 74 (1966): 545–555. When Laidler employed the correct statistical procedure, he found the usual result that the demand for money is sensitive to interest rates. In later work, Friedman has also concluded that the demand for money is sensitive to interest rates.

[4]Kevin Clinton, "The Demand for Money in Canada: 1955–1970: Some Single Equation Estimates and Stability Tests," *Canadian Journal of Economics* 6 (1973): 53–61; Norman Cameron, "The Stability of Canadian Demand for Money Functions," *Canadian Economics* 12 (1979): 258–281; Stephen Poloz, "Simultaneity and the Demand for Money in Canada," *Canadian Journal of Economics* 13 (1980): 407–420.

Tobin also assumes that the expected capital gain is zero[3] and its variance is σ_g^2. That is,

$$E(g) = 0 \quad \text{and so} \quad E(R_B) = i + 0 = i$$
$$Var(g) = E[g - E(g)]^2 = E(g^2) = \sigma_g^2$$

where E = expectation of the variable inside the parentheses
Var = variance of the variable inside the parentheses

If A is the fraction of the portfolio put into bonds ($0 \leq A \leq 1$) and $1 - A$ is the fraction of the portfolio held as money, the return R on the portfolio can be written as:

$$R = AR_B + (1 - A)(0) = AR_B = A(i + g)$$

Then the mean and variance of the return on the portfolio, denoted respectively as μ and σ^2, can be calculated as follows:

$$\mu = E(R) = E(AR_B) = AE(R_B) = Ai$$

$$\sigma^2 = E(R - \mu)^2 = E[A(i + g) - Ai]^2 = E(Ag)^2 = A^2E(g^2) = A^2\sigma_g^2$$

Taking the square root of both sides of the equation directly above and solving for A yields:

$$A = \frac{1}{\sigma_g}\sigma \tag{2}$$

Substituting for A in the equation $\mu = Ai$ using the preceding equation gives us:

$$\mu = \frac{i}{\sigma_g}\sigma \tag{3}$$

Equation 3 is known as the *opportunity locus* because it tells us the combinations of μ and σ that are feasible for the individual. This equation is written in a form in which the μ variable corresponds to the Y axis and the σ variable to the X axis. The opportunity locus is a straight line going through the origin with a slope of i/σ_g. It is drawn in the top half of Figure 2 along with the indifference curves from Figure 1.

The highest indifference curve is reached at point B, the tangency of the indifference curve and the opportunity locus. This point determines the optimal level of risk σ^* in the figure. As Equation 2 indicates, the optimal level of A, A^*, is:

$$A = \frac{\sigma}{\sigma_g}$$

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[5]David E. W. Laidler, "Some Evidence on the Demand for Money," *Journal of Political Economy* 74 (1966): 55–68; Allan H. Meltzer, "The Demand for Money: The Evidence from the Time Series," *Journal of Political Economy* 71 (1963): 219–246; Karl Brunner and Allan H. Meltzer, "Predicting Velocity: Implications for Theory and Policy," *Journal of Finance* 18 (1963): 319–354.

[6]Interest sensitivity is measured by the interest elasticity of money demand, which is defined as the percentage change in the demand for money divided by the percentage change in the interest rate.

This equation is solved in the bottom half of Figure 2. Equation 2 for A is a straight line through the origin with a slope of $1/\boldsymbol{\sigma}_g$. Given $\boldsymbol{\sigma}^*$, the value of A read off this line is the optimal value A^*. Notice that the bottom part of the figure is drawn so that as we move down, A is increasing.

Now let's ask ourselves what happens when the interest rate increases from i_1 to i_2. This situation is shown in Figure 3. Because $\boldsymbol{\sigma}_g$ is unchanged, the Equation 2 line in the bottom half of the figure does not change. However, the slope of the opportunity locus does increase as i increases. Thus the opportunity locus rotates up and we move to point C at the tangency of the new opportunity locus and the indifference curve. As you can see, the optimal level of risk increases from $\boldsymbol{\sigma}_1^*$ and $\boldsymbol{\sigma}_2^*$ the optimal fraction of the portfolio in bonds rises from A_1^* to A_2^*. The result is that as the interest rate on bonds rises, the demand for money falls; that is, $1 - A$, the fraction of the portfolio held as money, declines.[4]

Tobin's model then yields the same result as Keynes's analysis of the speculative demand for money: It is negatively related to the level of interest rates. This model, however, makes two important points that Keynes's model does not:

1. Individuals diversify their portfolios and hold money *and* bonds at the same time.
2. Even if the expected return on bonds is greater than the expected return on money, individuals will still hold money as a store of wealth because its return is more certain.

Here we examine the empirical evidence on the two primary issues that distinguish the different theories of money demand and affect their conclusions about whether the quantity of money is the primary determinant of aggregate spending: Is the demand for money sensitive to changes in interest rates, and is the demand for money function stable over time?

