Inflation: Its Causes, Effects, and Social Costs

Lenin is said to have declared that the best way to destroy the Capitalist System was to debauch the currency. . . . Lenin was certainly right. There is no subtler, no surer means of overturning the existing basis of society than to debauch the currency. The process engages all the hidden forces of economic law on the side of destruction, and does it in a manne r which not one man in a million is able to diagnose.

—John Maynard Keynes

In 1970 the *New York Times* cost 15 cents, the median price of a single-family home was $23,400, and the average wage in manufacturing was $3.36 per hour. In 2011 the *Times* cost $2, the median price of a home was $209,100, and the average wage was $23.09 per hour. This overall increase in prices is called **inflation**, which is the subject of this chapter.

The rate of inflation—the percentage change in the overall level of prices—varies greatly over time and across countries. In the United States, according to the consumer price index, prices rose at an average annual rate of 2.4 percent in the 1960s, 7.1 percent in the 1970s, 5.5 percent in the 1980s, 3.0 percent in the 1990s, and 2.3 percent in the 2000s. Even when the U.S. inflation problem became severe during the 1970s, however, it was nothing compared to the episodes of extraordinarily high inflation, called **hyperinflation**, that other countries have experienced from time to time. A classic example is Germany in 1923, when prices increased an average of 500 percent *per month*. In 2008, a similar hyperinflation gripped the nation of Zimbabwe.

In this chapter we examine the classical theory of the causes, effects, and social costs of inflation. The theory is "classical" in the sense that it assumes that prices are flexible. As we first discussed in Chapter 1, most economists believe this assumption describes the behavior of the economy in the long run. By contrast, many prices are thought to be sticky in the short run, and beginning in Chapter 10 we incorporate this fact into our analysis. For now, we ignore short-run price stickiness. As we will see, the classical theory of inflation not only provides a good description of the long run, it also provides a useful foundation for the short-run analysis we develop later.

The "hidden forces of economic law" that lead to inflation are not as mysterious as Keynes claims in the quotation that opens this chapter. Inflation is simply an increase in the average level of prices, and a price is the rate at which money is exchanged for a good or a service. To understand inflation, therefore, we must understand money—what it is, what affects its supply and demand, and what influence it has on the economy. In the previous chapter, we introduced the economist's concept of "money" and discussed how, in most modern economies, a central bank set up by the government controls the quantity of money in the hands of the public. This chapter begins in Section 5-1 by showing that the quantity of money determines the price level and that the rate of growth in the quantity of money determines the rate of inflation.

Inflation in turn has numerous effects of its own on the economy. Section 5-2 discusses the revenue that governments can raise by printing money, sometimes called the *inflation tax*. Section 5-3 examines how inflation affects the nominal interest rate. Section 5-4 discusses how the nominal interest rate in turn affects the quantity of money people wish to hold and, thereby, the price level.

After completing our analysis of the causes and effects of inflation, in Section 5-5 we address what is perhaps the most important question about inflation: Is it a major social problem? Does inflation amount to "overturning the existing basis of society," as the chapter's opening quotation suggests?

Finally, in Section 5-6, we discuss the dramatic case of hyperinflation. Hyperinflations are interesting to examine because they show clearly the causes, effects, and costs of inflation. Just as seismologists learn much by studying earthquakes, economists learn much by studying how hyperinflations begin and end.

5-1 The Quantity Theory of Money

In Chapter 4 we defined what money is and learned that the quantity of money available in the economy is called the money supply. We also saw how the money supply is determined by the banking system together with the policy decisions of the central bank. With that foundation, we can now start to examine the broad macroeconomic effects of monetary policy. To do this, we need a theory that tells us how the quantity of money is related to other economic variables, such as prices and incomes. The theory we develop in this section, called the *quantity theory of money*, has its roots in the work of the early monetary theorists, including the philosopher and economist David Hume (1711–1776). It remains the leading explanation for how money affects the economy in the long run.

Transactions and the Quantity Equation

If you hear an economist use the word "supply," you can be sure that the word "demand" is not far behind. Indeed, having fully explored the supply of money, we now focus on the demand for it.

The starting point of the quantity theory of money is the insight that people hold money to buy goods and services. The more money they need for such

transactions, the more money they hold. Thus, the quantity of money in the economy is related to the number of dollars exchanged in transactions.

The link between transactions and money is expressed in the following equation, called the **quantity equation**:

$$\text{Money} \times \text{Velocity} = \text{Price} \times \text{Transactions}$$

$$M \times V = P \times T.$$

Let's examine each of the four variables in this equation.

The right-hand side of the quantity equation tells us about transactions. T represents the total number of transactions during some period of time, say, a year. In other words, T is the number of times in a year that goods or services are exchanged for money. P is the price of a typical transaction—the number of dollars exchanged. The product of the price of a transaction and the number of transactions, PT, equals the number of dollars exchanged in a year.

The left-hand side of the quantity equation tells us about the money used to make the transactions. M is the quantity of money. V, called the **transactions velocity of money**, measures the rate at which money circulates in the economy. In other words, velocity tells us the number of times a dollar bill changes hands in a given period of time.

For example, suppose that 60 loaves of bread are sold in a given year at \$0.50 per loaf. Then T equals 60 loaves per year, and P equals \$0.50 per loaf. The total number of dollars exchanged is

$$PT = \$0.50/\text{loaf} \times 60 \text{ loaves/year} = \$30/\text{year}.$$

The right-hand side of the quantity equation equals \$30 per year, the dollar value of all transactions.

Suppose further that the quantity of money in the economy is \$10. By rearranging the quantity equation, we can compute velocity as

$$\begin{aligned} V &= PT/M \\ &= (\$30/\text{year})/(\$10) \\ &= 3 \text{ times per year}. \end{aligned}$$

That is, for \$30 of transactions per year to take place with \$10 of money, each dollar must change hands 3 times per year.

The quantity equation is an *identity*: the definitions of the four variables make it true. This type of equation is useful because it shows that if one of the variables changes, one or more of the others must also change to maintain the equality. For example, if the quantity of money increases and the velocity of money remains unchanged, then either the price or the number of transactions must rise.

From Transactions to Income

When studying the role of money in the economy, economists usually use a slightly different version of the quantity equation than the one just introduced.

The problem with the first equation is that the number of transactions is difficult to measure. To solve this problem, the number of transactions T is replaced by the total output of the economy Y.

Transactions and output are related because the more the economy produces, the more goods are bought and sold. They are not the same, however. When one person sells a used car to another person, for example, they make a transaction using money, even though the used car is not part of current output. Nonetheless, the dollar value of transactions is roughly proportional to the dollar value of output.

If Y denotes the amount of output and P denotes the price of one unit of output, then the dollar value of output is PY. We encountered measures for these variables when we discussed the national income accounts in Chapter 2: Y is real GDP; P, the GDP deflator; and PY, nominal GDP. The quantity equation becomes

$$\text{Money} \times \text{Velocity} = \text{Price} \times \text{Output}$$

$$M \times V = P \times Y.$$

Because Y is also total income, V in this version of the quantity equation is called the **income velocity of money**. The income velocity of money tells us the number of times a dollar bill enters someone's income in a given period of time. This version of the quantity equation is the most common, and it is the one we use from now on.

The Money Demand Function and the Quantity Equation

When we analyze how money affects the economy, it is often useful to express the quantity of money in terms of the quantity of goods and services it can buy. This amount, M/P, is called **real money balances**.

Real money balances measure the purchasing power of the stock of money. For example, consider an economy that produces only bread. If the quantity of money is \$10, and the price of a loaf is \$0.50, then real money balances are 20 loaves of bread. That is, at current prices, the stock of money in the economy is able to buy 20 loaves.

A **money demand function** is an equation that shows the determinants of the quantity of real money balances people wish to hold. A simple money demand function is

$$(M/P)^d = kY,$$

where k is a constant that tells us how much money people want to hold for every dollar of income. This equation states that the quantity of real money balances demanded is proportional to real income.

The money demand function is like the demand function for a particular good. Here the "good" is the convenience of holding real money balances. Just as owning an automobile makes it easier for a person to travel, holding money

makes it easier to make transactions. Therefore, just as higher income leads to a greater demand for automobiles, higher income also leads to a greater demand for real money balances.

This money demand function offers another way to view the quantity equation. To see this, add to the money demand function the condition that the demand for real money balances $(M/P)^d$ must equal the supply M/P. Therefore,

$$M/P = kY.$$

A simple rearrangement of terms changes this equation into

$$M(1/k) = PY,$$

which can be written as

$$MV = PY,$$

where $V = 1/k$. These few steps of simple mathematics show the link between the demand for money and the velocity of money. When people want to hold a lot of money for each dollar of income (k is large), money changes hands infrequently (V is small). Conversely, when people want to hold only a little money (k is small), money changes hands frequently (V is large). In other words, the money demand parameter k and the velocity of money V are opposite sides of the same coin.

The Assumption of Constant Velocity

The quantity equation can be viewed as a definition: it defines velocity V as the ratio of nominal GDP, PY, to the quantity of money M. Yet if we make the additional assumption that the velocity of money is constant, then the quantity equation becomes a useful theory about the effects of money, called the **quantity theory of money**.

As with many of the assumptions in economics, the assumption of constant velocity is only a simplification of reality. Velocity does change if the money demand function changes. For example, when automatic teller machines were introduced, people could reduce their average money holdings, which meant a fall in the money demand parameter k and an increase in velocity V. Nonetheless, experience shows that the assumption of constant velocity is a useful one in many situations. Let's therefore assume that velocity is constant and see what this assumption implies about the effects of the money supply on the economy.

With this assumption included, the quantity equation can be seen as a theory of what determines nominal GDP. The quantity equation says

$$M\bar{V} = PY,$$

where the bar over V means that velocity is fixed. Therefore, a change in the quantity of money (M) must cause a proportionate change in nominal GDP (PY). That is, if velocity is fixed, the quantity of money determines the dollar value of the economy's output.

