4

Financial Markets I

Financial markets are intimidating. They involve a maze of institutions, from banks, to money market funds, mutual funds, investment funds, and hedge funds. Trading involves bonds, stocks, and other financial claims with exotic names, such as swaps and options. The financial pages of newspapers quote interest rates on many government bonds, on many corporate bonds, on short-term bonds, on long-term bonds, and it is easy to get confused. But financial markets play an essential role in the economy. They determine the cost of funds for firms, for households, for the government, and in turn affect their spending decisions. To understand their role we must proceed in steps.

In this chapter, we focus on the role of the central bank in affecting these interest rates. To do so, we drastically simplify reality and think of the economy as having only *two* financial assets, namely money, which does not pay interest, and bonds, which do. This will allow us to understand how the interest rate on bonds is determined, and the role of the central bank (in the United States, the **Fed**, short for **Federal Reserve Bank**) in this determination.

In the next chapter, Chapter 5, we shall combine the model of the goods market we developed in the previous chapter with the model of financial markets we develop in this chapter, and have another look at equilibrium output. Having done so however, we shall return to financial markets in Chapter 6, allowing for more financial assets and more interest rates, and focusing on the role of banks and other financial institutions. This will give us a richer model, and allow us to better understand what happened in the recent crisis.

The chapter has four sections:

Section 4-1 looks at the demand for money.

Section 4-2 assumes that the central bank directly controls the supply of money and shows how the interest rate is determined by the condition that the demand for money be equal to the supply of money.

Section 4-3 introduces banks as suppliers of money, revisits the determination of the interest rate, and describes the role of the central bank in that context.

Section 4-4 looks at the constraint on monetary policy coming from the fact that the interest rate on bonds cannot be negative, a constraint that has played an important role in the crisis.

4-1 The Demand for Money

This section looks at the determinants of *the demand for money.* A warning before we start: Words such as *money* or *wealth* have specific meanings in economics, often not the same meanings as in everyday conversation. The purpose of the Focus box "Semantic Traps: Money, Income, and Wealth" is to help you avoid some of these traps. Read it carefully, and refer back to it once in a while.

Suppose, as a result of having steadily saved part of your income in the past, your financial wealth today is $50,000. You may intend to keep saving in the future and increase your wealth further, but its value today is given. Suppose also that you only have the choice between two assets, money and bonds:

Make sure you see the difference between the decision about how much to save (a decision that determines how your wealth changes over time) and the decision about how to allocate a given stock of wealth between money and bonds.

- *Money*, which you can use for transactions, pays no interest. In the real world, as we already mentioned, there are two types of money: **currency**, coins and bills, and **checkable deposits**, the bank deposits on which you can write checks or use a debit card. The distinction between the two will be important when we look at the supply of money. For the moment, however, the distinction does not matter and we can ignore it. Just think currency.
- **Bonds** pay a positive interest rate, i, but they cannot be used for transactions. In the real world, there are many types of bonds and other financial assets, each associated with a specific interest rate. For the time being, we also ignore this aspect of reality and assume that there is just one type of bond and that it pays, i, *the* rate of interest.

Assume that buying or selling bonds implies some cost; for example, a phone call to your broker and the payment of a transaction fee. How much of your $50,000 should you hold in money, and how much in bonds? On the one hand, holding all your wealth in the form of money is clearly very convenient. You won't ever need to call a broker or pay transaction fees. But it also means you will receive no interest income. On the other hand, if you hold all your wealth in the form of bonds, you will earn interest on the full amount, but you will have to call your broker frequently—whenever you need money to take the subway, pay for a cup of coffee, and so on. This is a rather inconvenient way of going through life.

You may want to pay by credit card and avoid carrying currency. But you still have to have money in your checking account when you pay the credit card company.

Therefore, it is clear that you should hold both money and bonds. But in what proportions? This will depend mainly on two variables:

- Your *level of transactions.* You will want to have enough money on hand to avoid having to sell bonds whenever you need money. Say, for example, that you typically spend $3,000 a month. In this case, you might want to have, on average, say, two months worth of spending on hand, or $6,000 in money, and the rest, $50,000 − $6,000 = $44,000, in bonds. If, instead, you typically spend $4,000 a month, you might want to have, say, $8,000 in money and only $42,000 in bonds.
- *The interest rate on bonds.* The only reason to hold any of your wealth in bonds is that they pay interest. The higher the interest rate, the more you will be willing to deal with the hassle and costs associated with buying and selling bonds. If the interest rate is very high, you might even decide to squeeze your money holdings to an average of only two weeks' worth of spending, or $1,500 (assuming your monthly spending is $3,000). This way, you will be able to keep, on average, $48,500 in bonds and earn more interest as a result.

Let's make this last point more concrete. Most of you probably do not hold bonds; my guess is that few of you have a broker. However, some of you hold bonds indirectly if you have a money market account with a financial institution. **Money market funds** (the full name is *money market mutual funds*) pool together the funds of many people. The funds are then used to buy bonds—typically government bonds. Money market

Semantic Traps: Money, Income, and Wealth

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In everyday conversation, we use "money" to denote many different things. We use it as a synonym for income: "making money." We use it as a synonym for wealth: "She has a lot of money." In economics, you must be more careful. Here is a basic guide to some terms and their precise meanings in economics.

Money is what can be used to pay for transactions. Money is currency and checkable deposits at banks. **Income** is what you earn from working plus what you receive in interest and dividends. It is a **flow**—something expressed in units of time: weekly income, monthly income, or yearly income, for example. J. Paul Getty was once asked what his income was. Getty answered: "$1,000." He meant but did not say: $1,000 per minute!

Saving is that part of after-tax income that you do not spend. It is also a flow. If you save 10% of your income, and your income is $3,000 per month, then you save $300 per month. **Savings** (plural) is sometimes used as a synonym for wealth—the value of what you have accumulated over time. To avoid confusion, I shall not use the term *savings* in this book.

Your **financial wealth**, or wealth for short, is the value of all your financial assets minus all your financial liabilities. In contrast to income or saving, which are flow variables, financial wealth is a **stock** variable. It is the value of wealth at a given moment in time.

At a given moment in time, you cannot change the total amount of your financial wealth. It can only change over time as you save or dissave, or as the value of your assets and liabilities change. But you can change the composition of your wealth; you can, for example, decide to repay part of your mortgage by writing a check against your checking account. This leads to a decrease in your liabilities (a smaller mortgage) and a corresponding decrease in your assets (a smaller checking account balance); but, at that moment, it does not change your wealth.

Financial assets that can be used directly to buy goods are called *money*. Money includes currency and checkable deposits—deposits against which you can write checks. Money is also a stock. Someone who is wealthy might have only small money holdings—say, $1,000,000 in stocks but only $500 in a checking account. It is also possible for a person to have a large income but only small money holdings—say, a monthly income of $10,000 but only $1,000 in his checking account.

Investment is a term economists reserve for the purchase of new capital goods, from machines to plants to office buildings. When you want to talk about the purchase of shares or other financial assets, you should refer them as a **financial investment**.

