economy in January 2008 and January 2011. All three measures of the money supply grew rapidly during the downturn that began in 2008 and the ensuing recovery.

Only about one-half of the M1 definition of the money supply is currency, and only about one-tenth of the M2 definition is currency. Economists disagree as to whether the more narrowly defined M1 or the more broadly defined M2 or something else is the best definition of the money supply. There is probably no best definition for all times and all purposes. For simplicity, in the rest of this chapter, we make no distinction between the M1 and M2 but simply refer to the money supply, M, as currency plus deposits.

**Table 22-1**

| Measures of Money in the United States, January 2008 and 2011 (billions of dollars) |
|---------------------------------|---------------------------------|
|                                 | 2008   | 2011   |
| Currency                       | 757    | 920    |
| M1: Currency plus checking deposits | 1,368  | 1,832  |
| M2: M1 plus time deposits, savings deposits, and other deposits on which check writing is limited or not allowed | 7,498  | 8,808  |

Source: Federal Reserve Board.

Review

- Commodity money—usually gold, silver, or bronze coins—originally served as the main type of money in most societies. Increases in the supply of these commodities would reduce their price relative to those of all other commodities and thereby cause inflation.

- Later, paper currency and deposits at banks became forms of money.

- Money has three roles: a medium of exchange, a store of value, and a unit of account.

The Fed, the Banks, and the Link from Reserves to Deposits

We have seen that increases in the supply of commodity money such as gold would increase inflation. So would the excessive printing of paper money (currency) by governments. But in the twenty-first century, money consists of both currency and deposits. Nevertheless, it is possible for governments—usually through a central bank—to control the supply of money. In the United States, the central bank is the **Federal Reserve System**, nicknamed the “Fed.” To understand how the Fed can control the supply of money, we must first look at how the Fed can control the amount of deposits at banks.

A **bank**—such as Bank of America or Citibank—is a firm that channels funds from savers to investors by accepting deposits and making loans. Figure 22-1 illustrates this function of banks. Banks are a type of **financial intermediary** because they “intermediate”
between savers and investors. Other examples of financial intermediaries are credit unions and savings and loan institutions. Banks are sometimes called commercial banks because many of their loans are to business firms engaged in commerce. Banks accept deposits from people who have funds and who want to earn interest and then lend the funds to other individuals who want to borrow and who are willing to pay interest. A bank earns profits by charging a higher interest rate on their loans than they pay on their deposits.

The Fed

The central bank of a country serves as a bank to other banks. In other words, commercial banks deposit funds at the central bank, and the central bank in turn makes loans to other commercial banks. We will see that the deposits of the commercial banks at the central bank are important for controlling the money supply. The Fed was established as the central bank for the United States in 1913 and now has more than 25,000 employees spread across the country.

Board of Governors At the core of the Fed is the Federal Reserve Board, or Board of Governors, consisting of seven people appointed to nonrenewable fourteen-year terms by the president of the United States and confirmed by the Senate. The Federal Reserve Board is located in Washington, D.C.

One of the governors is appointed by the president as chairman of the board; this appointment also requires Senate confirmation and can be renewed for additional terms. Alan Greenspan was first appointed chairman by President Reagan in 1987 and served until 2006, when Ben Bernanke was appointed by President George W. Bush. Chairman Bernanke’s term was renewed by President Obama in 2010.
The District Federal Reserve Banks

The Federal Reserve System includes not only the Federal Reserve Board in Washington but also twelve Federal Reserve Banks in different districts around the country (see Figure 22-2).

The term Fed refers to the whole Federal Reserve System, including the Board of Governors in Washington and the twelve district banks. Each district bank is headed by a president, who is chosen by commercial bankers and other people in the district and approved by the Board of Governors.

The Federal Open Market Committee

The Fed makes decisions about the supply of money through a committee called the Federal Open Market Committee (FOMC). The members of the FOMC are the seven governors and the twelve district bank presidents, but only five of the presidents vote at any one time. Thus, the FOMC has twelve voting members at any one time. The FOMC meets in Washington, D.C., about eight times a year to decide how to implement monetary policy. Figure 22-3 shows the relationship between the FOMC, the Board of Governors, and the district banks.

