To see how transactions theories explain the money demand function, let's develop one prominent model of this type. The **Baumol–Tobin model** was developed in the 1950s by economists William Baumol and James Tobin, and it remains a leading theory of money demand.[4]

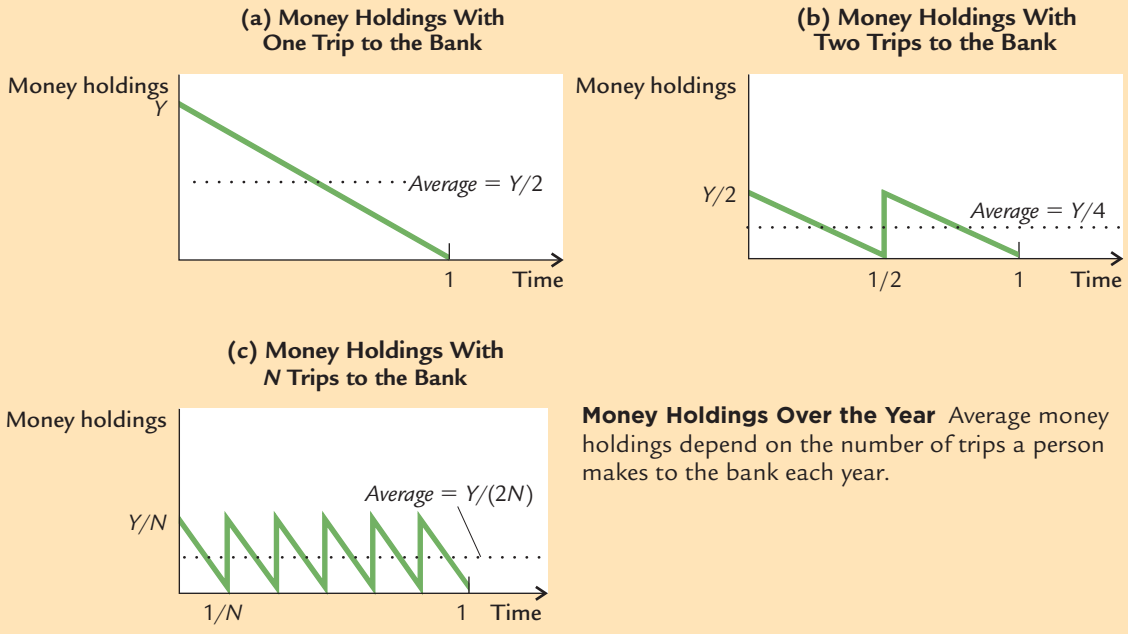
The Baumol–Tobin Model of Cash Management

The Baumol–Tobin model analyzes the costs and benefits of holding money. The benefit of holding money is convenience: people hold money to avoid making a trip to the bank every time they wish to buy something. The cost of this convenience is the forgone interest they would have received had they left the money deposited in a savings account that paid interest.

To see how people trade off these benefits and costs, consider a person who plans to spend Y dollars gradually over the course of a year. (For simplicity, assume that the price level is constant, so real spending is constant over the year.) How much money should he hold in the process of spending this amount? That is, what is the optimal size of average cash balances?

Consider the possibilities. He could withdraw the Y dollars at the beginning of the year and gradually spend the money. Panel (a) of Figure 19-1 shows his

FIGURE 19-1



Money Holdings Over the Year Average money holdings depend on the number of trips a person makes to the bank each year.

[4] William Baumol, "The Transactions Demand for Cash: An Inventory Theoretic Approach," *Quarterly Journal of Economics* 66 (November 1952): 545–556; and James Tobin, "The Interest Elasticity of the Transactions Demand for Cash," *Review of Economics and Statistics* (August 1956): 241–247.

money holdings over the course of the year under this plan. His money holdings begin the year at Y and end the year at zero, averaging $Y/2$ over the year.