Learn how to be economically correct:

> Do not say "Mary is making a lot of money"; say "Mary has a high income."
>
> Do not say "Joe has a lot of money"; say "Joe is very wealthy."

funds pay an interest rate close to but slightly below the interest rate on the bonds they hold—the difference coming from the administrative costs of running the funds and from their profit margins.

When the interest rate on these funds reached 14% per year in the early 1980s (a very high interest rate by today's standards), people who had previously kept all of their wealth in their checking accounts (which paid little or no interest) realized how much interest they could earn by moving some of it into money market accounts instead. Now that interest rates are much lower, people are less careful about putting as much as they can in money market funds. Put another way, for a given level of transactions, people now keep more of their wealth in money than they did in the early 1980s.

Deriving the Demand for Money

Let's go from this discussion to an equation describing the demand for money.

Denote the amount of money people want to hold—their *demand for money*—by M^d (the superscript d stands for *demand*). The demand for money in the economy as a whole is just the sum of all the individual demands for money by the people and firms in the economy. Therefore, it depends on the overall level of transactions in the economy and on the interest rate. The overall level of transactions in the economy is hard to measure, but it is likely to be roughly proportional to nominal income (income

Revisit Chapter 2's example of an economy composed of a steel company and a car company. Calculate the total value of transactions in that economy. If the steel and the car companies doubled in size, what would happen to transactions and to GDP?

measured in dollars). If nominal income were to increase by 10%, it is reasonable to think that the dollar value of transactions in the economy would also increase by roughly 10%. So we can write the relation between the demand for money, nominal income, and the interest rate as:

$$M^d = \$Y\ L(i) \qquad (4.1)$$
$$(-)$$

where $\$Y$ denotes nominal income. Read this equation in the following way: *The demand for money M^d is equal to nominal income $\$Y$ times a decreasing function of the interest rate i, with the function denoted by $L(i)$.* The minus sign under i in $L(i)$ captures the fact that the interest rate has a negative effect on money demand: An increase in the interest rate *decreases* the demand for money, as people put more of their wealth into bonds.

Equation (4.1) summarizes what we have discussed so far:

What matters here is nominal income—income in dollars, not real income. If real income does not change but prices double, leading to a doubling of nominal income, people will need to hold twice as much money to buy the same consumption basket.

- First, the demand for money increases in proportion to nominal income. If nominal income doubles, increasing from $\$Y$ to $\$2Y$, then the demand for money also doubles, increasing from $\$Y\ L(i)$ to $\$2Y\ L(i)$.
- Second, the demand for money depends negatively on the interest rate. This is captured by the function $L(i)$ and the negative sign underneath: An increase in the interest rate decreases the demand for money.

The relation between the demand for money, nominal income, and the interest rate implied by equation (4.1) is shown in Figure 4-1. The interest rate, i, is measured on the vertical axis. Money, M, is measured on the horizontal axis.

The relation between the demand for money and the interest rate *for a given level of nominal income* $\$Y$ is represented by the M^d curve. The curve is downward sloping: The lower the interest rate (the lower i), the higher the amount of money people want to hold (the higher M).

Figure 4-1

The Demand for Money

For a given level of nominal income, a lower interest rate increases the demand for money. At a given interest rate, an increase in nominal income shifts the demand for money to the right.

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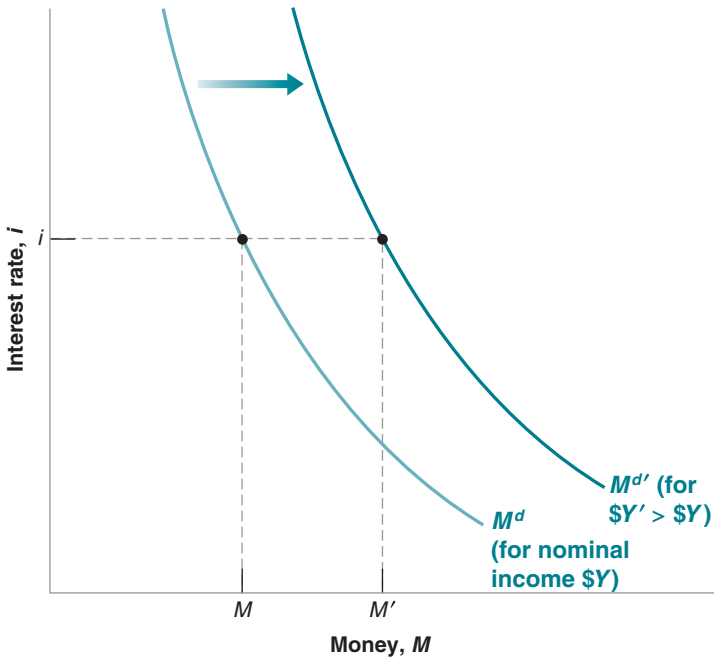

Who Holds U.S. Currency?

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According to household surveys, in 2006, the average U.S. household held $1,600 in currency (dollar bills and coins). Multiplying by the number of households in the U.S. economy at the time (about 110 million), this implies that the total amount of currency held by U.S. households was around $170 billion.

According to the Federal Reserve Board, however—which issues the dollar bills and therefore knows how much is in circulation—the amount of currency in circulation was actually a much higher $750 billion. Here lies the puzzle: If it was not held by households, where was all this currency?

Clearly some currency was held by firms rather than by households. And some was held by those involved in the underground economy or in illegal activities. When dealing with drugs, dollar bills (and, in the future, bitcoin?), not checks, are the way to settle accounts. Surveys of firms and IRS estimates of the underground economy suggest, however, that this can only account for another $80 billion at the most. This leaves $500 billion, or 66% of the total, unaccounted for. So where was it? The answer: Abroad, held by foreigners.

A few countries, Ecuador and El Salvador among them, have actually adopted the dollar as their own currency. So people in these countries use dollar bills for transactions. But these countries are just too small to explain the puzzle.

In a number of countries that have suffered from high inflation in the past, people have learned that their domestic currency may quickly become worthless and they see dollars as a safe and convenient asset. This is, for example, the case of Argentina and of Russia. Estimates by the U.S. Treasury suggest that Argentina holds more than $50 billion in dollar bills, Russia more than $80 billion—so together, close to the holdings of U.S. households.

In yet other countries, people who have emigrated to the United States bring home U.S. dollar bills; or tourists pay some transactions in dollars, and the dollar bills stay in the country. This is, for example, the case for Mexico or Thailand.

The fact that foreigners hold such a high proportion of the dollar bills in circulation has two main macroeconomic implications. First, the rest of the world, by being willing to hold U.S. currency, is making in effect an interest-free loan to the United States of $500 billion. Second, while we shall think of money demand (which includes both currency and checkable deposits) as being determined by the interest rate and the level of transactions in the country, it is clear that U.S. money demand also depends on other factors. Can you guess, for example, what would happen to U.S. money demand if the degree of civil unrest increased in the rest of the world?

For a given interest rate, an increase in nominal income increases the demand for money. In other words, an increase in nominal income shifts the demand for money to the right, from M^d to $M^{d\prime}$. For example, at interest rate i, an increase in nominal income from $\$Y$ to $\$Y'$ increases the demand for money from M to M'.