Even though the chair of the Fed has only one of the twelve votes on the FOMC, the position has considerably more power than this one vote might indicate. The chair also has executive authority over the operations of the whole Federal Reserve, sets the

---

**Figure 22-2**

*The Twelve Districts of the Fed*

The country is divided into 12 districts, each with a district Federal Reserve Bank. Each district bank is headed by a president, who sits on the Federal Open Market Committee. Alaska and Hawaii are in District 12.
agenda at FOMC meetings, and represents the Fed in testimony before Congress. When
journalists in the popular press write about the Fed, they usually talk as if the chair has
almost complete power over Fed decisions. Now that we have described the Fed, let us
examine the operation of banks and how they, along with the Fed, create money.

The Banks

A commercial bank accepts deposits from individuals and makes loans to others. To under-
stand how a bank functions, it is necessary to look at its balance sheet, which shows these
deposits and loans. Table 22-2 is an example of a balance sheet for a bank, called BankOne.

The different items are divided into assets and liabilities. An asset is something of value
owned by a person or a firm. A liability is something of value that a person or a
firm owes, such as a debt, to someone else. Thus a bank’s assets are anything the bank
owns and any sum owed to the bank by someone else. A bank’s liabilities are anything

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loans 70</td>
<td>Deposits 100</td>
</tr>
<tr>
<td>Bonds 20</td>
<td></td>
</tr>
<tr>
<td>Reserves 10</td>
<td></td>
</tr>
</tbody>
</table>

This table shows the initial situation. The ratio of reserves to deposits is 0.1.
People’s deposits at banks are the main liability of banks, as shown in Table 22-2. Certain assets, such as the bank’s building and furniture, are not shown in this balance sheet because they do not change when the money supply changes. Also, when a bank starts up, the owners must put in some funds, called the bank’s capital stock, that can be used if the bank needs cash in an emergency. This asset also is not shown in the balance sheet.

Consider each of the assets shown in the balance sheet in Table 22-2. Reserves are deposits that commercial banks hold at the Fed, much as people hold deposits at commercial banks. Remember, the Fed is the bank for the commercial banks. Just as you can hold a deposit at a commercial bank, a commercial bank can hold a deposit at the Fed. Reserves are simply a name for these deposits by commercial banks at the Fed.

Under U.S. law, a commercial bank is required to hold reserves at the Fed equal to a fraction of the deposits people hold at the commercial bank; this fraction is called the required reserve ratio. Banks may choose to hold a greater fraction of their deposits in the form of reserves at the Fed than required. In reality, then, the ratio of reserves to deposits, known as the reserve ratio, may differ from the required reserve ratio: It can be larger, but it cannot be smaller. In the following example, we will assume that the required reserve ratio is 10 percent. We will then consider what happens when the reserve ratio changes.

The two other assets of the bank are loans and bonds. Loans are made by banks to individuals or firms for a period of time; the banks earn interest on these loans. Bonds are promises of a firm or government to pay back a certain amount after a number of years. Bonds are issued by the U.S. government and by large corporations. Banks sometimes buy and hold such bonds, as BankOne has done in Table 22-2.

The Link between Reserves and Deposits

Because deposits at banks are a form of money, the Fed must be able to control the total amount of these deposits if it is to control the money supply. The link between the deposits at banks and the reserves at the Fed provides the key mechanism by which the Fed can exert control over the amount of deposits at the commercial banks. To see this control, we first look at some examples to show how this link between reserves and deposits works in the whole economy. To make the story simpler, we assume that everyone uses deposits rather than currency for their money. (We will take up currency again in the next section.)

A Formula Linking Reserves to Deposits

To see how the Fed can change the amount of deposits in the economy, let us assume that the Fed increases the amount of reserves that banks hold at the Fed. The Fed can cause such an increase in reserves simply by buying something from a bank and paying for it by increasing that bank’s reserves at the Fed. The Fed typically has purchased bonds when it wants to increase reserves. So we will start there.