Money, Prices, and Inflation

We now have a theory to explain what determines the economy's overall level of prices. The theory has three building blocks:

1. The factors of production and the production function determine the level of output Y. We borrow this conclusion from Chapter 3.
2. The money supply M set by the central bank determines the nominal value of output PY. This conclusion follows from the quantity equation and the assumption that the velocity of money is fixed.
3. The price level P is then the ratio of the nominal value of output PY to the level of output Y.

In other words, the productive capability of the economy determines real GDP, the quantity of money determines nominal GDP, and the GDP deflator is the ratio of nominal GDP to real GDP.

This theory explains what happens when the central bank changes the supply of money. Because velocity V is fixed, any change in the money supply M must lead to a proportionate change in the nominal value of output PY. Because the factors of production and the production function have already determined output Y, the nominal value of output PY can adjust only if the price level P changes. Hence, the quantity theory implies that the price level is proportional to the money supply.

Because the inflation rate is the percentage change in the price level, this theory of the price level is also a theory of the inflation rate. The quantity equation, written in percentage-change form, is

$$\%\ \text{Change in}\ M + \%\ \text{Change in}\ V = \%\ \text{Change in}\ P + \%\ \text{Change in}\ Y.$$

Consider each of these four terms. First, the percentage change in the quantity of money M is under the control of the central bank. Second, the percentage change in velocity V reflects shifts in money demand; we have assumed that velocity is constant, so the percentage change in velocity is zero. Third, the percentage change in the price level P is the rate of inflation; this is the variable in the equation that we would like to explain. Fourth, the percentage change in output Y depends on growth in the factors of production and on technological progress, which for our present purposes we are taking as given. This analysis tells us that (except for a constant that depends on exogenous growth in output) the growth in the money supply determines the rate of inflation.

Thus, the quantity theory of money states that the central bank, which controls the money supply, has ultimate control over the rate of inflation. If the central bank keeps the money supply stable, the price level will be stable. If the central bank increases the money supply rapidly, the price level will rise rapidly.

CASE STUDY

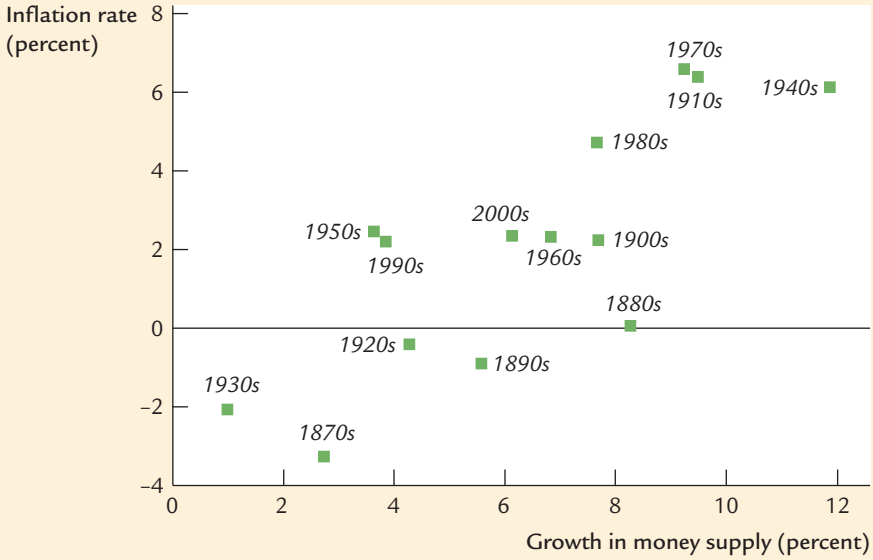
Inflation and Money Growth

"Inflation is always and everywhere a monetary phenomenon." So wrote Milton Friedman, the great economist who won the Nobel Prize in economics in 1976.

The quantity theory of money leads us to agree that the growth in the quantity of money is the primary determinant of the inflation rate. Yet Friedman's claim is empirical, not theoretical. To evaluate his claim, and to judge the usefulness of our theory, we need to look at data on money and prices.

Friedman, together with fellow economist Anna Schwartz, wrote two treatises on monetary history that documented the sources and effects of changes in the quantity of money over the past century.[1] Figure 5-1 uses some of their data and plots the average rate of money growth and the average rate of inflation in the United States over each decade since the 1870s. The data verify the link between inflation and growth in the quantity of money. Decades with high money growth

FIGURE 5-1

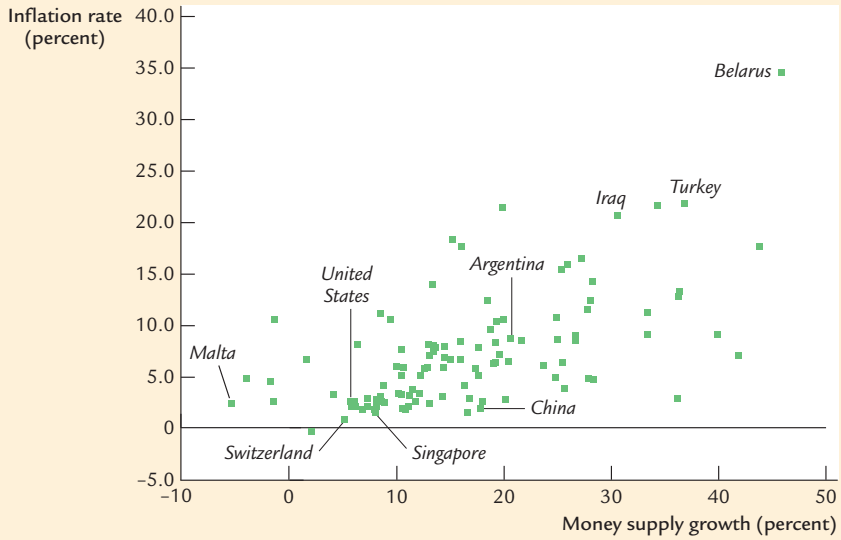


Historical Data on U.S. Inflation and Money Growth In this scatterplot of money growth and inflation, each point represents a decade. The horizontal axis shows the average growth in the money supply (as measured by *M*2) over the decade, and the vertical axis shows the average rate of inflation (as measured by the GDP deflator). The positive correlation between money growth and inflation is evidence for the quantity theory's prediction that high money growth leads to high inflation.

Source: For the data through the 1960s: Milton Friedman and Anna J. Schwartz, *Monetary Trends in the United States and the United Kingdom: Their Relation to Income, Prices, and Interest Rates 1867–1975* (Chicago: University of Chicago Press, 1982). For recent data: U.S. Department of Commerce and Federal Reserve Board.

[1]Milton Friedman and Anna J. Schwartz, *A Monetary History of the United States, 1867–1960* (Princeton, N.J.: Princeton University Press, 1963); Milton Friedman and Anna J. Schwartz, *Monetary Trends in the United States and the United Kingdom: Their Relation to Income, Prices, and Interest Rates, 1867–1975* (Chicago: University of Chicago Press, 1982).

FIGURE 5-2



International Data on Inflation and Money Growth
In this scatterplot, each point represents a country. The horizontal axis shows the average growth in the money supply (as measured by currency plus demand deposits) during the period 2000 to 2010, and the vertical axis shows the average rate of inflation (as measured by the CPI). Once again, the positive correlation is evidence for the quantity theory's prediction that high money growth leads to high inflation.

Source: International Monetary Fund.

(such as the 1970s) tend to have high inflation, and decades with low money growth (such as the 1930s) tend to have low inflation.

As you may have learned in a statistics class, one way to quantity a relationship between two variables is with a measure called *correlation*. A correlation is +1 if the two variables move exactly in tandem, 0 if they are unrelated, and –1 if they move exactly opposite each other. In Figure 5-1, the correlation is 0.79.

Figure 5-2 examines the same question using international data. It shows the average rate of inflation and the average rate of money growth in over 100 countries during the period from 2000 to 2010. Again, the link between money growth and inflation is clear. Countries with high money growth (such as Turkey and Belarus) tend to have high inflation, and countries with low money growth (such as Singapore and Switzerland) tend to have low inflation. The correlation here is 0.61.

If we looked at monthly data on money growth and inflation, rather than data for decade-long periods, we would not see as close a connection between these two variables. This theory of inflation works best in the long run, not in the short run. We examine the short-run impact of changes in the quantity of money when we turn to economic fluctuations in Part Four of this book. ■

5-2 Seigniorage: The Revenue From Printing Money

So far, we have seen how growth in the money supply causes inflation. With inflation as a consequence, what would ever induce a central bank to increase the money supply substantially? Here we examine one answer to this question.

Let's start with an indisputable fact: all governments spend money. Some of this spending is to buy goods and services (such as roads and police), and some is to provide transfer payments (for the poor and elderly, for example). A government can finance its spending in three ways. First, it can raise revenue through taxes, such as personal and corporate income taxes. Second, it can borrow from the public by selling government bonds. Third, it can print money.

The revenue raised by the printing of money is called **seigniorage**. The term comes from *seigneur,* the French word for "feudal lord." In the Middle Ages, the lord had the exclusive right on his manor to coin money. Today this right belongs to the central government, and it is one source of revenue.

When the government prints money to finance expenditure, it increases the money supply. The increase in the money supply, in turn, causes inflation. Printing money to raise revenue is like imposing an *inflation tax*.

At first it may not be obvious that inflation can be viewed as a tax. After all, no one receives a bill for this tax—the government merely prints the money it needs. Who, then, pays the inflation tax? The answer is the holders of money. As prices rise, the real value of the money in your wallet falls. Therefore, when the government prints new money for its use, it makes the old money in the hands of the public less valuable. Inflation is like a tax on holding money.

The amount of revenue raised by printing money varies from country to country. In the United States, the amount has been small: seigniorage has usually accounted for less than 3 percent of government revenue. In Italy and Greece, seigniorage has often been more than 10 percent of government revenue.[2] In countries experiencing hyperinflation, seigniorage is often the government's chief source of revenue—indeed, the need to print money to finance expenditure is a primary cause of hyperinflation.