4-2 Determining the Interest Rate: I

Having looked at the demand for money, we now look at the supply of money and then at the equilibrium.

In the real world, there are two types of money: checkable deposits, which are supplied by banks, and currency, which is supplied by the central bank. In this section, we shall assume that the only money in the economy is currency, central bank money. This is clearly not realistic, but it will make the basic mechanisms most transparent. We shall reintroduce checkable deposits, and look at the role banks play in the next section.

Money Demand, Money Supply, and the Equilibrium Interest Rate

Suppose the central bank decides to supply an amount of money equal to M, so

$$M^s = M$$

The superscript s stands for *supply*. (Let's disregard, for the moment, the issue of how exactly the central bank supplies this amount of money. We shall return to it in a few paragraphs.)

◀ Throughout this section, the term *money* means central bank money, or currency.

Figure 4-2

The Determination of the Interest Rate

The interest rate must be such that the supply of money (which is independent of the interest rate) is equal to the demand for money (which does depend on the interest rate).

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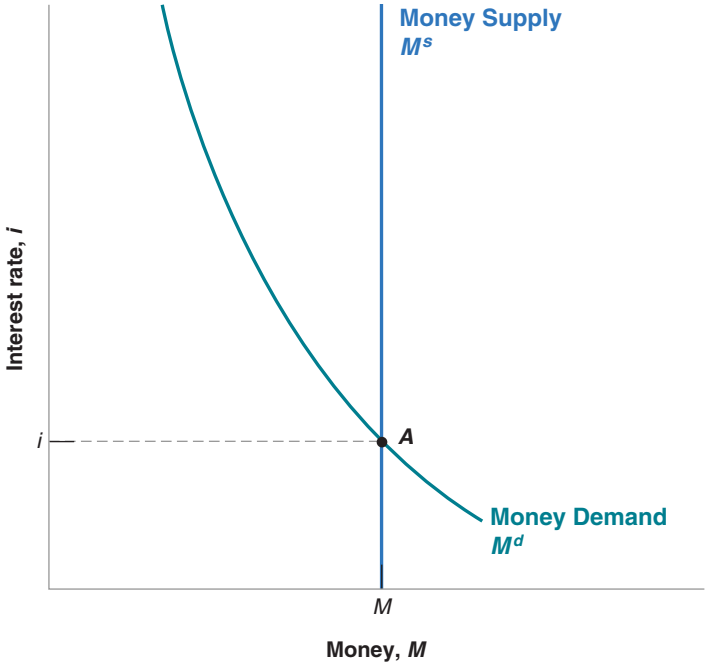

Equilibrium in financial markets requires that money supply be equal to money demand, that $M^s = M^d$. Then, using $M^s = M$, and equation (4.1) for money demand, the equilibrium condition is

$$\begin{aligned} \text{Money supply} &= \text{Money demand} \\ M &= \$Y\ L(i) \end{aligned} \tag{4.2}$$

This equation tells us that the interest rate i must be such that, given their income $\$Y$, people are willing to hold an amount of money equal to the existing money supply M.

This equilibrium condition is represented graphically in Figure 4-2. As in Figure 4-1, money is measured on the horizontal axis, and the interest rate is measured on the vertical axis. The demand for money, M^d, drawn for a given level of nominal income, $\$Y$, is downward sloping: A higher interest rate implies a lower demand for money. The supply of money is drawn as the vertical line denoted M^s: The money supply equals M and is independent of the interest rate. Equilibrium occurs at point A, and the equilibrium interest rate is given by i.

Now that we have characterized the equilibrium, we can look at how changes in nominal income or changes in the money supply by the central bank affect the equilibrium interest rate.

- Figure 4-3 shows the effects of an increase in nominal income on the interest rate.

  The figure replicates Figure 4-2, and the initial equilibrium is at point A. An increase in nominal income from $\$Y$ to Y' increases the level of transactions, which increases the demand for money at any interest rate. The money demand curve *shifts* to the right, from M^d to $M^{d'}$. The equilibrium moves from A up to A', and the equilibrium interest rate increases from i to i'.

  In words: For a given money supply, *an increase in nominal income leads to an increase in the interest rate*. The reason: At the initial interest rate, the demand for

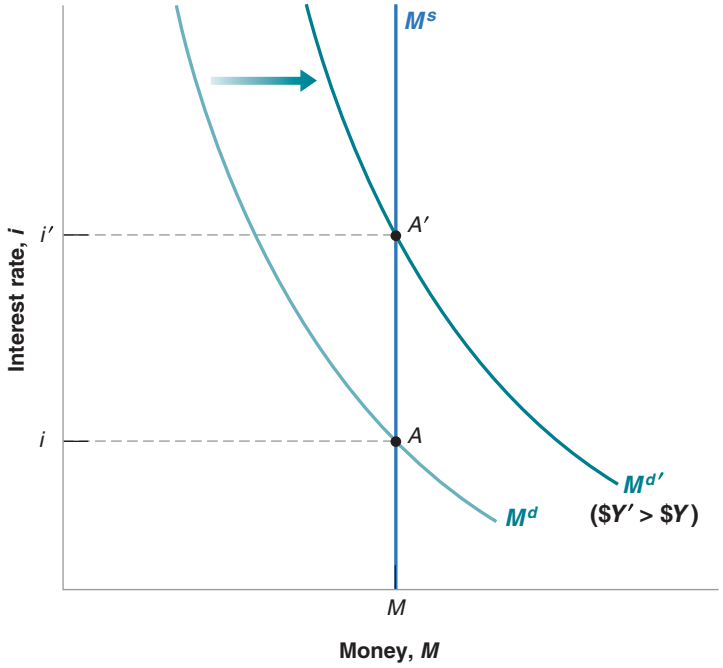

Figure 4-3

The Effects of an Increase in Nominal Income on the Interest Rate

Given the money supply, an increase in nominal income leads to an increase in the interest rate.

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money exceeds the supply. The increase in the interest rate decreases the amount of money people want to hold and reestablishes equilibrium.

- Figure 4-4 shows the effects of an increase in the money supply on the interest rate.

The initial equilibrium is at point A, with interest rate i. An increase in the money supply, from $M^s = M$ to $M^{s'} = M'$, leads to a shift of the money supply curve to the right, from M^s to $M^{s'}$. The equilibrium moves from A down to A'; the interest rate decreases from i to i'.