When the Fed buys bonds, it has to pay for them with something. It pays for them with bank reserves—the deposits banks have with the Fed. For example, if the Fed wants to buy bonds held by Citibank, it says, “We want $10 million worth of bonds, and we will pay for them by increasing Citibank’s account with us by $10 million.” This purchase is an electronic transaction. Citibank’s deposits at the Fed (reserves) have increased by $10 million, and the Fed gets the bonds. It has exchanged bank reserves for the bonds. The buying or selling of bonds by the Federal Reserve is called an open market operation.

So next assume that the Fed buys $10 million of bonds from BankOne and pays for the bonds by increasing BankOne’s reserves by $10 million. Thus, reserves rise at banks in the economy. Now, with the reserve ratio the same (in this example, equal to 0.1) for each bank in the economy, a formula links reserves and deposits for the whole economy. It is given by

\[ \text{Reserves} = \text{(reserve ratio)} \times \text{deposits} \]
where reserves and deposits refer to the amounts in the whole economy. If we divide both sides of this expression by the reserve ratio, we get

$$\text{Deposits} = \left(\frac{1}{\text{reserve ratio}}\right) \times \text{reserves}$$

Thus, any increase in reserves is multiplied by the inverse of the reserve ratio to get the increase in deposits. For example, if the $10 million change in reserves is multiplied by $(1/0.1) = 10$, we get $100 million change in deposits.

One could have started the example by assuming that the Fed bought $10 million in bonds from some person other than a bank. That person would deposit the check from the Fed in a bank, and in the end, the answer would be exactly the same: A $10 million increase in reserves leads to a $100 million increase in deposits.

One also could analyze the effects of a decrease in reserves using the same formula linking reserves and deposits. A decrease in reserves occurs when the Fed sells bonds. For example, a decrease in reserves of $10 million would lead to a decrease in deposits of $100 million.

**Bank-by-Bank Deposit Expansion** Now let’s look at the details of what is going on in the banks. In our example, when the Fed buys bonds, BankOne’s holdings of bonds decline by $10 million, from $20 million to $10 million, and BankOne’s reserves at the Fed increase by $10 million, from $10 million to $20 million. The balance sheet would then look like Table 22-3, a change from Table 22-2. The key point is that now $10 million more reserves are in the economy than before the Fed purchased the bonds from BankOne. The reserves are held by BankOne, but they will not be held for long.

Recall that in this example we are assuming that banks hold reserves equal to 10 percent of their deposits. But now, after the Fed’s actions, BankOne has 20 percent of its deposits as reserves, or more than the 10 percent. Because banks can earn more by making loans or buying bonds than by holding reserves, the bank will have an incentive to reduce its reserves and make more loans or buy more bonds.

Suppose BankOne decreases its reserves by making more loans; with the reserve ratio of 0.1, the bank can loan $10 million. Suppose the bank loans $10 million to UNO, a small oil company, which uses the funds to buy an oil tanker from DOS, a shipbuilding firm. UNO pays DOS with a check from BankOne, and DOS deposits the check in its checking account at its own bank, BankTwo. Now BankTwo must ask BankOne for payment; BankOne will make the payment by lowering its reserve account at the Fed and increasing BankTwo’s reserve account at the Fed by $10 million. BankOne’s balance sheet at the end of these transactions is shown in Table 22-4.

Hence, after BankOne makes the loan and transfers its reserves to BankTwo, its reserves are back to 10 percent of its deposits. The story ends here for BankOne, but not for the economy as a whole because BankTwo now has $10 million more in reserves, and this addition will affect BankTwo’s decisions. Let us see how.

### Table 22-3

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loans</td>
<td>Deposits</td>
</tr>
<tr>
<td>Bonds</td>
<td>70</td>
</tr>
<tr>
<td>Reserves</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>20</td>
</tr>
</tbody>
</table>

Note the effect of the Fed’s purchase of bonds: Compared with Table 22-2, bonds are lower and reserves are higher in Table 22-3. The ratio of reserves to deposits is 0.2.
Now BankTwo finds itself with $10 million in additional deposits and $10 million in additional reserves at the Fed. (Remember that deposits are a liability to BankTwo and the reserves are an asset; thus, assets and liabilities each have risen by $10 million.) Continuing with the 10 percent reserve ratio assumption, however, BankTwo needs to hold only $1 million in reserves for the additional $10 million in deposits. Thus, BankTwo will want to make more loans until its reserves equal 10 percent of its deposits. It will lend to other people an amount equal to 90 percent of the $10 million, or $9 million. The first row of Table 22-5 shows the increase in deposits, loans, and reserves at BankTwo. The story ends here for BankTwo, but not for the economy as a whole.