CASE STUDY

Paying for the American Revolution

Although seigniorage has not been a major source of revenue for the U.S. government in recent history, the situation was very different two centuries ago. Beginning in 1775, the Continental Congress needed to find a way to finance the Revolution, but it had limited ability to raise revenue through taxation. It therefore relied on the printing of fiat money to help pay for the war.

The Continental Congress's reliance on seigniorage increased over time. In 1775 new issues of continental currency were about $6 million. This amount increased to $19 million in 1776, $13 million in 1777, $63 million in 1778, and $125 million in 1779.

[2]Stanley Fischer, "Seigniorage and the Case for a National Money," *Journal of Political Economy* 90 (April 1982): 295–313.

Not surprisingly, this rapid growth in the money supply led to massive inflation. At the end of the war, the price of gold measured in continental dollars was more than 100 times its level of only a few years earlier. The large quantity of the continental currency made the continental dollar nearly worthless. This experience also gave birth to a once-popular expression: people used to say something was "not worth a continental" to mean that the item had little real value.

When the new nation won its independence, there was a natural skepticism about fiat money. Upon the recommendation of the first Secretary of the Treasury, Alexander Hamilton, Congress passed the Mint Act of 1792, which established gold and silver as the basis for a new system of commodity money. ■

5-3 Inflation and Interest Rates

As we first discussed in Chapter 3, interest rates are among the most important macroeconomic variables. In essence, they are the prices that link the present and the future. Here we discuss the relationship between inflation and interest rates.

Two Interest Rates: Real and Nominal

Suppose you deposit your savings in a bank account that pays 8 percent interest annually. Next year, you withdraw your savings and the accumulated interest. Are you 8 percent richer than you were when you made the deposit a year earlier?

The answer depends on what "richer" means. Certainly, you have 8 percent more dollars than you had before. But if prices have risen, each dollar buys less, and your purchasing power has not risen by 8 percent. If the inflation rate was 5 percent over the year, then the amount of goods you can buy has increased by only 3 percent. And if the inflation rate was 10 percent, then your purchasing power has fallen by 2 percent.

The interest rate that the bank pays is called the **nominal interest rate**, and the increase in your purchasing power is called the **real interest rate**. If i denotes the nominal interest rate, r the real interest rate, and π the rate of inflation, then the relationship among these three variables can be written as

$$r = i - \pi.$$

The real interest rate is the difference between the nominal interest rate and the rate of inflation.[3]

The Fisher Effect

Rearranging terms in our equation for the real interest rate, we can show that the nominal interest rate is the sum of the real interest rate and the inflation rate:

$$i = r + \pi.$$

The equation written in this way is called the **Fisher equation**, after economist Irving Fisher (1867–1947). It shows that the nominal interest rate can change

[3] *Mathematical note:* This equation relating the real interest rate, nominal interest rate, and inflation rate is only an approximation. The exact formula is $(1 + r) = (1 + i)/(1 + \pi)$. The approximation in the text is reasonably accurate as long as r, i, and π are relatively small (say, less than 20 percent per year).

for two reasons: because the real interest rate changes or because the inflation rate changes.

Once we separate the nominal interest rate into these two parts, we can use this equation to develop a theory that explains the nominal interest rate. Chapter 3 showed that the real interest rate adjusts to equilibrate saving and investment. The quantity theory of money shows that the rate of money growth determines the rate of inflation. The Fisher equation then tells us to add the real interest rate and the inflation rate together to determine the nominal interest rate.

The quantity theory and the Fisher equation together tell us how money growth affects the nominal interest rate. *According to the quantity theory, an increase in the rate of money growth of 1 percent causes a 1 percent increase in the rate of inflation. According to the Fisher equation, a 1 percent increase in the rate of inflation in turn causes a 1 percent increase in the nominal interest rate.* The one-for-one relation between the inflation rate and the nominal interest rate is called the **Fisher effect**.

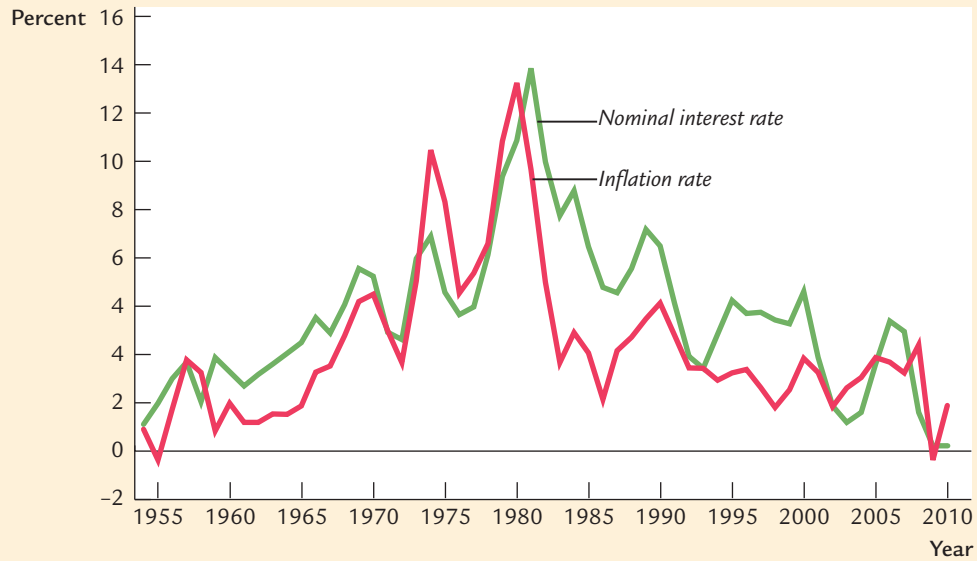
CASE STUDY

Inflation and Nominal Interest Rates

How useful is the Fisher effect in explaining interest rates? To answer this question, we look at two types of data on inflation and nominal interest rates.

Figure 5-3 shows the variation over time in the nominal interest rate and the inflation rate in the United States. You can see that the Fisher effect has done a

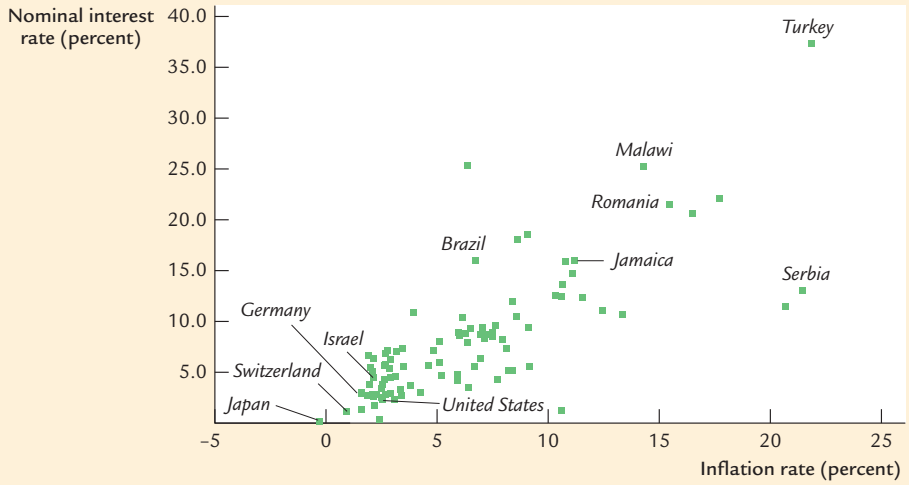
FIGURE 5-3



Inflation and Nominal Interest Rates Over Time This figure plots the nominal interest rate (on three-month Treasury bills) and the inflation rate (as measured by the CPI) in the United States since 1954. It shows the Fisher effect: higher inflation leads to a higher nominal interest rate.

Source: Federal Reserve and U.S. Department of Labor.

FIGURE 5-4



Inflation and Nominal Interest Rates Across Countries
This scatterplot shows the average nominal interest rate on short-term Treasury bills and the average inflation rate in almost 100 countries during the period 2000 to 2010. The positive correlation between the inflation rate and the nominal interest rate is evidence for the Fisher effect.

Source: International Monetary Fund.

good job explaining fluctuations in the nominal interest rate over the past half century. When inflation is high, nominal interest rates are typically high, and when inflation is low, nominal interest rates are typically low as well. Their correlation is 0.77.

Similar support for the Fisher effect comes from examining the variation across countries. As Figure 5-4 shows, a nation's inflation rate and its nominal interest rate are related. Countries with high inflation tend to have high nominal interest rates as well, and countries with low inflation tend to have low nominal interest rates. The correlation between these two variables is 0.76.

The link between inflation and interest rates is well known to Wall Street investment firms. Because bond prices move inversely with interest rates, one can get rich by correctly predicting the direction in which interest rates will move. Many Wall Street firms hire *Fed watchers* to monitor monetary policy and news about inflation to anticipate changes in interest rates. ■

Two Real Interest Rates: *Ex Ante* and *Ex Post*

When a borrower and lender agree on a nominal interest rate, they do not know what the inflation rate over the term of the loan will be. Therefore, we must distinguish between two concepts of the real interest rate: the real interest rate that the borrower and lender expect when the loan is made, called the

***ex ante* real interest rate**, and the real interest rate that is actually realized, called the ***ex post* real interest rate**.

Although borrowers and lenders cannot predict future inflation with certainty, they do have some expectation about what the inflation rate will be. Let π denote actual future inflation and $E\pi$ the expectation of future inflation. The *ex ante* real interest rate is $i - E\pi$, and the *ex post* real interest rate is $i - \pi$. The two real interest rates differ when actual inflation π differs from expected inflation $E\pi$.