A second possible plan is to make two trips to the bank. In this case, he withdraws $Y/2$ dollars at the beginning of the year, gradually spends this amount over the first half of the year, and then makes another trip to withdraw $Y/2$ for the second half of the year. Panel (b) of Figure 19-1 shows that money holdings over the year vary between $Y/2$ and zero, averaging $Y/4$. This plan has the advantage that less money is held on average, so the individual forgoes less interest, but it has the disadvantage of requiring two trips to the bank rather than one.

More generally, suppose the individual makes N trips to the bank over the course of the year. On each trip, he withdraws Y/N dollars; he then spends the money gradually over the following $1/N$th of the year. Panel (c) of Figure 19-1 shows that money holdings vary between Y/N and zero, averaging $Y/(2N)$.

The question is, what is the optimal choice of N? The greater N is, the less money the individual holds on average and the less interest he forgoes. But as N increases, so does the inconvenience of making frequent trips to the bank.

Suppose that the cost of going to the bank is some fixed amount F. We can view F as representing the value of the time spent traveling to and from the bank and waiting in line to make the withdrawal. For example, if a trip to the bank takes 15 minutes and a person's wage is \$12 per hour, then F is \$3. Also, let i denote the interest rate; because money does not bear interest, i measures the opportunity cost of holding money.

Now we can analyze the optimal choice of N, which determines money demand. For any N, the average amount of money held is $Y/(2N)$, so the forgone interest is $iY/(2N)$. Because F is the cost per trip to the bank, the total cost of making trips to the bank is FN. The total cost the individual bears is the sum of the forgone interest and the cost of trips to the bank:

$$\text{Total Cost} = \text{Forgone Interest} + \text{Cost of Trips}$$

$$= \quad iY/(2N) \quad + \quad FN.$$

The larger the number of trips N, the smaller the forgone interest, and the larger the cost of going to the bank.

Figure 19-2 shows how total cost depends on N. There is one value of N that minimizes total cost. The optimal value of N, denoted N^*, is[5]

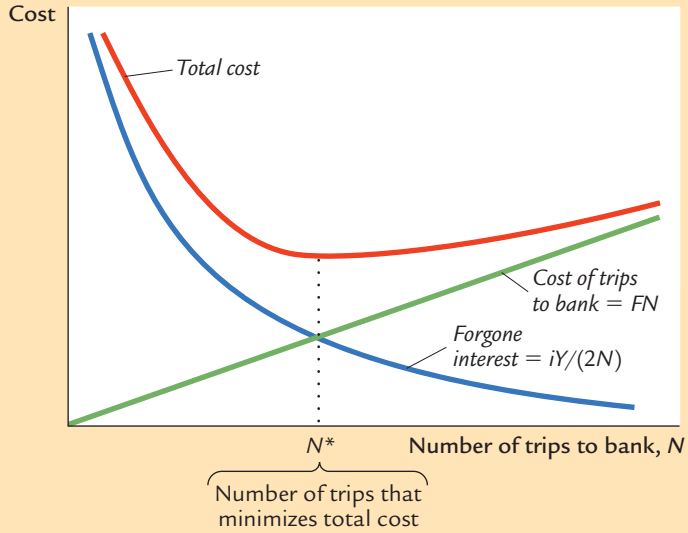
$$N^* = \sqrt{\frac{iY}{2F}}.$$

[5] *Mathematical note:* Deriving this expression for the optimal choice of N requires simple calculus. Differentiate total cost C with respect to N to obtain

$$dC/dN = -iYN^{-2}/2 + F.$$

At the optimum, $dC/dN = 0$, which yields the formula for N^*.

FIGURE 19-2



The Cost of Money Holding
Forgone interest, the cost of trips to the bank, and total cost depend on the number of trips N. One value of N, denoted N^*, minimizes total cost.