The people who get loans from BankTwo will use these loans to pay others. Thus, the funds probably will end up in yet another bank, called BankThree. Then, BankThree will find it has $9 million in additional deposits and $9 million in additional reserves. BankThree then will lend 90 percent of the $9 million, or $8.1 million, as shown in the second row of Table 22-5. This process will continue from bank to bank. We begin to see that the initial increase in reserves is leading to a much bigger expansion of deposits. The whole process is shown in Table 22-5. Each row shows what happens at one of the banks. The sums of the columns show the change for the whole economy. If we sum the columns through the end of the process, we will see that deposits, and thus the money supply, increase by $100 million as a result of the $10 million increase in reserves. The increase in deposits is 10 times the actual increase in reserves—exactly what the formula predicted. Usually, the whole process takes a short period of time (days rather than weeks) because banks quickly adjust their loans and reserves.

<table>
<thead>
<tr>
<th>Table 22-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deposit Expansion (millions of dollars)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>BankTwo</td>
</tr>
<tr>
<td>BankThree</td>
</tr>
<tr>
<td>BankFour</td>
</tr>
<tr>
<td>BankFive</td>
</tr>
<tr>
<td>BankSix</td>
</tr>
<tr>
<td>BankSeven</td>
</tr>
<tr>
<td>BankEight</td>
</tr>
<tr>
<td>BankNine</td>
</tr>
<tr>
<td>BankTen</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Final sum</td>
</tr>
</tbody>
</table>
The Explosion of Reserves and the Reserve Ratio in 2008

Banks sometimes hold more than the required amount of reserves at the Fed, and the reserve ratio can rise above the required reserve ratio. In our examples so far, we have assumed that the reserve ratio is constant. In this section, we explain what can happen when the reserve ratio changes. We focus on a particularly interesting real-world example.

In the fall of 2008, reserves at the Fed started increasing at a rapid rate. As in our examples in the previous section, the Fed increased reserves by purchasing bonds and paying for them by creating deposits. In this case, however, the Fed purchased large amounts of bonds and other securities issued by private firms rather than the federal government as it usually does. It also made loans to private financial firms to contain the financial crisis. The Fed reasoned that by buying the bonds it could drive the interest rate on those bonds down, which would ease the financial crisis, and that making loans to certain financial firms would help those firms avoid bankruptcy and reduce risks to the financial system.

When the Fed purchased these bonds and made the loans, it paid for them by creating reserves—crediting banks with deposits at the Fed. The increase in reserves was unprecedented. Figure 22-4 shows how large, sudden, and unusual the increase was. After remaining relatively steady, reserves exploded in the fall of 2008. They increased from $44 billion in August 2008 to $858 billion in January 2009, almost a 20-fold increase.

Demand deposits at banks also increased as a result of this increase in reserves, which is not surprising, given the connection between deposits and reserves explained in the previous section. The increase in demand deposits at banks also is shown in Figure 22-4. Note that the increase in demand deposits was not as large as one would expect if the reserve ratio were constant. In fact, as shown in Figure 22-5, the reserve ratio was not constant. It was nearly constant for a number of years, but then it increased sharply in the fall of 2008 as banks held some of the large increase in reserves as excess reserves over the amount they were required to hold. In other words, they did not lend out all the reserves. Banks did not lend out all the reserves because demand was insufficient for loans and because they were concerned about risks.