How does this distinction between actual and expected inflation modify the Fisher effect? Clearly, the nominal interest rate cannot adjust to actual inflation, because actual inflation is not known when the nominal interest rate is set. The nominal interest rate can adjust only to expected inflation. The Fisher effect is more precisely written as

$$i = r + E\pi.$$

The *ex ante* real interest rate r is determined by equilibrium in the market for goods and services, as described by the model in Chapter 3. The nominal interest rate i moves one-for-one with changes in expected inflation $E\pi$.

CASE STUDY

Nominal Interest Rates in the Nineteenth Century

Although recent data show a positive relationship between nominal interest rates and inflation rates, this finding is not universal. In data from the late nineteenth and early twentieth centuries, high nominal interest rates did not accompany high inflation. The apparent absence of any Fisher effect during this time puzzled Irving Fisher. He suggested that inflation "caught merchants napping."

How should we interpret the absence of an apparent Fisher effect in nineteenth-century data? Does this period of history provide evidence against the adjustment of nominal interest rates to inflation? Recent research suggests that this period has little to tell us about the validity of the Fisher effect. The reason is that the Fisher effect relates the nominal interest rate to *expected* inflation and, according to this research, inflation at this time was largely unexpected.

Although expectations are not easily observable, we can draw inferences about them by examining the persistence of inflation. In recent experience, inflation has been very persistent: when it is high one year, it tends to be high the next year as well. Therefore, when people have observed high inflation, it has been rational for them to expect high inflation in the future. By contrast, during the nineteenth century, when the gold standard was in effect, inflation had little persistence. High inflation in one year was just as likely to be followed the next year by low inflation as by high inflation. Therefore, high inflation did not imply high expected inflation and did not lead to high nominal interest rates. So, in a sense, Fisher was right to say that inflation "caught merchants napping."[4] ■

[4]Robert B. Barsky, "The Fisher Effect and the Forecastability and Persistence of Inflation," *Journal of Monetary Economics* 19 (January 1987): 3–24.

5-4 The Nominal Interest Rate and the Demand for Money

The quantity theory is based on a simple money demand function: it assumes that the demand for real money balances is proportional to income. The quantity theory is a good place to start when analyzing the effects of money on the economy, but it is not the whole story. Here we add another determinant of the quantity of money demanded—the nominal interest rate.

The Cost of Holding Money

The money you hold in your wallet does not earn interest. If, instead of holding that money, you used it to buy government bonds or deposited it in a savings account, you would earn the nominal interest rate. Therefore, the nominal interest rate is the opportunity cost of holding money: it is what you give up by holding money rather than bonds.

Another way to see that the cost of holding money equals the nominal interest rate is by comparing the real returns on alternative assets. Assets other than money, such as government bonds, earn the real return r. Money earns an expected real return of $-E\pi$, because its real value declines at the rate of inflation. When you hold money, you give up the difference between these two returns. Thus, the cost of holding money is $r - (-E\pi)$, which the Fisher equation tells us is the nominal interest rate i.

Just as the quantity of bread demanded depends on the price of bread, the quantity of money demanded depends on the price of holding money. Hence, the demand for real money balances depends both on the level of income and on the nominal interest rate. We write the general money demand function as

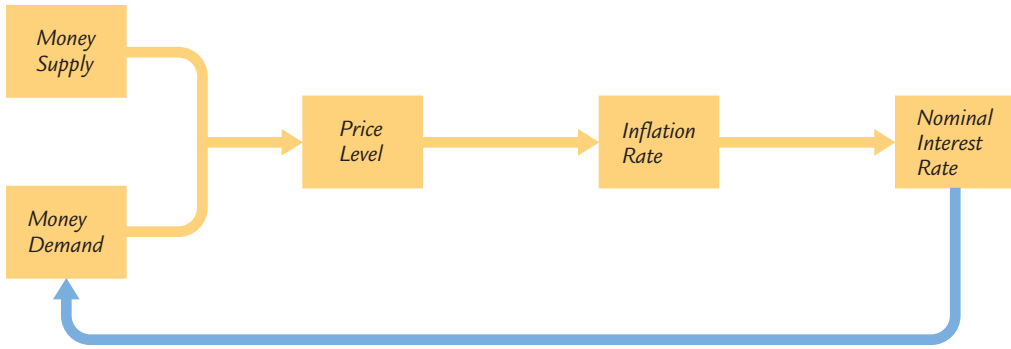
$$(M/P)^d = L(i, Y).$$

The letter L is used to denote money demand because money is the economy's most liquid asset (the asset most easily used to make transactions). This equation states that the demand for the liquidity of real money balances is a function of income and the nominal interest rate. The higher the level of income Y, the greater the demand for real money balances. The higher the nominal interest rate i, the lower the demand for real money balances.

Future Money and Current Prices

Money, prices, and interest rates are now related in several ways. Figure 5-5 illustrates the linkages we have discussed. As the quantity theory of money explains, money supply and money demand together determine the equilibrium price level. Changes in the price level are, by definition, the rate of inflation. Inflation, in turn, affects the nominal interest rate through the Fisher effect. But now, because the nominal interest rate is the cost of holding money, the nominal interest rate feeds back to affect the demand for money.

FIGURE 5-5



The Linkages Among Money, Prices, and Interest Rates This figure illustrates the relationships among money, prices, and interest rates. Money supply and money demand determine the price level. Changes in the price level determine the inflation rate. The inflation rate influences the nominal interest rate. Because the nominal interest rate is the cost of holding money, it may affect money demand. This last link (shown as a blue line) is omitted from the basic quantity theory of money.

Consider how the introduction of this last link affects our theory of the price level. First, equate the supply of real money balances M/P to the demand $L(i, Y)$:

$$M/P = L(i, Y).$$

Next, use the Fisher equation to write the nominal interest rate as the sum of the real interest rate and expected inflation:

$$M/P = L(r + E\pi, Y).$$

This equation states that the level of real money balances depends on the expected rate of inflation.

The last equation tells a more sophisticated story about the determination of the price level than does the quantity theory. The quantity theory of money says that today's money supply determines today's price level. This conclusion remains partly true: if the nominal interest rate and the level of output are held constant, the price level moves proportionately with the money supply. Yet the nominal interest rate is not constant; it depends on expected inflation, which in turn depends on growth in the money supply. The presence of the nominal interest rate in the money demand function yields an additional channel through which money supply affects the price level.

This general money demand equation implies that the price level depends not only on today's money supply but also on the money supply expected in the future. To see why, suppose the Fed announces that it will increase the money supply in the future, but it does not change the money supply today. This announcement causes people to expect higher money growth and higher inflation. Through the Fisher effect, this increase in expected inflation raises the nominal interest rate. The higher nominal interest rate increases the cost of holding money and therefore reduces the demand for real money balances. Because

the Fed has not changed the quantity of money available today, the reduced demand for real money balances leads to a higher price level. Hence, expectations of higher money growth in the future lead to a higher price level today.

The effect of money on prices is complex. The appendix to this chapter presents the *Cagan model*, which shows how the price level is related to current and expected future monetary policy. In particular, the analysis concludes that the price level depends on a weighted average of the current money supply and the money supply expected to prevail in the future.

5-5 The Social Costs of Inflation

Our discussion of the causes and effects of inflation does not tell us much about the social problems that result from inflation. We turn to those problems now.

The Layman's View and the Classical Response

If you ask the average person why inflation is a social problem, he will probably answer that inflation makes him poorer. "Each year my boss gives me a raise, but prices go up and that takes some of my raise away from me." The implicit assumption in this statement is that if there were no inflation, he would get the same raise and be able to buy more goods.

This complaint about inflation is a common fallacy. As we know from Chapter 3, the purchasing power of labor—the real wage—depends on the marginal productivity of labor, not on how much money the government chooses to print. If the central bank reduces inflation by slowing the rate of money growth, workers will not see their real wage increasing more rapidly. Instead, when inflation slows, firms will increase the prices of their products less each year and, as a result, will give their workers smaller raises.

According to the classical theory of money, a change in the overall price level is like a change in the units of measurement. It is as if we switched from measuring distances in feet to measuring them in inches: numbers get larger, but nothing really changes. Imagine that tomorrow morning you wake up and find that, for some reason, all dollar figures in the economy have been multiplied by ten. The price of everything you buy has increased tenfold, but so have your wage and the value of your savings. What difference would such a price increase make to your life? All numbers would have an extra zero at the end, but nothing else would change. Your economic well-being depends on relative prices, not the overall price level.

Why, then, is a persistent increase in the price level a social problem? It turns out that the costs of inflation are subtle. Indeed, economists disagree about the size of the social costs. To the surprise of many laymen, some economists argue that the costs of inflation are small—at least for the moderate rates of inflation that most countries have experienced in recent years.[5]

[5]See, for example, Chapter 2 of Alan Blinder, *Hard Heads, Soft Hearts: Tough-Minded Economics for a Just Society* (Reading, Mass.: Addison Wesley, 1987).

CASE STUDY

What Economists and the Public Say About Inflation

As we have been discussing, laymen and economists hold very different views about the costs of inflation. In 1996, economist Robert Shiller documented this difference of opinion in a survey of the two groups. The survey results are striking, for they show how the study of economics changes a person's attitudes.

In one question, Shiller asked people whether their "biggest gripe about inflation" was that "inflation hurts my real buying power, it makes me poorer." Of the general public, 77 percent agreed with this statement, compared to only 12 percent of economists. Shiller also asked people whether they agreed with the following statement: "When I see projections about how many times more a college education will cost, or how many times more the cost of living will be in coming decades, I feel a sense of uneasiness; these inflation projections really make me worry that my own income will not rise as much as such costs will." Among the general public, 66 percent said they fully agreed with this statement, whereas only 5 percent of economists agreed with it.

Survey respondents were asked to judge the seriousness of inflation as a policy problem: "Do you agree that preventing high inflation is an important national priority, as important as preventing drug abuse or preventing deterioration in the quality of our schools?" Shiller found that 52 percent of laymen, but only 18 percent of economists, fully agreed with this view. Apparently, inflation worries the public much more than it does the economics profession.