Average money holding is

$$\text{Average Money Holding} = Y/(2N^*) = \sqrt{\frac{YF}{2i}}.$$

This expression shows that the individual holds more money if the fixed cost of going to the bank F is higher, if expenditure Y is higher, or if the interest rate i is lower.

So far, we have been interpreting the Baumol–Tobin model as a model of the demand for currency. That is, we have used it to explain the amount of money held outside of banks. Yet one can interpret the model more broadly. Imagine a person who holds a portfolio of monetary assets (currency and checking accounts) and nonmonetary assets (stocks and bonds). Monetary assets are used for transactions but offer a low rate of return. Let i be the difference in the return between monetary and nonmonetary assets, and let F be the cost of transforming nonmonetary assets into monetary assets, such as a brokerage fee. The decision about how often to pay the brokerage fee is analogous to the decision about how often to make a trip to the bank. Therefore, the Baumol–Tobin model describes this person's demand for monetary assets. By showing that money demand depends positively on expenditure Y and negatively on the interest rate i, the model provides a microeconomic justification for the money demand function, $L(i, Y)$, that we have used throughout this book.

One implication of the Baumol–Tobin model is that any change in the fixed cost of going to the bank F alters the money demand function—that is, it

changes the quantity of money demanded for any given interest rate and income. It is easy to imagine events that might influence this fixed cost. The spread of automatic teller machines, for instance, reduces F by reducing the time it takes to withdraw money. Similarly, the introduction of Internet banking reduces F by making it easier to transfer funds among accounts. On the other hand, an increase in real wages increases F by increasing the value of time. And an increase in banking fees increases F directly. Thus, although the Baumol–Tobin model gives us a very specific money demand function, it does not give us reason to believe that this function will necessarily be stable over time.

CASE STUDY

Empirical Studies of Money Demand

Many economists have studied the data on money, income, and interest rates to learn more about the money demand function. One purpose of these studies is to estimate how money demand responds to changes in income and the interest rate. The sensitivity of money demand to these two variables determines the slope of the *LM* curve; it thus influences how monetary and fiscal policy affect the economy.

Another purpose of the empirical studies is to test the theories of money demand. The Baumol–Tobin model, for example, makes precise predictions for how income and interest rates influence money demand. The model's square-root formula implies that the income elasticity of money demand is 1/2: a 10-percent increase in income should lead to a 5-percent increase in the demand for real balances. It also says that the interest elasticity of money demand is 1/2: a 10-percent increase in the interest rate (say, from 10 percent to 11 percent) should lead to a 5-percent decrease in the demand for real balances.

Most empirical studies of money demand do not confirm these predictions. They find that the income elasticity of money demand is larger than 1/2 and that the interest elasticity is smaller than 1/2. Thus, although the Baumol–Tobin model may capture part of the story behind the money demand function, it is not completely correct.

One possible explanation for the failure of the Baumol–Tobin model is that some people may have less discretion over their money holdings than the model assumes. For example, consider a person who must go to the bank once a week to deposit her paycheck; while at the bank, she takes advantage of her visit to withdraw the currency needed for the coming week. For this person, the number of trips to the bank, N, does not respond to changes in expenditure or the interest rate. Because N is fixed, average money holdings [which equals $Y/(2N)$] are proportional to expenditure and insensitive to the interest rate.

Now imagine that the world is populated with two sorts of people. Some obey the Baumol–Tobin model, so they have income and interest elasticities of 1/2. The others have a fixed N, so they have an income elasticity of 1 and an interest elasticity of zero. In this case, the overall demand for money looks like a

weighted average of the demands of the two groups. The income elasticity will be between 1/2 and 1, and the interest elasticity will be between 1/2 and zero, as the empirical studies find.[6] ■

Financial Innovation, Near Money, and the Demise of the Monetary Aggregates

Traditional macroeconomic analysis groups assets into two categories: those used as a medium of exchange as well as a store of value (currency, checking accounts) and those used only as a store of value (stocks, bonds, savings accounts). The first category of assets is called "money." In this chapter we have discussed its supply and demand.