Figure 22-4

The Great Expansion of Reserves and Deposits in 2008

This chart shows bank reserves (deposits of banks at the Fed) and demand deposits at banks. The explosion of reserves occurred in the fall of 2008. Reserves increased as the Fed bought bonds and made loans, in an attempt to contain the financial crisis, and paid for them by crediting banks with deposits at the Fed.
The increase in demand deposits, in turn, increased the money supply, because demand deposits are part of the money supply. Recalling earlier periods of high money growth, some people became concerned that the increase in the money supply would cause inflation, and they criticized the Fed for increasing the money supply by such a large amount. The Fed, however, indicated that it did not see inflation as a problem. Policy officials were more concerned about the financial crisis. These officials indicated that if inflation picked up, they would be able to reduce the amount of reserves and reduce deposits and the money supply.

**How the Fed Controls the Money Supply:**

**Currency plus Deposits**

We now have seen how an increase in reserves will increase the amount of deposits or a decrease in reserves will reduce the amount of deposits. But the money supply includes currency as well as deposits. With currency in the picture, the Fed must keep track of whether people want to hold more currency or less currency compared with deposits.

Although currency and deposits are both part of the money supply, they have different characteristics. For some purposes, people prefer currency to checking deposits, and vice versa. These preferences determine the amount of currency and checking deposits in the economy. If you want to hold more currency in your wallet because you find it is more convenient than a checking deposit, you just go to the bank and reduce your checking deposit and carry around more currency. If you are worried about crime and do not want to have much currency in your wallet, then you go to the bank and deposit a larger amount in your checking account. Thus, people decide on the amount of currency versus deposits in the economy. In Japan, where crime is less prevalent than in many other countries, people use much more currency compared with checking accounts than in other countries. Even Japanese business executives who earn the equivalent of $120,000 a year frequently are paid monthly with the equivalent of $10,000 in cash.

As long as the Fed keeps track of the amount of currency versus deposits that people want to hold, it can control the money supply—the sum of currency plus demands. For example, if it observes a decline in deposits compared with currency, it can increase reserves, thereby increasing deposits and preventing the money supply from declining.
How a Credit Crunch Affects Deposit Expansion

Earlier, we saw how the Fed can influence the money supply in the economy through an increase in reserves, which is transformed into a much larger increase in deposits by way of the banking sector. Occasionally, the economy suffers from a credit crunch, a period during which banks become cautious about making new loans. A credit crunch greatly reduces the amount by which deposits respond to an increase in reserves initiated by the Fed. An extreme version of this can be demonstrated using the balance sheet for BankOne, shown in Table 22-3. Once the Fed increases BankOne’s reserves by $10 million through an open market operation, if BankOne holds onto $20 million in reserves (even though they are required to hold only $10 million), or if they buy $10 million worth of safe U.S. government bonds instead of making $10 million worth of new loans, then no further expansion of deposits will occur through the banking sector.

Why might banks become more cautious about making loans? One possibility is that they perceive an increased risk of lending to all of their clients. For example, in late 2008, with house prices falling and many borrowers defaulting on their mortgages, banks may have become extremely cautious about the creditworthiness of clients. Another possibility is that bank balance sheets have suffered because an existing asset has lost value. For example, if some of the bonds that BankOne was holding in Table 22-3 were mortgage-linked bonds whose value declined sharply in 2008, then BankOne may decide to use the expanded reserves to fortify their other assets instead of to make new loans. To overcome the credit crunch, the central bank may have to dramatically increase the amount of new reserves to increase the money supply by the desired amount.

Money Growth and Inflation

Early in this chapter, in the section “Commodity Money,” we showed that when gold, silver, or other commodities were the primary form of money, increases in the supply of money would cause inflation. Even though paper currency and deposits are now the main forms of money, the same principle holds in the twenty-first century. That is, all other things being equal, an increase in the supply of money will cause inflation. In this section, we examine this principle by looking at some important episodes of inflation during the twentieth century. Before we do so, we introduce a famous equation that can help us test the principle that an increase in the supply of money eventually causes inflation.