The public's distaste for inflation may be psychological. Shiller asked those surveyed if they agreed with the following statement: "I think that if my pay went up I would feel more satisfaction in my job, more sense of fulfillment, even if prices went up just as much." Of the public, 49 percent fully or partly agreed with this statement, compared to 8 percent of economists.

Do these survey results mean that laymen are wrong and economists are right about the costs of inflation? Not necessarily. But economists do have the advantage of having given the issue more thought. So let's now consider what some of the costs of inflation might be.[6] ■

The Costs of Expected Inflation

Consider first the case of expected inflation. Suppose that every month the price level rose by 1 percent. What would be the social costs of such a steady and predictable 12 percent annual inflation?

One cost is the distorting effect of the inflation tax on the amount of money people hold. As we have already discussed, a higher inflation rate leads to a higher nominal interest rate, which in turn leads to lower real money balances. If people hold lower money balances on average, they must make more frequent trips to the bank to withdraw money—for example, they might withdraw $50 twice

[6]Robert J. Shiller, "Why Do People Dislike Inflation?" in Christina D. Romer and David H. Romer, eds., *Reducing Inflation: Motivation and Strategy* (Chicago: University of Chicago Press, 1997): 13–65.

a week rather than $100 once a week. The inconvenience of reducing money holding is metaphorically called the **shoeleather cost** of inflation, because walking to the bank more often causes one's shoes to wear out more quickly.

A second cost of inflation arises because high inflation induces firms to change their posted prices more often. Changing prices is sometimes costly; for example, it may require printing and distributing a new catalog. These costs are called **menu costs**, because the higher the rate of inflation, the more often restaurants have to print new menus.

A third cost of inflation arises because firms facing menu costs change prices infrequently; therefore, the higher the rate of inflation, the greater the variability in relative prices. For example, suppose a firm issues a new catalog every January. If there is no inflation, then the firm's prices relative to the overall price level are constant over the year. Yet if inflation is 1 percent per month, then from the beginning to the end of the year the firm's relative prices fall by 12 percent. Sales from this catalog will tend to be low early in the year (when its prices are relatively high) and high later in the year (when its prices are relatively low). Hence, when inflation induces variability in relative prices, it leads to microeconomic inefficiencies in the allocation of resources.

A fourth cost of inflation results from the tax laws. Many provisions of the tax code do not take into account the effects of inflation. Inflation can alter individuals' tax liability, often in ways that lawmakers did not intend.

One example of the failure of the tax code to deal with inflation is the tax treatment of capital gains. Suppose you buy some stock today and sell it a year from now at the same real price. It would seem reasonable for the government not to levy a tax, because you have earned no real income from this investment. Indeed, if there is no inflation, a zero tax liability would be the outcome. But suppose the rate of inflation is 12 percent and you initially paid $100 per share for the stock; for the real price to be the same a year later, you must sell the stock for $112 per share. In this case the tax code, which ignores the effects of inflation, says that you have earned $12 per share in income, and the government taxes you on this capital gain. The problem is that the tax code measures income as the nominal rather than the real capital gain. In this example, and in many others, inflation distorts how taxes are levied.

A fifth cost of inflation is the inconvenience of living in a world with a changing price level. Money is the yardstick with which we measure economic transactions. When there is inflation, that yardstick is changing in length. To continue the analogy, suppose that Congress passed a law specifying that a yard would equal 36 inches in 2013, 35 inches in 2014, 34 inches in 2015, and so on. Although the law would result in no ambiguity, it would be highly inconvenient. When someone measured a distance in yards, it would be necessary to specify whether the measurement was in 2013 yards or 2014 yards; to compare distances measured in different years, one would need to make an "inflation" correction. Similarly, the dollar is a less useful measure when its value is always changing. The changing value of the dollar requires that we correct for inflation when comparing dollar figures from different times.

For example, a changing price level complicates personal financial planning. One important decision that all households face is how much of their income to consume today and how much to save for retirement. A dollar saved today and invested at a fixed nominal interest rate will yield a fixed dollar amount in the future. Yet the real

value of that dollar amount—which will determine the retiree's living standard—depends on the future price level. Deciding how much to save would be much simpler if people could count on the price level in 30 years being similar to its level today.

The Costs of Unexpected Inflation

Unexpected inflation has an effect that is more pernicious than any of the costs of steady, anticipated inflation: it arbitrarily redistributes wealth among individuals. You can see how this works by examining long-term loans. Most loan agreements specify a nominal interest rate, which is based on the rate of inflation expected at the time of the agreement. If inflation turns out differently from what was expected, the *ex post* real return that the debtor pays to the creditor differs from what both parties anticipated. On the one hand, if inflation turns out to be higher than expected, the debtor wins and the creditor loses because the debtor repays the loan with less valuable dollars. On the other hand, if inflation turns out to be lower than expected, the creditor wins and the debtor loses because the repayment is worth more than the two parties anticipated.

Consider, for example, a person taking out a mortgage in 1960. At the time, a 30-year mortgage had an interest rate of about 6 percent per year. This rate was based on a low rate of expected inflation—inflation over the previous decade had averaged only 2.5 percent. The creditor probably expected to receive a real return of about 3.5 percent, and the debtor expected to pay this real return. In fact, over the life of the mortgage, the inflation rate averaged 5 percent, so the *ex post* real return was only 1 percent. This unanticipated inflation benefited the debtor at the expense of the creditor.

Unanticipated inflation also hurts individuals on fixed pensions. Workers and firms often agree on a fixed nominal pension when the worker retires (or even earlier). Because the pension is deferred earnings, the worker is essentially providing the firm a loan: the worker provides labor services to the firm while young but does not get fully paid until old age. Like any creditor, the worker is hurt when inflation is higher than anticipated. Like any debtor, the firm is hurt when inflation is lower than anticipated.

These situations provide a clear argument against variable inflation. The more variable the rate of inflation, the greater the uncertainty that both debtors and creditors face. Because most people are *risk averse*—they dislike uncertainty—the unpredictability caused by highly variable inflation hurts almost everyone.

Given these effects of uncertain inflation, it is puzzling that nominal contracts are so prevalent. One might expect debtors and creditors to protect themselves from this uncertainty by writing contracts in real terms—that is, by indexing to some measure of the price level. In economies with high and variable inflation, indexation is often widespread; sometimes this indexation takes the form of writing contracts using a more stable foreign currency. In economies with moderate inflation, such as the United States, indexation is less common. Yet even in the United States, some long-term obligations are indexed. For example, Social Security benefits for the elderly are adjusted annually in response to changes in the consumer price index. And in 1997, the U.S. federal government issued inflation-indexed bonds for the first time.

Finally, in thinking about the costs of inflation, it is important to note a widely documented but little understood fact: high inflation is variable inflation. That is, countries with high average inflation also tend to have inflation rates that change greatly from year to year. The implication is that if a country decides to pursue a high-inflation monetary policy, it will likely have to accept highly variable inflation as well. As we have just discussed, highly variable inflation increases uncertainty for both creditors and debtors by subjecting them to arbitrary and potentially large redistributions of wealth.

CASE STUDY

The Free Silver Movement, the Election of 1896, and *The Wizard of Oz*

The redistributions of wealth caused by unexpected changes in the price level are often a source of political turmoil, as evidenced by the Free Silver movement in the late nineteenth century. From 1880 to 1896 the price level in the United States fell 23 percent. This deflation was good for creditors, primarily the bankers of the Northeast, but it was bad for debtors, primarily the farmers of the South and West. One proposed solution to this problem was to replace the gold standard with a bimetallic standard, under which both gold and silver could be minted into coin. The move to a bimetallic standard would increase the money supply and stop the deflation.

The silver issue dominated the presidential election of 1896. William McKinley, the Republican nominee, campaigned on a platform of preserving the gold standard. William Jennings Bryan, the Democratic nominee, supported the bimetallic standard. In a famous speech, Bryan proclaimed, "You shall not press down upon the brow of labor this crown of thorns, you shall not crucify mankind upon a cross of gold." Not surprisingly, McKinley was the candidate of the conservative eastern establishment, whereas Bryan was the candidate of the southern and western populists.

This debate over silver found its most memorable expression in a children's book, *The Wizard of Oz*. Written by a midwestern journalist, L. Frank Baum, just after the 1896 election, it tells the story of Dorothy, a girl lost in a strange land far from her home in Kansas. Dorothy (representing traditional American values) makes three friends: a scarecrow (the farmer), a tin woodman (the industrial worker), and a lion whose roar exceeds his might (William Jennings Bryan). Together, the four of them make their way along a perilous yellow brick road (the gold standard), hoping to find the Wizard who will help Dorothy return home. Eventually they arrive in Oz (Washington), where everyone sees the world through green glasses (money). The Wizard (William McKinley) tries to be all things to all people but turns out to be a fraud. Dorothy's problem is solved only when she learns about the magical power of her silver slippers.[7]

[7]The movie made forty years later hid much of the allegory by changing Dorothy's slippers from silver to ruby. For more on this topic, see Henry M. Littlefield, "The Wizard of Oz: Parable on Populism," *American Quarterly* 16 (Spring 1964): 47–58; and Hugh Rockoff, "The Wizard of Oz as a Monetary Allegory," *Journal of Political Economy* 98 (August 1990): 739–760. It should be noted that there is no direct evidence that Baum intended his work as a monetary allegory, so some people believe that the parallels are the work of economic historians' overactive imaginations.

The Republicans won the election of 1896, and the United States stayed on a gold standard, but the Free Silver advocates got the inflation that they wanted. Around the time of the election, gold was discovered in Alaska, Australia, and South Africa. In addition, gold refiners devised the cyanide process, which facilitated the extraction of gold from ore. These developments led to increases in the money supply and in prices. From 1896 to 1910 the price level rose 35 percent. ■

One Benefit of Inflation

So far, we have discussed the many costs of inflation. These costs lead many economists to conclude that monetary policymakers should aim for zero inflation. Yet there is another side to the story. Some economists believe that a little bit of inflation—say, 2 or 3 percent per year—can be a good thing.