Although the distinction between monetary and nonmonetary assets remains a useful theoretical tool, in recent years it has become more difficult to use in practice. In part because of the deregulation of banks and other financial institutions, and in part because of improved computer technology, the past two decades have seen rapid financial innovation. Monetary assets such as checking accounts once paid no interest; today they earn market interest rates and are comparable to nonmonetary assets as stores of value. Nonmonetary assets such as stocks and bonds were once inconvenient to buy and sell; today mutual funds allow depositors to hold stocks and bonds and to make withdrawals simply by writing checks from their accounts. These nonmonetary assets that have acquired some of the liquidity of money are called **near money.**

The existence of near money complicates monetary policy by making the demand for money unstable. Because money and near money are close substitutes, households can easily switch their assets from one form to the other. Such changes can occur for minor reasons and do not necessarily reflect changes in spending. Thus, the velocity of money becomes unstable, and the quantity of money gives faulty signals about aggregate demand.

One response to this problem is to use a broad definition of money that includes near money. Yet, because there is a continuum of assets in the world with varying characteristics, it is not clear how to choose a subset to label "money." Moreover, if we adopt a broad definition of money, the Fed's ability to control this quantity may be limited, because many forms of near money have no reserve requirement.

The instability in money demand caused by near money has been an important practical problem for the Federal Reserve. In February 1993, Fed Chairman Alan Greenspan announced that the Fed would pay less attention to the monetary aggregates than it had in the past. The aggregates, he said, "do not appear to be giving reliable indications of economic developments and price pressures." It's easy to see why he reached this conclusion when he did. Over the preceding

[6] To learn more about the empirical studies of money demand, see Stephen M. Goldfeld and Daniel E. Sichel, "The Demand for Money," *Handbook of Monetary Economics,* vol. 1 (Amsterdam: North-Holland, 1990), 299–356; and David Laidler, *The Demand for Money: Theories and Evidence,* 3rd ed. (New York: Harper & Row, 1985).

12 months, *M*1 had grown at an extremely high 12-percent rate, while *M*2 had grown at an extremely low 0.5-percent rate. Depending on how much weight was given to each of these two measures, monetary policy was either very loose, very tight, or somewhere in between.

Since then, the Fed has conducted policy by setting a target for the *federal funds rate,* the short-term interest rate at which banks make loans to one another. It adjusts the target interest rate in response to changing economic conditions. Under such a policy, the money supply becomes endogenous: it is allowed to adjust to whatever level is necessary to keep the interest rate on target. Chapter 14 presented a dynamic model of aggregate demand and aggregate supply in which an interest rate rule for the central bank is explicitly incorporated into the analysis of short-run economic fluctuations.

19-3 Conclusion

Money is at the heart of much macroeconomic analysis. Models of money supply and money demand can help shed light on the long-run determinants of the price level and the short-run causes of economic fluctuations. The rise of near money in recent years has shown that there is still much to be learned. Building reliable microeconomic models of money and near money remains a central challenge for macroeconomists.

Summary

1. The system of fractional-reserve banking creates money, because each dollar of reserves generates many dollars of demand deposits.
2. The supply of money depends on the monetary base, the reserve–deposit ratio, and the currency–deposit ratio. An increase in the monetary base leads to a proportionate increase in the money supply. A decrease in the reserve–deposit ratio or in the currency–deposit ratio increases the money multiplier and thus the money supply.
3. The Federal Reserve changes the money supply using three policy instruments. It can increase the monetary base by making an open-market purchase of bonds or by lowering the discount rate. It can reduce the reserve–deposit ratio by relaxing reserve requirements.
4. To start a bank, the owners must contribute some of their own financial resources, which become the bank's capital. Because banks are highly leveraged, however, a small decline in the value of their assets can potentially have a major impact on the value of bank capital. Bank regulators require that banks hold sufficient capital to ensure that depositors can be repaid.