Interest Rates and Money Demand

James Tobin conducted one of the earliest studies on the link between interest rates and money demand using U.S. data.[1] Tobin separated out transactions balances from other money balances, which he called "idle balances," assuming that transactions balances were proportional to income only, and idle balances were related to interest rates only. He then looked at whether his measure of idle balances was inversely related to interest rates in the period 1922–1941 by plotting the average level of idle balances each year against the average interest rate on commercial paper that year. When he found a clear-cut inverse relationship between interest rates and idle balances, Tobin concluded that the demand for money is sensitive to interest rates.[2]

Additional empirical evidence on the demand for money strongly confirms Tobin's finding.[3] Also, studies of the demand for money in Canada, using post-war data, by Kevin Clinton, Norman Cameron, and Stephen Poloz found that the demand for money is sensitive to interest rates.[4] Does this sensitivity ever become so high that we approach the case of the liquidity trap in which monetary policy is ineffective? The answer is almost certainly no. Keynes suggested in *The General Theory* that a liquid-

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[7]Stephen M. Goldfeld, "The Demand for Money Revisited," *Brookings Papers on Economic Activity* 3 (1973): 577–638.

[8]See, for example, William R. White, "The Demand for Money in Canada and the Control of Monetary Aggregates: Evidence from the Monthly Data." *Bank of Canada Staff Research Study* 12, Ottawa: Bank of Canada, 1976.

[9]Stephen M. Goldfeld, "The Case of the Missing Money," *Brookings Papers on Economic Activity* 3 (1976): 683–730.

[10]Charles Freedman, "Financial Innovation in Canada: Causes and Consequences," *American Economic Review, Papers and Proceedings*, 73 (May 1983): 101–106; Ed Fine, "Institutional Developments Affecting Monetary Aggregates," in *Monetary Seminar* 90 (Ottawa: Bank of Canada, 1990): pp. 555–563.

[11]Francesco Caramaza, "The Demand for M2 and M2+ in Canada," *Bank of Canada Review*, December 1989: 3-19.

ity trap might occur when interest rates are extremely low. (However, he did state that he had never yet seen an occurrence of a liquidity trap.)

Typical of the evidence demonstrating that the liquidity trap has never occurred is that of David Laidler, Karl Brunner, and Allan Meltzer, who looked at whether the interest sensitivity of money demand increased in periods when interest rates were very low.[5] Laidler and Meltzer looked at this question by seeing whether the interest sensitivity of money demand differed across periods, especially in periods such as the 1930s when interest rates were particularly low.[6] They found that there was no tendency for interest sensitivity to increase as interest rates fell—in fact, interest sensitivity did not change from period to period. Brunner and Meltzer explored this question by recognizing that higher interest sensitivity in the 1930s as a result of a liquidity trap implies that a money demand function estimated for this period should not predict well in more normal periods. What Brunner and Meltzer found was that a money demand function, estimated mostly with data from the 1930s, accurately predicted the demand for money in the 1950s. This result provided little evidence in favour of the existence of a liquidity trap during the Great Depression period.

The evidence on the interest sensitivity of the demand for money found by different researchers is remarkably consistent. Neither extreme case is supported by the data: The demand for money is sensitive to interest rates, but there is little evidence that a liquidity trap has ever existed.

Stability of Money Demand

If the money demand function, like Equation 4 or 6 in Chapter 22, is unstable and undergoes substantial unpredictable shifts, as Keynes thought, then velocity is unpredictable, and the quantity of money may not be tightly linked to aggregate spending, as it is in the modern quantity theory. The stability of the money demand function is also crucial to whether the central bank should target interest rates or the money supply (see Chapter 24). Thus it is important to look at the question of whether the money demand function is stable, because it has important implications for how monetary policy should be conducted.

As our discussion of the Brunner and Meltzer article indicates, evidence on the stability of the demand for money function is related to the evidence on the existence of a liquidity trap. Brunner and Meltzer's finding that a money demand function estimated using data mostly from the 1930s predicted the demand for money well in the postwar period not only suggests that a liquidity trap did not exist in the 1930s, but also indicates that the money demand function has been stable over long periods of

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[12]David Longworth and Joseph Attah-Mensah, "The Canadian Experience with Weighted Monetary Aggregates," *Bank of Canada Working Paper* 95-10.

[13]John P. Cockerline and John Murray, "A Comparison of Alternative Methods of Monetary Aggregation: Some Preliminary Evidence," *Bank of Canada Technical Report* 28, Ottawa: Bank of Canada, 1981.

[14]Francesco Caramaza, Doug Hostland, and Kim McPhail, "Studies on the Demand for M2 and M2+ in Canada," in *Monetary Seminar 90* (Ottawa: Bank of Canada, 1990): pp. 1–114.

[15]Steve Ambler and Alain Paquet, "Cointegration and the Demand for M2 and M2+ in Canada," in *Monetary Seminar 90* (Ottawa: Bank of Canada, 1990): pp. 125–168.

[16]This research is discussed in John P. Judd and John L. Scadding, "The Search for a Stable Money Demand Function, "Journal of Economic Literature 20 (1982): 993–1023.

[17]Apostolos Serletis, *The Demand for Money: Theoretical and Empirical Approaches*, Kluwer Academic (2001), is the state-of-the-art regarding recent theoretical and empirical approaches to the demand for money.

[18]Thomas F. Cooley and Stephen F. Le Roy, "Identification and Estimation of Money Demand," *American Economic Review* 71 (1981): 825–844, is especially critical of the empirical research on the demand for money.