The argument for moderate inflation starts with the observation that cuts in nominal wages are rare: firms are reluctant to cut their workers' nominal wages, and workers are reluctant to accept such cuts. A 2 percent wage cut in a zero-inflation world is, in real terms, the same as a 3 percent raise with 5 percent inflation, but workers do not always see it that way. The 2 percent wage cut may seem like an insult, whereas the 3 percent raise is, after all, still a raise. Empirical studies confirm that nominal wages rarely fall.

This finding suggests that some inflation may make labor markets work better. The supply and demand for different kinds of labor are always changing. Sometimes an increase in supply or decrease in demand leads to a fall in the equilibrium real wage for a group of workers. If nominal wages can't be cut, then the only way to cut real wages is to allow inflation to do the job. Without inflation, the real wage will be stuck above the equilibrium level, resulting in higher unemployment.

For this reason, some economists argue that inflation "greases the wheels" of labor markets. Only a little inflation is needed: an inflation rate of 2 percent lets real wages fall by 2 percent per year, or 20 percent per decade, without cuts in nominal wages. Such automatic reductions in real wages are impossible with zero inflation.[8]

5-6 Hyperinflation

Hyperinflation is often defined as inflation that exceeds 50 percent per month, which is just over 1 percent per day. Compounded over many months, this rate of inflation leads to very large increases in the price level. An inflation rate of 50 percent per month implies a more than 100-fold increase in the price level over a year and a more than 2-million-fold increase over three years. Here we consider the costs and causes of such extreme inflation.

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[8]For an examination of this benefit of inflation, see George A. Akerlof, William T. Dickens, and George L. Perry, "The Macroeconomics of Low Inflation," *Brookings Papers on Economic Activity*, 1996:1, pp. 1–76. Another argument for positive inflation is that it allows for the possibility of negative real interest rates. This issue is discussed in Chapter 12 in an FYI box on The Liquidity Trap.

The Costs of Hyperinflation

Although economists debate whether the costs of moderate inflation are large or small, no one doubts that hyperinflation extracts a high toll on society. The costs are qualitatively the same as those we discussed earlier. When inflation reaches extreme levels, however, these costs are more apparent because they are so severe.

The shoeleather costs associated with reduced money holding, for instance, are serious under hyperinflation. Business executives devote much time and energy to cash management when cash loses its value quickly. By diverting this time and energy from more socially valuable activities, such as production and investment decisions, hyperinflation makes the economy run less efficiently.

Menu costs also become larger under hyperinflation. Firms have to change prices so often that normal business practices, such as printing and distributing catalogs with fixed prices, become impossible. In one restaurant during the German hyperinflation of the 1920s, a waiter would stand up on a table every 30 minutes to call out the new prices.

Similarly, relative prices do not do a good job of reflecting true scarcity during hyperinflations. When prices change frequently by large amounts, it is hard for customers to shop around for the best price. Highly volatile and rapidly rising prices can alter behavior in many ways. According to one report, when patrons entered a pub during the German hyperinflation, they would often buy two pitchers of beer. Although the second pitcher would lose value by getting warm over time, it would lose value less rapidly than the money left sitting in the patron's wallet.

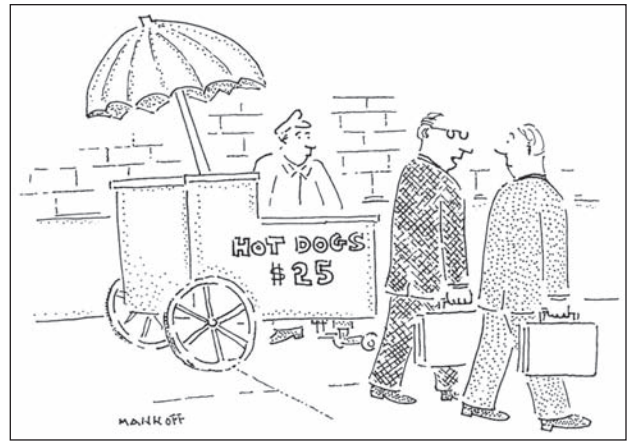
Tax systems are also distorted by hyperinflation—but in ways that are different from the distortions of moderate inflation. In most tax systems there is a delay between the time a tax is levied and the time it is actually paid to the government. In the United States, for example, taxpayers are required to make estimated income tax payments every three months. This short delay does not matter much under low inflation. By contrast, during hyperinflation, even a short delay greatly reduces real tax revenue. By the time the government gets the money it is due, the money has fallen in value. As a result, once hyperinflations start, the real tax revenue of the government often falls substantially.

Finally, no one should underestimate the sheer inconvenience of living with hyperinflation. When carrying money to the grocery store is as burdensome as carrying the groceries back home, the monetary system is not doing its best to facilitate exchange. The government tries to overcome this problem by adding more and more zeros to the paper currency, but often it cannot keep up with the exploding price level.

Eventually, these costs of hyperinflation become intolerable. Over time, money loses its role as a store of value, unit of account, and medium of exchange. Barter becomes more common. And more stable unofficial monies—cigarettes or the U.S. dollar—start to replace the official money.

The Causes of Hyperinflation

Why do hyperinflations start, and how do they end? This question can be answered at different levels.



"I told you the Fed should have tightened."

The most obvious answer is that hyperinflations are due to excessive growth in the supply of money. When the central bank prints money, the price level rises. When it prints money rapidly enough, the result is hyperinflation. To stop the hyperinflation, the central bank must reduce the rate of money growth.

This answer is incomplete, however, for it leaves open the question of why central banks in hyperinflating economies choose to print so much money. To address this deeper question, we must turn our attention from monetary to fiscal policy. Most hyperinflations begin when the government has inadequate tax revenue to pay for its spending. Although the government might prefer to finance this budget deficit by issuing debt, it may find itself unable to borrow, perhaps because lenders view the government as a bad credit risk. To cover the deficit, the government turns to the only mechanism at its disposal—the printing press. The result is rapid money growth and hyperinflation.

Once the hyperinflation is under way, the fiscal problems become even more severe. Because of the delay in collecting tax payments, real tax revenue falls as inflation rises. Thus, the government's need to rely on seigniorage is self-reinforcing. Rapid money creation leads to hyperinflation, which leads to a larger budget deficit, which leads to even more rapid money creation.

The ends of hyperinflations almost always coincide with fiscal reforms. Once the magnitude of the problem becomes apparent, the government musters the political will to reduce government spending and increase taxes. These fiscal reforms reduce the need for seigniorage, which allows a reduction in money growth. Hence, even if inflation is always and everywhere a monetary phenomenon, the end of hyperinflation is often a fiscal phenomenon as well.[9]

CASE STUDY

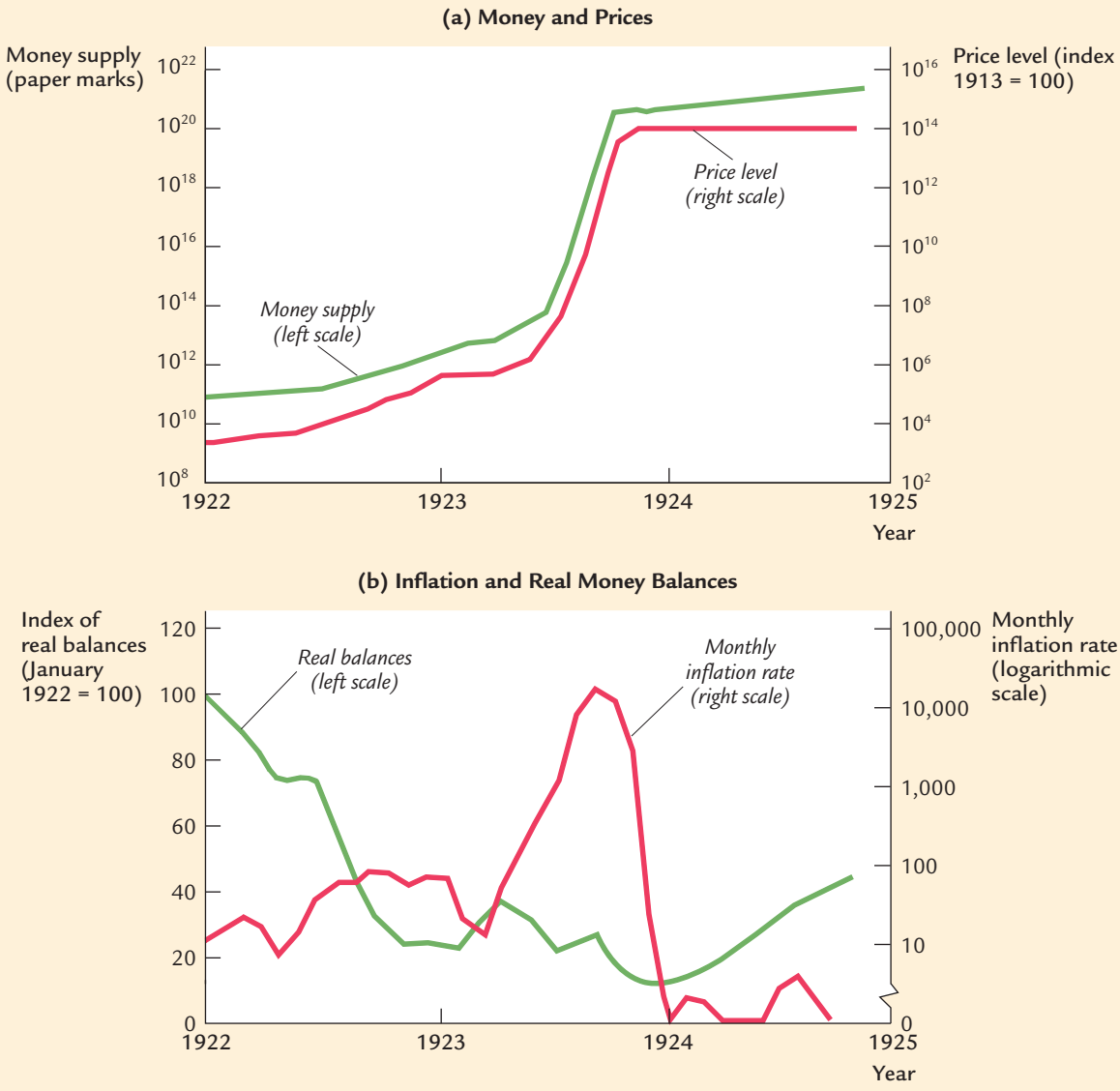
Hyperinflation in Interwar Germany

After World War I, Germany experienced one of history's most spectacular examples of hyperinflation. At the war's end, the Allies demanded that Germany pay substantial reparations. These payments led to fiscal deficits in Germany, which the German government eventually financed by printing large quantities of money.