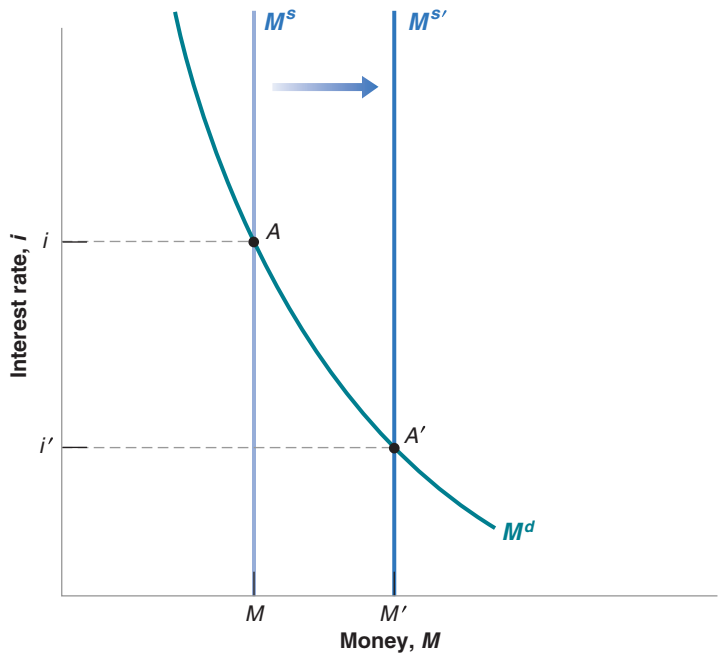

Figure 4-4

The Effects of an Increase in the Money Supply on the Interest Rate

An increase in the supply of money leads to a decrease in the interest rate.

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In words: *an increase in the supply of money by the central bank leads to a decrease in the interest rate.* The decrease in the interest rate increases the demand for money so it equals the now larger money supply.

Monetary Policy and Open Market Operations

We can get a better understanding of the results in Figures 4-3 and 4-4 by looking more closely at how the central bank actually changes the money supply, and what happens when it does so.

In modern economies, the way central banks typically change the supply of money is by buying or selling bonds in the bond market. If a central bank wants to increase the amount of money in the economy, it buys bonds and pays for them by creating money. If it wants to decrease the amount of money in the economy, it sells bonds and removes from circulation the money it receives in exchange for the bonds. These actions are called **open market operations** because they take place in the "open market" for bonds.

The balance sheet of a bank (or firm, or individual) is a list of its assets and liabilities at a point in time. The assets are the sum of what the bank owns and what is owed to the bank by others. The liabilities are what the bank owes to others. It goes without saying that Figure 4-5 gives a much simplified version of an actual central bank balance sheet, but it will do for our purposes.

The Balance Sheet of the Central Bank

To understand what open market operations do, it is useful to start with the balance sheet of the central bank, given in Figure 4-5. The assets of the central bank are the bonds it holds in its portfolio. Its liabilities are the stock of money in the economy. Open market operations lead to equal changes in assets and liabilities.

If the central bank buys, say, $1 million worth of bonds, the amount of bonds it holds is higher by $1 million, and so is the amount of money in the economy. Such an operation is called an **expansionary open market operation**, because the central bank increases (*expands*) the supply of money.

If the central bank sells $1 million worth of bonds, both the amount of bonds held by the central bank and the amount of money in the economy are lower by $1 million. Such an operation is called a **contractionary open market operation**, because the central bank decreases (*contracts*) the supply of money.

Bond Prices and Bond Yields

We have focused so far on the interest rate on bonds. In fact, what is determined in bond markets are not interest rates, but bond *prices.* The two are however directly related. Understanding the relation between the two will prove useful both here and later in this book.

Figure 4-5

The Balance Sheet of the Central Bank and the Effects of an Expansionary Open Market Operation

The assets of the central bank are the bonds it holds. The liabilities are the stock of money in the economy. An open market operation in which the central bank buys bonds and issues money increases both assets and liabilities by the same amount.

Central Bank Balance Sheet

Assets	Liabilities
Bonds	Money (currency)

The Effects of an Expansionary Open Market Operation

Assets	Liabilities
Change in bond holdings: +$1 million	Change in money stock: +$1 million

- Suppose the bonds in our economy are one-year bonds—bonds that promise a payment of a given number of dollars, say \$100, a year from now. In the United States, bonds issued by the government promising payment in a year or less are called **Treasury bills** or **T-bills**. Let the price of a bond today be $\$P_B$, where the subscript B stands for "bond." If you buy the bond today and hold it for a year, the rate of return on holding the bond for a year is $(\$100 - \$P_B)/\$P_B$. Therefore, the interest rate on the bond is given by

$$i = \frac{\$100 - \$P_B}{\$P_B}$$

The interest rate is what you get for the bond a year from now (\$100) minus what you pay for the bond today ($\$P_B$), divided by the price of the bond today, ($\$P_B$).

  If $\$P_B$ is \$99, the interest rate equals $\$1/\$99 = 0.010$, or 1.0% per year. If $\$P_B$ is \$90, the interest rate is $\$1/\$90 = 11.1\%$ per year. *The higher the price of the bond, the lower the interest rate.*
- If we are given the interest rate, we can figure out the price of the bond using the same formula. Reorganizing the formula above, the price today of a one-year bond paying \$100 a year from today is given by

$$\$P_B = \frac{100}{1 + i}$$

  The price of the bond today is equal to the final payment divided by 1 plus the interest rate. If the interest rate is positive, the price of the bond is less than the final payment. *The higher the interest rate, the lower the price today*. You may read or hear that "bond markets went up today." This means that *the prices of bonds went up*, and therefore that *interest rates went down.*

Back to Open Market Operations

We are now ready to return to the effects of an open market operation and its effect on equilibrium in the money market.

Consider first an expansionary open market operation, in which the central bank buys bonds in the bond market and pays for them by creating money. As the central bank buys bonds, the demand for bonds goes up, increasing their price. Conversely, the interest rate on bonds goes down. Note that by buying the bonds in exchange for money that it created, the central bank has increased the money supply.

Consider instead a contractionary open market operation, in which the central bank decreases the supply of money. This leads to a decrease in their price. Conversely, the interest rate goes up. Note that by selling the bonds in exchange for money previously held by households, the central bank has reduced the money supply.

This way of describing how monetary policy affects interest rates is more intuitive. By buying or selling bonds in exchange for money, the central bank affects the price of bonds, and by implication, the interest rate on bonds.

Let's summarize what we have learned in the first two sections:

- The interest rate is determined by the equality of the supply of money and the demand for money.
- By changing the supply of money, the central bank can affect the interest rate.
- The central bank changes the supply of money through open market operations, which are purchases or sales of bonds for money.
- Open market operations in which the central bank increases the money supply by buying bonds lead to an increase in the price of bonds and a decrease in the interest rate. In Figure 4-2, the purchase of bonds by the central bank shifts the money supply to the right.

- Open market operations in which the central bank decreases the money supply by selling bonds lead to a decrease in the price of bonds and an increase in the interest rate. In Figure 4-2, the purchase of bonds by the central bank shifts the money supply to the left.

Choosing Money or Choosing the Interest Rate?

Let me take up one more issue before moving on. I have described the central bank as choosing the money supply and letting the interest rate be determined at the point where money supply equals money demand. Instead, I could have described the central bank as choosing the interest rate and then adjusting the money supply so as to achieve the interest rate it has chosen.

To see this, return to Figure 4-4. Figure 4-4 showed the effect of a decision by the central bank to increase the money supply from M^s to $M^{s'}$, causing the interest rate to fall from i to i'. However, we could have described the figure in terms of the central bank decision to lower the interest rate from i to i' by increasing the money supply from M^s to $M^{s'}$.