Consider first a simple example. Suppose that all of your transactions are in a video game arcade with food-vending machines and video game machines. You will need money in your pocket to carry out your transactions each day. If you use the vending
and video game machines 10 times a day, you will need 10 times more money in your pocket than if you use the machines once a day. Hence, 10 times more transactions means 10 times more money. If the prices for vending machine items and minutes on a video game machine double, then you will need twice as much money for each day’s activities, assuming that the higher price does not cure your habit. Hence, whether the value of transactions increases because the number of items purchased increases or because the price of each item increases, the amount of money used for transactions will rise.

What is true for you and the machines is true for the whole population and the whole economy. For the whole economy, real gross domestic product (GDP) is like the number of transactions with the machines, and the GDP deflator (a measure of the average price in the economy) is like the average price of the vending and game machines. Just as the amount of money you use for transactions in the game arcade is related to the number of transactions and the price of each transaction, so too is the supply of money in the economy related to real GDP and the GDP deflator.

The Quantity Equation of Money

This relationship between money, real GDP, and the GDP deflator can be summarized by the quantity equation of money, which is written

\[
\text{Money supply} \times \text{velocity} = \text{GDP deflator} \times \text{real GDP}
\]

or

\[
MV = PY
\]

where \( V \) is velocity, \( P \) is the GDP deflator, and \( Y \) is real GDP. For example, if the money supply was $1,000 billion, real GDP was $8,000 billion, and the GDP deflator was 1.1, then a value of 8.8 for velocity would satisfy the quantity equation \((1,000 \times 8.8 = 1.1 \times 8,000)\).

The term velocity measures how frequently money is turned over. It is the number of times a dollar is used on average each period to make purchases. To see this, suppose an automatic teller machine (ATM) is installed in the room with the vending machines and video games from the preceding example. Each morning, you withdraw cash from the ATM for your morning games, and each day at midday, an employee takes the cash from the vending and game machines and restocks the ATM. You then replenish your cash from the ATM to pay for your afternoon use of the games and vending machines; you now need to carry only half as much currency in your pocket as before the ATM was installed, when you had to bring enough cash to last all day. From your perspective, therefore, the velocity of money doubles. Money turns over twice as fast. As this example shows, velocity in the economy depends on technology and, in particular, on how efficient we are at using money.

Now, let’s use the quantity equation to show how an increase in the money supply is related to inflation. If you look carefully at the quantity equation of money, you can see that if velocity and real GDP are not affected by a change in money, then an increase in the money supply will increase the GDP deflator (the average level of prices in the economy). A higher percentage increase in money—that is, higher money growth—will lead to a higher percentage increase in prices—that is, higher inflation. Thus, the quantity equation of money shows that higher rates of money growth lead to higher inflation, just as in the case of commodity money early in the chapter.

A restatement of the quantity equation using growth rates leads to a convenient relationship between money growth, inflation, real GDP growth, and velocity growth. In particular,

\[
\text{Money growth} + \text{velocity growth} = \text{inflation} + \text{real GDP growth}
\]
For example, if the money supply growth is 5 percent per year, velocity growth is 0 percent per year, and real GDP growth is 3 percent per year, then this equation says that inflation is 2 percent per year. (This growth rate form of the quantity equation follows directly from the quantity equation itself; in general, the rate of growth of a product of two terms is approximately equal to the sum of the growth rates of the two terms. Thus,

Hyperinflation and Too Much Money

So much money was printed during the period of German hyperinflation that it became cheaper to burn several million German marks to cook breakfast—as this woman was doing in 1923—than to buy kindling wood with the nearly worthless money. Inflation rose to more than 100 percent per week. Shop owners closed their shops at lunchtime to change the prices. Workers were paid twice weekly. People would rush to the stores and buy everything they needed for the next few days. Firms also set up barter systems with their workers, exchanging consumer goods directly for labor.

Almost three quarters of a century later, a similar story prevailed in Zimbabwe. At the very peak of the inflation, prices were doubling overnight, which meant that a daily laborer’s real purchasing power was being cut in half every day. Even the most mundane transaction required carrying unimaginable quantities of money around, as the picture of the one hundred trillion dollar note shows.