Panel (a) of Figure 5-6 shows the quantity of money and the general price level in Germany from January 1922 to December 1924. During this period

[9]For more on these issues, see Thomas J. Sargent, "The End of Four Big Inflations," in Robert Hall, ed., *Inflation* (Chicago: University of Chicago Press, 1983), 41–98; and Rudiger Dornbusch and Stanley Fischer, "Stopping Hyperinflations: Past and Present," *Weltwirtschaftliches Archiv* 122 (April 1986): 1–47.

FIGURE 5-6



Money and Prices in Interwar Germany Panel (a) shows the money supply and the price level in Germany from January 1922 to December 1924. The immense increases in the money supply and the price level provide a dramatic illustration of the effects of printing large amounts of money. Panel (b) shows inflation and real money balances. As inflation rose, real money balances fell. When the inflation ended at the end of 1923, real money balances rose.

Source: Adapted from Thomas J. Sargent, "The End of Four Big Inflations," in Robert Hall, ed., *Inflation* (Chicago: University of Chicago Press, 1983), 41–98.

both money and prices rose at an amazing rate. For example, the price of a daily newspaper rose from 0.30 mark in January 1921 to 1 mark in May 1922, to 8 marks in October 1922, to 100 marks in February 1923, and to 1,000 marks in September 1923. Then, in the fall of 1923, prices took off: the newspaper sold for 2,000 marks on October 1, 20,000 marks on October 15, 1 million marks on October 29, 15 million marks on November 9, and 70 million marks on November 17. In December 1923 the money supply and prices abruptly stabilized.[10]

Just as fiscal problems caused the German hyperinflation, a fiscal reform ended it. At the end of 1923, the number of government employees was cut by one-third, and the reparations payments were temporarily suspended and eventually reduced. At the same time, a new central bank, the Rentenbank, replaced the old central bank, the Reichsbank. The Rentenbank was committed to not financing the government by printing money.

According to our theoretical analysis of money demand, an end to a hyperinflation should lead to an increase in real money balances as the cost of holding money falls. Panel (b) of Figure 5-6 shows that real money balances in Germany did fall as inflation increased and then increased again as inflation fell. Yet the increase in real money balances was not immediate. Perhaps the adjustment of real money balances to the cost of holding money is a gradual process. Or perhaps it took time for people in Germany to believe that the inflation had ended, so that expected inflation fell more gradually than actual inflation. ■

CASE STUDY

Hyperinflation in Zimbabwe

In 1980, after years of colonial rule, the old British colony of Rhodesia became the new African nation of Zimbabwe. A new currency, the Zimbabwe dollar, was introduced to replace the Rhodesian dollar. For the first decade, inflation in the new nation was modest—about 10 to 20 percent per year. That, however, would soon change.

The hero of the Zimbabwe independence movement was Robert Mugabe. In general elections in 1980, he became the nation's first prime minister and later, after a government reorganization, its president. Over the years, he continued to get reelected. In his 2008 reelection, however, there were widespread claims of electoral fraud and threats against voters who supported rival candidates. At the age of 84, Mugabe was no longer as popular as he once was, but he gave no sign of any willingness to relinquish power.

Throughout his tenure, Mugabe's economic philosophy was Marxist, and one of his goals was to redistribute wealth. In the 1990s his government instituted a series of land reforms with the ostensible purpose of redistributing land from

[10]The data on newspaper prices are from Michael Mussa, "Sticky Individual Prices and the Dynamics of the General Price Level," *Carnegie-Rochester Conference on Public Policy* 15 (Autumn 1981): 261–296.

the white minority who ruled Zimbabwe during the colonial era toward the historically disenfranchised black population. One result of these reforms was widespread corruption. Many abandoned and expropriated white farms ended up in the hands of cabinet ministers and senior government officials. Another result was a substantial decline in farm output. Productivity fell as many of the experienced white farmers fled the country.

The decline in the economy's output led to a fall in the government's tax revenue. The government responded to this revenue shortfall by printing money to pay the salaries of government employees. As textbook economic theory predicts, the monetary expansion led to higher inflation.

Mugabe tried to deal with inflation by imposing price controls. Once again, the result was predictable: a shortage of many goods and the growth of an underground economy where price controls and tax collection were evaded. The government's tax revenue declined further, inducing even more monetary expansion and yet higher inflation. In July 2008, the officially reported inflation rate was 231 million percent. Other observers put the inflation rate even higher.

The repercussions of the hyperinflation were widespread. In an article in the *Washington Post*, one Zimbabwean citizen describes the situation as follows: "If you don't get a bill collected in 48 hours, it isn't worth collecting, because it is worthless. Whenever we get money, we must immediately spend it, just go and buy what we can. Our pension was destroyed ages ago. None of us have any savings left."

The Zimbabwe hyperinflation finally ended in March 2009, when the government abandoned its own money. The U.S. dollar became the nation's official currency. Inflation quickly stabilized. Zimbabwe still had its problems, but at least hyperinflation was not among them. ■

5-7 Conclusion: The Classical Dichotomy

Over the course of this and the previous chapter, we have studied the meaning of money and the impact of the money supply on inflation and various other variables. This analysis builds on our model of national income in Chapter 3. Let's now step back and examine a key assumption that has been implicit in our discussion.

In Chapter 3, we explained many macroeconomic variables. Some of these variables were *quantities*, such as real GDP and the capital stock; others were *relative prices*, such as the real wage and the real interest rate. But all of these variables had one thing in common—they measured a physical (rather than a monetary) quantity. Real GDP is the quantity of goods and services produced in a given year, and the capital stock is the quantity of machines and structures available at a given time. The real wage is the quantity of output a worker earns for each hour of work, and the real interest rate is the quantity of output a person earns in the future by lending one unit of output today. All variables measured in physical units, such as quantities and relative prices, are called **real variables**.

In this chapter we examined **nominal variables**—variables expressed in terms of money. The economy has many nominal variables, such as the price level, the inflation rate, and the dollar wage a person earns.

At first it may seem surprising that we were able to explain real variables without introducing nominal variables or the existence of money. In Chapter 3 we studied the level and allocation of the economy's output without mentioning the price level or the rate of inflation. Our theory of the labor market explained the real wage without explaining the nominal wage.

Economists call this theoretical separation of real and nominal variables the **classical dichotomy**. It is the hallmark of classical macroeconomic theory. The classical dichotomy is an important insight because it simplifies economic theory. In particular, it allows us to examine real variables, as we have done, while ignoring nominal variables. The classical dichotomy arises because, in classical economic theory, changes in the money supply do not influence real variables. This irrelevance of money for real variables is called **monetary neutrality**. For many purposes—in particular for studying long-run issues—monetary neutrality is approximately correct.

Yet monetary neutrality does not fully describe the world in which we live. Beginning in Chapter 10, we discuss departures from the classical model and monetary neutrality. These departures are crucial for understanding many macroeconomic phenomena, such as short-run economic fluctuations.

Summary

1. The quantity theory of money assumes that the velocity of money is stable and concludes that nominal GDP is proportional to the stock of money. Because the factors of production and the production function determine real GDP, the quantity theory implies that the price level is proportional to the quantity of money. Therefore, the rate of growth in the quantity of money determines the inflation rate.
2. Seigniorage is the revenue that the government raises by printing money. It is a tax on money holding. Although seigniorage is quantitatively small in most economies, it is often a major source of government revenue in economies experiencing hyperinflation.
3. The real interest rate is the nominal interest rate (the interest rate as usually reported) corrected for the effects of inflation. The *ex post* real interest rate is based on actual inflation, whereas the *ex ante* real interest rate is based on expected inflation. The Fisher effect says that the nominal interest rate moves one-for-one with expected inflation.
4. The nominal interest rate is the opportunity cost of holding money. Thus, one might expect the demand for money to depend on the nominal interest rate. If it does, then the price level depends on both the current quantity of money and the quantities of money expected in the future.

5. The costs of expected inflation include shoeleather costs, menu costs, the cost of relative price variability, tax distortions, and the inconvenience of making inflation corrections. In addition, unexpected inflation causes arbitrary redistributions of wealth between debtors and creditors. One possible benefit of inflation is that it improves the functioning of labor markets by allowing real wages to reach equilibrium levels without cuts in nominal wages.
6. During hyperinflations, most of the costs of inflation become severe. Hyperinflations typically begin when governments finance large budget deficits by printing money. They end when fiscal reforms eliminate the need for seigniorage.
7. According to classical economic theory, money is neutral: the money supply does not affect real variables. Therefore, classical theory allows us to study how real variables are determined without any reference to the money supply. The equilibrium in the money market then determines the price level and, as a result, all other nominal variables. This theoretical separation of real and nominal variables is called the classical dichotomy.

KEY CONCEPTS

Inflation
Hyperinflation
Quantity equation
Transactions velocity of money
Income velocity of money
Real money balances
Money demand function
Quantity theory of money
Seigniorage
Nominal and real interest rates
Fisher equation and Fisher effect
Ex ante and *ex post* real interest rates
Shoeleather costs
Menu costs
Real and nominal variables
Classical dichotomy
Monetary neutrality

QUESTIONS FOR REVIEW

1. Write the quantity equation and explain it.
2. What does the assumption of constant velocity imply?
3. Who pays the inflation tax?
4. If inflation rises from 6 to 8 percent, what happens to real and nominal interest rates according to the Fisher effect?
5. List all the costs of inflation you can think of, and rank them according to how important you think they are.
6. Explain the roles of monetary and fiscal policy in causing and ending hyperinflations.
7. Define the terms "real variable" and "nominal variable," and give an example of each.