Why is it useful to think about the central bank as choosing the interest rate? Because this is what modern central banks, including the Fed, typically do. They typically think about the interest rate they want to achieve, and then move the money supply so as to achieve it. This is why, when you listen to the news, you do not hear: "The Fed decided to decrease the money supply today." Instead you hear: "The Fed decided to increase the interest rate today." The way the Fed did it was by increasing the money supply appropriately.

Suppose nominal income increases, as in Figure 4-3, and that the central bank wants to keep the interest rate unchanged. How does it need to adjust the money supply? ▶

4-3 Determining the Interest Rate: II

We took a shortcut in Section 4-2 in assuming that all money in the economy consisted of currency supplied by the central bank. In the real world, money includes not only currency but also checkable deposits. Checkable deposits are supplied not by the central bank but by (private) banks. In this section, we reintroduce checkable deposits and examine how this changes our conclusions. Let me give you the bottom line: Even, in this more complicated case, by changing the amount of central bank money, the central bank can and does control the interest rate.

To understand what determines the interest rate in an economy with both currency and checkable deposits, we must first look at what banks do.

What Banks Do

Modern economies are characterized by the existence of many types of **financial intermediaries**—institutions that receive funds from people and firms and use these funds to buy financial assets or to make loans to other people and firms. The assets of these institutions are the financial assets they own and the loans they have made. Their liabilities are what they owe to the people and firms from whom they have received funds.

Banks are one type of financial intermediary. What makes banks special—and the reason we focus on banks here rather than on financial intermediaries in general—is that their liabilities are money: People can pay for transactions by writing checks up to the amount of their account balance. Let's look more closely at what they do.

The balance sheet of banks is shown in the bottom half of Figure 4-6, Figure 4-6b.

Banks have other types of liabilities in addition to checkable deposits, and they are engaged in more activities than just holding bonds or making loans. Ignore these complications for the moment. We consider them in Chapter 6. ▶

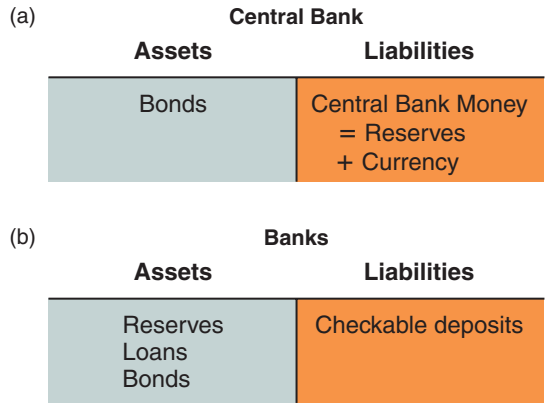

Figure 4-6

The Balance Sheet of Banks, and the Balance Sheet of the Central Bank Revisited

- Banks receive funds from people and firms who either deposit funds directly or have funds sent to their checking accounts (via direct deposit of their paychecks, for example). At any point in time, people and firms can write checks, use a debit card, or withdraw funds, up to the full amount of their account balances. The liabilities of the banks are therefore equal to the value of these *checkable deposits.*
- Banks keep as **reserves** some of the funds they receive. They are held partly in cash and partly in an account the banks have at the central bank, which they can draw on when they need to. Banks hold reserves for three reasons:

  On any given day, some depositors withdraw cash from their checking accounts, whereas others deposit cash into their accounts. There is no reason for the inflows and outflows of cash to be equal, so the bank must keep some cash on hand.

  In the same way, on any given day, people with accounts at the bank write checks to people with accounts at other banks, and people with accounts at other banks write checks to people with accounts at the bank. What the bank, as a result of these transactions, owes the other banks can be larger or smaller than what the other banks owe to it. For this reason also, the bank needs to keep reserves.

  The first two reasons imply that the banks would want to keep some reserves even if they were not required to do so. But, in addition, banks are typically subject to reserve requirements, which require them to hold reserves in some proportion of their checkable deposits. In the United States, reserve requirements are set by the Fed. In the U.S. banks are required to hold at least 10% of the value of the checkable deposits. They can use the rest to make loans or buy bonds.
- Loans represent roughly 70% of banks' non reserve assets. Bonds account for the rest, 30%. The distinction between bonds and loans is unimportant for our purposes in this chapter—which is to understand how the money supply is determined. For this reason, to keep the discussion simple, we will assume in this chapter that banks do not make loans, that they hold only reserves and bonds as assets.

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The distinction between loans and bonds is important for other purposes, from the possibility of "bank runs" to the role of federal deposit insurance. ◀ More on this in Chapter 6.

Figure 4-6a returns to the balance sheet of the central bank, in an economy in which there are banks. It is similar to the balance sheet of the central bank we saw in Figure 4-5. The asset side is the same as before: The assets of the central bank are the bonds it holds. The liabilities of the central bank are the money it has issued, **central bank money**. The new feature, relative to Figure 4-5, is that not all of central bank money is held as currency by the public. Some of it is held as reserves by banks.

The Demand and Supply for Central Bank Money

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So how do we think about the equilibrium in this more realistic setting? Very much in the same way as before, in terms of the demand and the supply of central bank money.

- The demand for central bank money is now equal to the demand for currency by people plus the demand for reserves by banks.
- The supply of central bank money is under the direct control of the central bank.
- The equilibrium interest rate is such that the demand and the supply for central bank money are equal.

The Demand for Central Bank Money

The demand for central bank money now has two components. The first is the demand for currency by people, the second is the demand for reserves by banks. To make the algebra simple, I shall assume in the text that people only want to hold money in the form of checkable deposits, and do not hold any currency. The more general case, where people hold both currency and checkable deposits, is treated in the appendix to this chapter. It involves more algebra but yields the same basic conclusions.

In this case, the demand for central bank money is simply the demand for reserves by banks. This demand in turn depends on the demand for checkable deposits by people. So let's start there. Under our assumption that people hold no currency, the demand for checkable deposits in turn is just equal to the demand for money by people. So, to describe the demand for checkable deposits, we can use the same equation as we used before (equation (4.1)):

$$M^d = \$Y\ L(i) \qquad (4.3)$$
$$(-)$$

People want to hold more checkable deposits the higher their level of transactions and the lower the interest rate on bonds.

Now turn to the demand for reserves by banks. The larger the amount of checkable deposits, the larger the amount of reserves the banks must hold, both for precautionary and for regulatory reasons. Let θ (the Greek lowercase letter theta) be the **reserve ratio**, the amount of reserves banks hold per dollar of checkable deposits. Then, using equation (4.3), the demand for reserves by banks, call it H^d, is given by:

The use of the letter H comes from the fact that central bank money is sometimes called **high-powered money**, to reflect its role in determining the equilibrium interest rate. Yet another name for central bank money is also the **monetary base**.

$$H^d = \theta M^d = \theta \$Y\ L(i) \qquad (4.4)$$

The first equality reflects the fact that the demand for reserves is proportional to the demand for checkable deposits. The second equality reflects the fact that the demand for checkable deposits depends on nominal income and on the interest rate. So, the demand for central bank money, equivalent the demand for reserves by banks, is equal to θ times the demand for money by people.