In both countries, the hyperinflation initially was caused by the huge increase in money growth resulting from misguided government policies. However, once it started, everyone tried to get rid of cash as soon as possible, accelerating the inflationary process. Also, by the time the government received its tax revenue, it was not worth much because prices had risen sharply. So the government had to print even more money to pay its bills. In the last months of hyperinflation in Germany, more than 30 paper mills worked at full capacity to deliver paper currency. Even though 150 printing firms had 2,000 presses running 24 hours a day to print German marks, they could not keep up with the need for new notes.

Hyperinflations can be stopped only by a substantial break in the policy behavior of the government or central bank. On November 15, 1923, an economic reform stabilized the inflation rate. By then, the German prices were 100 billion times higher than they had been before the hyperinflation. In Zimbabwe, people stopped using Zimbabwean dollars and the government gave in to the inevitable and sanctioned the use of foreign currency. So the hyperinflation ended once the people decided that a different medium of exchange was needed and switched to using currency notes that could no longer be printed by the government of Zimbabwe.
the growth rate of $M$ times $V$ equals the growth rate of $M$ plus the growth rate of $V$, and the growth rate of $P$ times $Y$ equals the growth rate of $P$ plus the growth rate of $Y$.)

According to the quantity equation, along a long-run economic growth path in which real GDP growth is equal to potential GDP growth, an increase in money growth by a certain number of percentage points in the long run will result in an increase in inflation of the same number of percentage points unless velocity growth changes. Thus, higher money growth will lead to higher inflation in the long run. If velocity growth remains at zero, as in the previous example, and real GDP growth remains at 3 percent per year, then an increase in money growth by 10 percentage points, from 5 to 15 percent, will increase inflation by 10 percentage points, from 2 to 12 percent.

**Evidence**

What evidence do we have that higher money growth leads to more inflation? The quantity equation tells us that we should look for evidence during periods when changes in real GDP and velocity were small compared with changes in money growth and inflation. During such periods, the change in money growth and inflation will be the dominant terms in the quantity equation.

**Worldwide Inflation in the 1970s and 1980s** Figure 22-6 shows such a period: the years from 1973 to 1991, when many economies had big inflations, some much bigger than others. Money growth is plotted on the vertical axis, and inflation on the horizontal axis. In Figure 22-6, each point represents a country. For countries with higher money growth, inflation was higher. Hence, the quantity equation works well during this period. During the 1990s, inflation was low in all these countries, so the difference was insufficient to test how well the equation works. This period of high inflation is sometimes called the Great Inflation.

**Hyperinflations** An even more dramatic type of evidence showing that high money growth can cause inflation is hyperinflation. A hyperinflation is simply a period of very high inflation. The inflation in Germany in 1923 is one of the most famous examples of a hyperinflation. The German government had incurred huge expenses during World War I, and huge demands for war reparations from the victors in World War I compounded the problem. Because the government could not raise enough taxes to pay its expenses, it started printing huge amounts of money, which caused the hyperinflation of 1923. Figure 22-7 shows the weekly increase in German prices.

The German hyperinflation of 1923 was not a unique historic episode, and hyperinflation is not necessarily linked to war. Until recently, hyperinflations were common in Latin America. The size of the Latin American inflations is hard to imagine. The inflation rate in Brazil averaged 43.6 percent per year from 1912 to 1996. A Brazilian good that cost one dollar in 1912 would cost a quadrillion dollars (1,000 trillion) in the 1990s. Inflation in Chile was also very high—about 90 percent throughout the 1970s.

Figure 22-8 shows the price level in Brazil and Chile as well as the money supply in both countries. Clearly, money and prices are closely related. Fortunately, inflation in Chile has been much lower since the 1990s, and inflation in Brazil also has been declining. Not surprisingly, money growth is much lower now too. Money growth has been the cause of all hyperinflations. The most recent hyperinflation occurred in Zimbabwe starting in February 2007 when inflation exceeded 50 percent per month. By late 2009 the inflation rate was 98 percent a day. Prices doubled overnight and the currency became worthless. The Zimbabwean inflation was the second worst in history after Hungary in 1946.
Money and Prices in Brazil and Chile during the Twentieth Century

The close relationship between money and the price level is obvious during this period of very high inflation. So far in the twenty-first century, inflation and money growth have been much lower in both countries.