PROBLEMS AND APPLICATIONS

1. In the country of Wiknam, the velocity of money is constant. Real GDP grows by 5 percent per year, the money stock grows by 14 percent per year, and the nominal interest rate is 11 percent. What is the real interest rate?

2. A newspaper article once reported that the U.S. economy was experiencing a low rate of inflation. It said that "low inflation has a downside: 45 million recipients of Social Security and other benefits will see their checks go up by just 2.8 percent next year."

a. Why does inflation affect the increase in Social Security and other benefits?

b. Is this effect a cost of inflation, as the article suggests? Why or why not?

3. Suppose a country has a money demand function $(M/P)^d = kY$, where k is a constant parameter. The money supply grows by 12 percent per year, and real income grows by 4 percent per year.

a. What is the average inflation rate?

b. How would inflation be different if real income growth were higher? Explain.

c. How do you interpret the parameter k? What is its relationship to the velocity of money?

d. Suppose, instead of a constant money demand function, the velocity of money in this economy was growing steadily because of financial innovation. How would that affect the inflation rate? Explain.

4. During World War II, both Germany and England had plans for a paper weapon: they each printed the other's currency, with the intention of dropping large quantities by airplane. Why might this have been an effective weapon?

5. Suppose that the money demand function takes the form

$$(M/P)^d = L(i, Y) = Y/(5i)$$

a. If output grows at rate g, at what rate will the demand for real balances grow (assuming constant nominal interest rates)?

b. What is the velocity of money in this economy?

c. If inflation and nominal interest rates are constant, at what rate, if any, will velocity grow?

d. How will a permanent (once-and-for-all) increase in the level of interest rates affect the level of velocity? How will it affect the subsequent growth rate of velocity?

6. In each of the following scenarios, explain and categorize the cost of inflation.

a. Because inflation has risen, the L.L. Bean Company decides to issue a new catalog quarterly rather than annually.

b. Grandma buys an annuity for $100,000 from an insurance company, which promises to pay her $10,000 a year for the rest of her life. After buying it, she is surprised that high inflation triples the price level over the next few years.

c. Maria lives in an economy with hyperinflation. Each day after being paid, she runs to the store as quickly as possible so she can spend her money before it loses value.

d. Warren lives in an economy with an inflation rate of 10 percent. Over the past year, he earned a return of $50,000 on his million-dollar portfolio of stocks and bonds. Because his tax rate is 20 percent, he paid $10,000 to the government.

e. Your father tells you that when he was your age, he worked for only $3 an hour. He suggests that you are lucky to have a job that pays $7 an hour.

7. When Calvin Coolidge was vice president and giving a speech about government finances, he said that "inflation is repudiation." What might he have meant by this? Do you agree? Why or why not? Does it matter whether the inflation is expected or unexpected?

8. Some economic historians have noted that during the period of the gold standard, gold discoveries were most likely to occur after a long deflation. (The discoveries of 1896 are an example.) Why might this be true?

APPENDIX

The Cagan Model: How Current and Future Money Affect the Price Level

In this chapter we showed that if the quantity of real money balances demanded depends on the cost of holding money, the price level depends on both the current money supply and the future money supply. This appendix develops the *Cagan model* to show more explicitly how this relationship works.[11]

To keep the math as simple as possible, we posit a money demand function that is linear in the natural logarithms of all the variables. The money demand function is

$$m_t - p_t = -\gamma(p_{t+1} - p_t), \tag{A1}$$

where m_t is the log of the quantity of money at time t, p_t is the log of the price level at time t, and γ is a parameter that governs the sensitivity of money demand to the rate of inflation. By the property of logarithms, $m_t - p_t$ is the log of real money balances, and $p_{t+1} - p_t$ is the inflation rate between period t and period $t + 1$. This equation states that if inflation goes up by 1 percentage point, real money balances fall by γ percent.

We have made a number of assumptions in writing the money demand function in this way. First, by excluding the level of output as a determinant of money demand, we are implicitly assuming that it is constant. Second, by including the rate of inflation rather than the nominal interest rate, we are assuming that the real interest rate is constant. Third, by including actual inflation rather than expected inflation, we are assuming perfect foresight. All of these assumptions are made to keep the analysis as simple as possible.

We want to solve Equation A1 to express the price level as a function of current and future money. To do this, note that Equation A1 can be rewritten as

$$p_t = \left(\frac{1}{1+\gamma}\right)m_t + \left(\frac{\gamma}{1+\gamma}\right)p_{t+1}. \tag{A2}$$

This equation states that the current price level p_t is a weighted average of the current money supply m_t and the next period's price level p_{t+1}. The next period's price level will be determined the same way as this period's price level:

$$p_{t+1} = \left(\frac{1}{1+\gamma}\right)m_{t+1} + \left(\frac{\gamma}{1+\gamma}\right)p_{t+2}. \tag{A3}$$

[11]This model is derived from Phillip Cagan, "The Monetary Dynamics of Hyperinflation," in Milton Friedman, ed., *Studies in the Quantity Theory of Money* (Chicago: University of Chicago Press, 1956): 25–117.

Now substitute Equation A3 for p_{t+1} in Equation A2 to obtain

$$p_t = \frac{1}{1+\gamma} m_t + \frac{\gamma}{(1+\gamma)^2} m_{t+1} + \frac{\gamma^2}{(1+\gamma)^2} p_{t+2}. \tag{A4}$$

Equation A4 states that the current price level is a weighted average of the current money supply, the next period's money supply, and the following period's price level. Once again, the price level in period $t + 2$ is determined as in Equation A2:

$$p_{t+2} = \left(\frac{1}{1+\gamma}\right) m_{t+2} + \left(\frac{\gamma}{1+\gamma}\right) p_{t+3}. \tag{A5}$$

Now substitute Equation A5 into Equation A4 to obtain

$$p_t = \frac{1}{1+\gamma} m_t + \frac{\gamma}{(1+\gamma)^2} m_{t+1} + \frac{\gamma^2}{(1+\gamma)^3} m_{t+2} + \frac{\gamma^3}{(1+\gamma)^3} p_{t+3}. \tag{A6}$$

By now you see the pattern. We can continue to use Equation A2 to substitute for the future price level. If we do this an infinite number of times, we find

$$p_t = \left(\frac{1}{1+\gamma}\right)\left[m_t + \left(\frac{\gamma}{1+\gamma}\right) m_{t+1} + \left(\frac{\gamma}{1+\gamma}\right)^2 m_{t+2} + \left(\frac{\gamma}{1+\gamma}\right)^3 m_{t+3} + \cdots \right], \tag{A7}$$

where ". . ." indicates an infinite number of analogous terms. According to Equation A7, the current price level is a weighted average of the current money supply and all future money supplies.

Note the importance of γ, the parameter governing the sensitivity of real money balances to inflation. The weights on the future money supplies decline geometrically at rate $\gamma/(1 + \gamma)$. If γ is small, then $\gamma/(1 + \gamma)$ is small, and the weights decline quickly. In this case, the current money supply is the primary determinant of the price level. (Indeed, if γ equals zero, we obtain the quantity theory of money: the price level is proportional to the current money supply, and the future money supplies do not matter at all.) If γ is large, then $\gamma/(1 + \gamma)$ is close to 1, and the weights decline slowly. In this case, the future money supplies play a key role in determining today's price level.

Finally, let's relax the assumption of perfect foresight. If the future is not known with certainty, then we should write the money demand function as

$$m_t - p_t = -\gamma(Ep_{t+1} - p_t), \tag{A8}$$

where Ep_{t+1} is the expected price level. Equation A8 states that real money balances depend on expected inflation. By following steps similar to those above, we can show that

$$p_t = \left(\frac{1}{1+\gamma}\right)\left[m_t + \left(\frac{\gamma}{1+\gamma}\right) Em_{t+1} + \left(\frac{\gamma}{1+\gamma}\right)^2 Em_{t+2} + \left(\frac{\gamma}{1+\gamma}\right)^3 Em_{t+3} + \cdots \right]. \tag{A9}$$

Equation A9 states that the price level depends on the current money supply and expected future money supplies.

Some economists use this model to argue that *credibility* is important for ending hyperinflation. Because the price level depends on both current and expected future money, inflation depends on both current and expected future money growth. Therefore, to end high inflation, both money growth and expected money growth must fall. Expectations, in turn, depend on credibility—the perception that the central bank is committed to a new, more stable policy.

How can a central bank achieve credibility in the midst of hyperinflation? Credibility is often achieved by removing the underlying cause of the hyperinflation—the need for seigniorage. Thus, a credible fiscal reform is often necessary for a credible change in monetary policy. This fiscal reform might take the form of reducing government spending and making the central bank more independent from the government. Reduced spending decreases the need for seigniorage, while increased independence allows the central bank to resist government demands for seigniorage.

MORE PROBLEMS AND APPLICATIONS

1. In the Cagan model, if the money supply is expected to grow at some constant rate μ (so that $Em_{t+s} = m_t + s\mu$), then Equation A9 can be shown to imply that $p_t = m_t + \gamma\mu$.

a. Interpret this result.

b. What happens to the price level p_t when the money supply m_t changes, holding the money growth rate μ constant?

c. What happens to the price level p_t when the money growth rate μ changes, holding the current money supply m_t constant?

d. If a central bank is about to reduce the rate of money growth μ but wants to hold the price level p_t constant, what should it do with m_t? Can you see any practical problems that might arise in following such a policy?

e. How do your previous answers change in the special case where money demand does not depend on the expected rate of inflation (so that $\gamma = 0$)?