Equilibrium in the Market for Central Bank Money

Just as before, the supply of central bank money—equivalently the supply of reserves by the central bank—is under the control of the central bank. Let H denote the supply of central bank money. And just as before, the central bank can change the amount of H through open market operations. The equilibrium condition is that the supply of central bank money be equal to the demand for central bank money:

$$H = H^d \qquad (4.5)$$

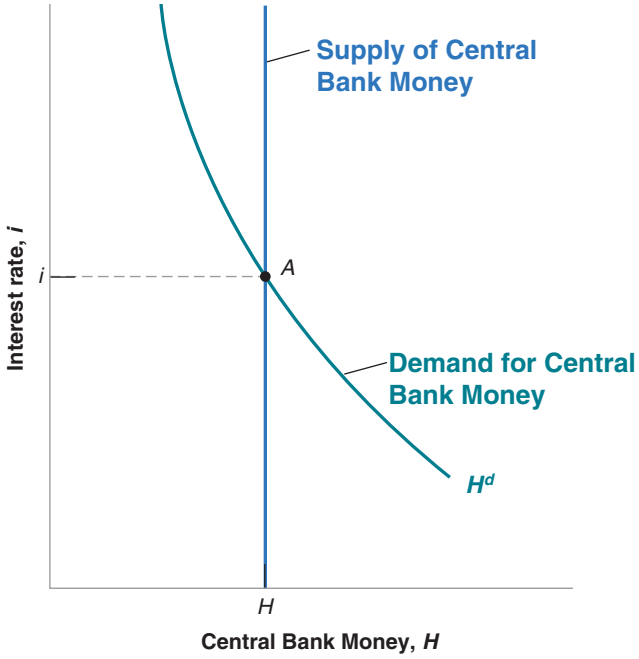

Figure 4-7

Equilibrium in the Market for Central Bank Money and the Determination of the Interest Rate

The equilibrium interest rate is such that the supply of central bank money is equal to the demand for central bank money.

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Or, using equation (4.4):

$$H = \theta \$Y\ L(i) \tag{4.6}$$

We can represent the equilibrium condition, equation (4.6), graphically, and we do this in Figure 4-7. The figure looks the same as Figure 4-2, but with central bank money rather than money on the horizontal axis. The interest rate is measured on the vertical axis. The demand for central bank money, H^d, is drawn for a given level of nominal income. A higher interest rate implies a lower demand for central bank money as demand for checkable deposits by people, and thus the demand for reserves by banks goes down. The supply of money is fixed and is represented by a vertical line at H. Equilibrium is at point A, with interest rate i.

The effects of either changes in nominal income or changes in the supply of central bank money are qualitatively the same as in the previous section. In particular, an increase in the supply of central bank money leads to a shift in the vertical supply line to the right. This leads to a lower interest rate. As before, an increase in central bank money leads to a decrease in the interest rate. Conversely, a decrease in central bank money leads to an increase in the interest rate. So, the basic conclusion is the same as in Section 4-2: By controlling the supply of central bank money, the central bank can determine the interest rate on bonds.

The Federal Funds Market and the Federal Funds Rate

You may wonder whether there is an actual market in which the demand and the supply of reserves determine the interest rate. And, indeed, in the United States, there is an actual market for bank reserves, where the interest rate adjusts to balance the supply and demand for reserves. This market is called the **federal funds market**. The interest rate determined in this market is called the **federal funds rate**. Because the Fed can in effect choose the federal funds rate it wants by changing the supply of central bank money, H,

the federal funds rate is typically thought of as the main indicator of U.S. monetary policy. This is why so much attention is focused on it, and why changes in the federal funds rate typically make front page news.

4-4 The Liquidity Trap

The concept of a liquidity trap (i.e., a situation in which increasing the amount of money ["liquidity"] does not have an effect on the interest rate [the liquidity is "trapped"]), was developed by Keynes in the 1930s, although the expression itself came later.

The main conclusion from the first three sections was that the central bank can, by choosing the supply of central bank money, choose the interest rate that it wants. If it wants to increase the interest rate, it decreases the amount of central bank money. If it wants to decrease the interest rate, it increases the amount of central bank money. This section shows that this conclusion comes with an important caveat: The interest rate cannot go below zero, a constraint known as the **zero lower bound**. When the interest rate is down to zero, monetary policy cannot decrease it further. Monetary policy no longer works, and the economy is said to be in a **liquidity trap**.

Ten years ago, the zero lower bound was seen as a minor issue. Most economists believe that central banks would not want to have negative interest rates in any case, so the constraint would be unlikely to bind. The crisis however, has changed those perceptions. Many central banks decreased interest rates to zero and would have liked to go down even further. But the zero lower bound stood in the way, and turned out to be a serious constraint on policy.

If you look at Figure 4-1, you will see that I avoided the issue by not drawing the demand for money for interest rates close to zero.

Let's look at the argument more closely. When we derived the demand for money in Section 4-1, we did not ask what happens when the interest rate becomes equal to zero. Now we must ask the question. The answer: Once people hold enough money for transaction purposes, they are then indifferent between holding the rest of their financial wealth in the form of money or in the form of bonds. The reason they are indifferent is that both money and bonds pay the same interest rate, namely zero. Thus, the demand for money is as shown in Figure 4-8:

In fact, because of the inconvenience and the dangers of holding currency in very large amounts, people and firms are willing to hold some bonds even when the interest rate is a bit negative. We shall ignore this complication here.

- As the interest rate decreases, people want to hold more money (and thus fewer bonds): The demand for money increases.

Figure 4-8

Money Demand, Money Supply, and the Liquidity Trap

When the interest rate is equal to zero, and once people have enough money for transaction purposes, they become indifferent between holding money and holding bonds. The demand for money becomes horizontal. This implies that, when the interest rate is equal to zero, further increases in the money supply have no effect on the interest rate, which remains equal to zero.

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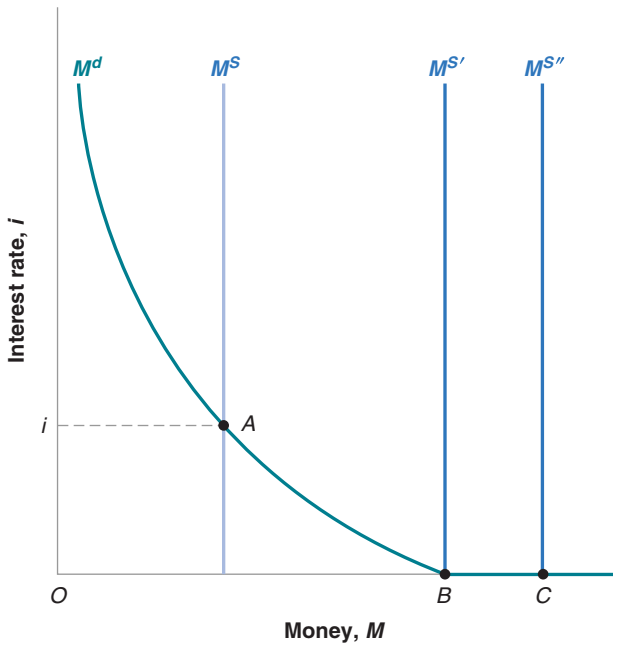

The Liquidity Trap in the United Kingdom

FOCUS

As we mentioned in Chapter 1, the global financial crisis prompted central banks in many countries to cut short-term policy rates to near zero levels. The Monetary Policy Committee of the Bank of England (BoE) cut the bank rate from 5% in mid-2008 to 0.5% in early 2009. In 2015–2016, the slowdown in the global economy, coupled with persistently low rates of inflation, has led several central banks across Europe, as well as in Japan, to cut interest rates below zero into negative territory. BoE was reluctant to cut interest rates below zero in the fear that negative rates could discourage depositors from keeping their savings in banks. The weaknesses of the recovery from the global financial crisis and the European sovereign crisis have led to a decline in household spending and business investment. The analysis in the text shows that uncertainty in the economic outlook would cause households to increase bank deposits and would prompt banks to increase their reserve holdings. As shown in Figure 1, this is precisely what happened. BoE has expanded cash and bank reserves substantially. Bank deposits increased more than ten-fold, from £23.6 billion in 2007 to £265.5 billion in mid-2016. This shows that the sharp expansion in money was absorbed by households and by banks as the bank rate remained at 0.5%. To boost the economy, BoE prefers to use expansionary monetary policy, through open market operations in which it buys government bonds in exchange for money. But negative interest rates remain an option for BoE.

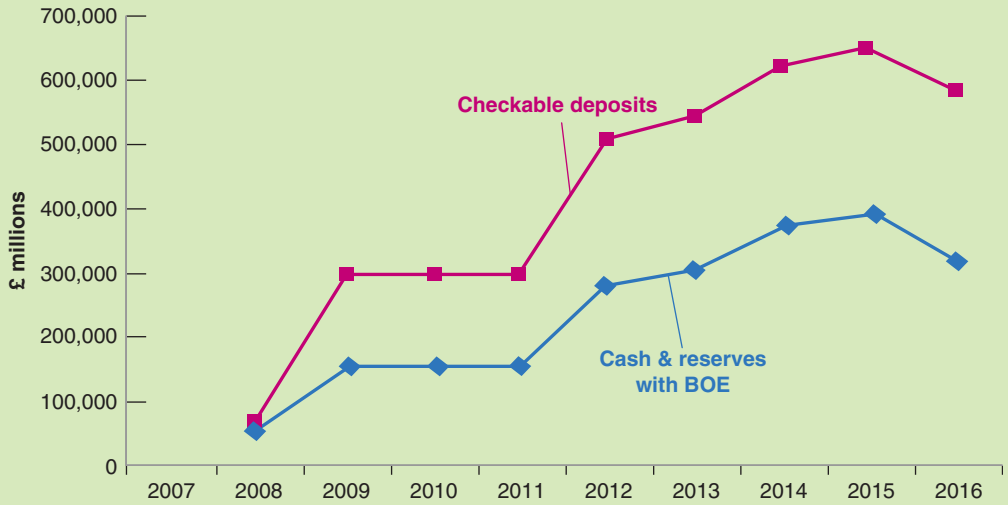

Figure 1 *Checkable Deposits, Cash, and Reserves with BoE, 2007–2016*

Source: Bank of England, Bankstats (Monetary & Financial Statistics).

- As the interest rate becomes equal to zero, people want to hold an amount of money at least equal to the distance, *OB*. This is what they need for transaction purposes. But they are willing to hold even more money (and therefore hold fewer bonds) because they are indifferent between money and bonds. Therefore, the demand for money becomes horizontal beyond point *B*.

Now consider the effects of an increase in the money supply. (Let's ignore banks for the time being, and assume, as in Section 4-2, that all money is currency, so we can use the same diagram as in Figure 4-2 extended to allow for the horizontal portion of money demand. We shall come back to banks and bank money later.)

- Consider the case where the money supply is M^s, so the interest rate consistent with financial market equilibrium is positive and equal to i. (This is the case we considered in Section 4-2.) Starting from that equilibrium, an increase in the money supply—a shift of the M^s line to the right—leads to a decrease in the interest rate.

- Now consider the case where the money supply is $M^{s'}$, so the equilibrium is at point B; or the case where the money supply is $M^{s''}$, so the equilibrium is given by point C. In either case, the initial interest rate is zero. And, in either case, an increase in the money supply has no effect on the interest rate. Think of it this way:

  Suppose the central bank increases the money supply. It does so through an open market operation in which it buys bonds and pays for them by creating money. As the interest rate is zero, people are indifferent to how much money or bonds they hold, so they are willing to hold fewer bonds and more money at the same interest rate, namely zero. The money supply increases, but with no effect on the interest rate—which remains equal to zero.

  What happens when we reintroduce checkable deposits and a role for banks, along the lines of Section 4-3? Everything we just said still applies to the demand for money by people: If the interest rate is zero, they are indifferent to whether they hold money or bonds: Both pay zero interest. But, now a similar argument also applies to banks and their decision whether to hold reserves or buy bonds. If the interest rate is equal to zero, they will also be indifferent as to whether to hold reserves and to buy bonds: Both pay zero interest. Thus, when the interest rate is down to zero, and the central bank increases the money supply, we are likely to see an increase in checkable deposits and an increase in bank reserves, with the interest rate remaining at zero. As the Focus box "The Liquidity Trap in the United Kingdom" shows, this is exactly what we saw during the crisis. As the BoE decreased the interest rate to zero, and continued to expand the money supply, both checkable deposits by people and reserves by banks steadily increased.

In this context, you may ask why the Fed increased the money supply despite the fact that the federal funds rate was down to zero. We shall see the reason in Chapter 6: In effect, in an economy with more than one type of bond, open market operations can affect relative interest rates on other bonds and affect the economy. ▶

Summary

- The demand for money depends positively on the level of transactions in the economy and negatively on the interest rate.
- The interest rate is determined by the equilibrium condition that the supply of money be equal to the demand for money.
- For a given supply of money, an increase in income leads to an increase in the demand for money and an increase in the interest rate. An increase in the supply of money for a given income leads to a decrease in the interest rate.
- The way the central bank changes the supply of money is through open market operations.
- Expansionary open market operations, in which the central bank increases the money supply by buying bonds, lead to an increase in the price of bonds and a decrease in the interest rate.
- Contractionary open market operations, in which the central bank decreases the money supply by selling bonds, lead to a decrease in the price of bonds and an increase in the interest rate.
- When money includes both currency and checkable deposits, we can think of the interest rate as being determined by the condition that the supply of central bank money be equal to the demand for central bank money.
- The supply of central bank money is under the control of the central bank. In the special case where people hold only checkable deposits, the demand for central bank money is equal to the demand for reserves by banks, which is itself equal to the overall demand for money times the reserve ratio chosen by banks.
- The market for bank reserves is called the *federal funds market*. The interest rate determined in that market is called the *federal funds rate*.
- The interest rate chosen by the central bank cannot go below zero. When the interest rate is equal to zero, people and banks are indifferent to holding money or bonds. An increase in the money supply leads to an increase in money demand, an increase in reserves by banks, and no change in the interest rate. This case is known as the liquidity trap. In the liquidity trap monetary policy no longer affects the interest rate.

Key Terms

Federal Reserve Bank (Fed), 87
currency, 88
checkable deposits, 88
bonds, 88
money market funds, 88
money, 89
income, 89
flow, 89
saving, 89
savings, 89
financial wealth, 89
stock, 89
investment, 89
financial investment, 89
open market operation, 94
expansionary open market operation, 94
contractionary open market operation, 94
Treasury bill (T-bill), 95
financial intermediaries, 96
(bank) reserves, 97
central bank money, 97
reserve ratio, 98
high-powered money, 98
monetary base, 98
federal funds market, 99
federal funds rate, 99
zero lower bound, 100
liquidity trap, 100

Questions and Problems

QUICK CHECK

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1. Using the information in this chapter, label each of the following statements true, false, or uncertain. Explain briefly.

a. Income is a flow variable while financial wealth is a stock variable.
b. Economists distinguish between investors as those who produce goods and services, and traders as those who buy and sell financial instruments.
c. The demand for money is determined by income but not by interest rates.
d. Eurodollars comprise of the proportion of U.S. currency that is held in Europe only.
e. The central bank can contract money supply by selling Treasury bonds in the market for bonds.
f. Monetary policy determines money supply while interest policy determines interest rates
g. As the price of a bond rises, its interest rate also rises.
h. The central bank can either increase the money supply or raise interest rates to boost GDP growth in the economy.

2. Suppose that the household nominal income for an economy is £50,000 billion and the demand for money in this economy is given by

$$M^d = £Y(0.2 - 0.8i)$$

a. What is the demand for money when the interest rate is 1% and 5%?
b. What will be the impact on the demand for money if the nominal income declines by 20%?
c. What is the relationship between the demand for money and income? Money demand and the interest rate?
d. Explain what the central bank should do to interest rates if it needs to increase the demand for money.

3. Consider a bond that promises to pay $100 in one year.

a. What is the interest rate on the bond if its price today is $75? $85? $95?
b. What is the relation between the price of the bond and the interest rate?
c. If the interest rate is 8%, what is the price of the bond today?

4. The following are the money demand and money supply functions in an economy.

$$M^s = €8{,}000$$
$$M^d = €40{,}000\,(0.25 - i)$$

a. Calculate the equilibrium interest rate.
b. Suppose the central bank raises the equilibrium interest rate to 10%, will there be excess money supply or money demand? What monetary policy should be followed to reach the new equilibrium interest rate?

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5. Suppose that a person's wealth is $50,000 and that her yearly income is $60,000. Also suppose that her money demand function is given by

$$M^d = \$Y(0.35 - i)$$

a. Derive the demand for bonds. Suppose the interest rate increases by 10 percentage points. What is the effect on her demand for bonds?
b. What are the effects of an increase in wealth on her demand for money and her demand for bonds? Explain in words.
c. What are the effects of an increase in income on her demand for money and her demand for bonds? Explain in words.

d. Consider the statement "When people earn more money, they obviously will hold more bonds." What is wrong with this statement?

6. The demand for money and bonds

You have learnt in this chapter that the interest rate affects both the prices of bonds and the demand for money. Explain each of these relationships.

Do these relationships hold when interest rates are negative? Why do you think central banks would choose to lower interest rates in their economies in the negative domain?

7. ATMs and credit cards

This problem examines the effect of the introduction of ATMs and credit cards on money demand. For simplicity, let's examine a person's demand for money over a period of four days.

Suppose that before ATMs and credit cards, this person goes to the bank once at the beginning of each four-day period and withdraws from her savings account all the money she needs for four days. Assume that she needs \$4 per day.

a. How much does this person withdraw each time she goes to the bank? Compute this person's money holdings for days 1 through 4 (in the morning, before she needs any of the money she withdraws).
b. What is the amount of money this person holds, on average?

Suppose now that with the advent of ATMs, this person withdraws money once every two days.

c. Recompute your answer to part (a).
d. Recompute your answer to part (b).

Finally, with the advent of credit cards, this person pays for all her purchases using her card. She withdraws no money until the fourth day, when she withdraws the whole amount necessary to pay for her credit card purchases over the previous four days.

e. Recompute your answer to part a.
f. Recompute your answer to part b.
g. Based on your previous answers, what do you think has been the effect of ATMs and credit cards on money demand?

8. Money and the banking system

I described a monetary system that included simple banks in Section 4-3. Assume the following:

i. *The public holds no currency.*
ii. *The ratio of reserves to deposits is 0.1.*
iii. *The demand for money is given by*

$$M^d = \$Y(0.8 - 4i)$$

Initially, the monetary base is \$100 billion, and nominal income is \$5 trillion.

a. What is the demand for central bank money?
b. Find the equilibrium interest rate by setting the demand for central bank money equal to the supply of central bank money.
c. What is the overall supply of money? Is it equal to the overall demand for money at the interest rate you found in part (b)?
d. What is the effect on the interest rate if central bank money is increased to \$300 billion?
e. If the overall money supply increases to \$3,000 billion, what will be the effect on i? [*Hint*: Use what you discovered in part (c).]

9. Tools of monetary policy

Suppose that the household nominal income in an economy is £5,000 billion and the demand for money is given by

$$M^d = £Y(0.08 - 0.4i)$$

a. If the money demand is equal to £100 billion what is the interest rate?
b. What should the central bank do to interest rates if it wants to increase the money supply to £300 billion?
c. If the central bank decides to expand money supply to £300 billion, should it change the interest rate or implement open market operations?

10. Monetary policy in a liquidity trap

Suppose that money demand in problem 9 holds as long as interest rates are positive. Answer the following questions when the interest rate is equal to zero:

a. What is the demand for money when the central bank sets the interest rate at zero?
b. If the central bank cuts interest rate to −0.5%, what is the effect on the demand for money?
c. Which central banks have adopted a zero or a sub-zero interest rate policy?
d. Can you justify the reasons behind the negative interest rate policy? Do these reasons always hold in practice?
e. Bank of Japan has been using negative interest rates for a long period of time. Go to the Web site of the Bank of Japan and check the statistical database (https://www.stat-search.boj.or.jp) to trace the interest rates. Identify the periods when Bank of Japan followed a zero and sub-zero interest rate policy. Check from the same database how interest rates affect money stock.

EXPLORE FURTHER

11. Current monetary policy

The central bank of the Federal Republic of Germany is the Deutsche Bundesbank, also known as BUBA. BUBA is the most influential member of the European Central Bank and the European System of Central Bank. Go to the Web site of BUBA (www.bundesbank.de) and check the monetary policy tools of the Deutsche Bundesbank.

a. What is the mandate of the Deutsche Bundesbank and how is it defined? How does this mandate differ from that of the European Central Bank? What are the tools that BUBA uses in order to achieve price stability?
b. Find a press release explaining the monetary policy used by the Deutsche Bundesbank. What is the rationale explained by the BUBA to justify its need to adopt this policy?
c. By examining the most recent press releases of the Deutsche Bundesbank, which of the tools of monetary policy does BUBA use more frequently? Can you explain the reason why BUBA prefers to use this specific policy most often?