Inflation is the rate of growth in the price level. If inflation is negative, it is called deflation, while the movement to a lower rate of inflation, say from 6% to 4%, is called disinflation. Among the public and professionals alike inflation is one of the most discussed macroeconomic topics.

The CPI is plotted in Figure 1. This graph uses a proportional scale for the CPI so that the slope of the line in these graphs equals the rate of inflation. This graph highlights changes in the core or long run rate of inflation. For example, from 1955 to 1967 inflation averaged about 1.5%. Inflation averaged 6.8% per year over the next 15 years, and from 1982 to 1992 inflation fell to 3.7% per year. From 1993 through 2003, the inflation rate has fallen to 2.4%.

Figure 1 gives the illusion that inflation is rather stable. Figure 2 plots the inflation rate and shatters this illusion. The inflation rate follows a very jagged and erratic pattern. Neverthe-
less, you can tell from the plot that inflation was on average higher in the '70s than in either the '60s or the '80s. We now begin our study of these price level movements.

**Jumps, Temporary Inflation, and the Core Rate of Inflation**

We have discussed many shocks that can change the price level. For example, a once-and-for-all increase in the money supply will cause a once-and-for-all change in the price level. Suppose that this occurs at time $t_1$. This is graphed in panel A of Figure 3. The price level before time $t_1$ is constant at $P_0$ so that inflation is zero. The price level is also constant after time $t_1$, and again this means that inflation is zero. A one-time change in the money supply causes a **jump** in the price level, but no change in the inflation rate. It is zero both before and after time $t_1$.

It is possible that the price level doesn't immediately and fully adjust to the change in the money supply. This is the case pictured in Panel B. At time $t_1$ the money supply increases once-and-for-all, but the price level doesn't reach its new permanent level until time $t_2$. In the interim the price level rises, and there is inflation. It should be mentioned that the path between the old price level and the new one need not be a straight line. For example, the price level may initially overshoot before returning to its new permanent level as pictured by the dotted line.
The price level behavior in Panels A and B should be contrasted with the behavior depicted in Panel C. In Panel C inflation is zero before time $t_1$, and afterwards it is positive, say 3%. In this case the price level is continually increasing, and we say that the **long run** or **core rate of inflation** has increased.

### Interpreting Price Level Changes

Price level jumps occur frequently and make the identification of changes in the core rate of inflation difficult. For example, suppose that at time $t_1$ a jump in the price level occurs at the same time as an increase in the core rate of inflation. This scenario is drawn in Figure 4.

Price level data does not arrive continuously, instead it shows up in discrete intervals, for example, the CPI is calculated each month. Suppose at time $t_0$ the price level $P_0$ is observed and at time $t_2$ $P_2$ is reported. How might a "naive" observer...
interpret these events? The observer, being naive, doesn't make the distinction between a jump in the price level and a change in the core rate of inflation. This observer thinks that the core rate of inflation is measured along the dotted line between A and B, and will calculate it as, say, 6%. But the well-schooled observer knows that this overstates the increase in the core rate of inflation. The core rate of inflation has increased to be sure, but not up to 6%. In our example we assumed that the increase is only up to 3%. The moral of this story is that positive jumps in the price level will lead naive observers to overestimate the change in the core rate of inflation.

This is not just an academic exercise. The average rate of inflation in the 1960s was about 2.5%, and rose to about 6% in the 1970s. Roughly speaking, then, the core rate of inflation increased by 3.5%. By historical measures this is a substantial increase, but at the time it looked far worse. The increase in the core rate of inflation was accompanied by several large price shocks or jumps. In particular, OPEC raised the price of oil by a factor of four toward the end of 1973 and into 1974, and the cartel more than doubled the price of oil in 1979. At approximately the same time bad weather conditions around the world produced poor harvests and rising food prices. These shocks, combined with the increase in the core rate of inflation, were the major contributors to the double-digit inflation in 1974 and 1979. For these two years the inflation rates using the CPI were 12.2% and 13.3%, respectively. The double-digit inflation in these two years did not reflect pure changes in the core rate of inflation, but also included price level jumps caused by supply shocks. Nevertheless, these two episodes typically identify the 1970s as the decade of double-digit inflation.36

**Explaining Changes in the Core Rate of Inflation**

We noted earlier the differences between jumps in the price level, transitory inflation and permanent changes in inflation. A price level jump may be caused by many different things; for example, supply shocks, shocks to money demand or money supply. It is now time to look at the determinants of the long run or core rate of inflation.

To understand inflation we must remember the determinants of the price level, and then adjust the arguments to account for rates of change. The price level is determined by the supply

and demand for money. The price level rises if there is an excess supply of money and falls if there is an excess demand for money. Since inflation is the rate of growth in the price level a reasonable guess would be that inflation is determined by the relative rates of growth in money demand and money supply. If the supply of money grows faster than the demand for money, then we would expect inflation as the result. Deflation would occur if money demand grows faster than money supply. In short, since levels of money demand and supply determine the price level, we expect that rates of growth in money demand and money supply determine the inflation rate. In the next section we confirm this guess.

From Levels to Rates of Change

The natural place to start our analysis of inflation is the equilibrium condition in the money market. Equilibrium requires that the supply of real money balances equals the demand for real money balances. In symbols,

$$\frac{M^s}{P} = L(r, Y, \gamma, \pi^{expected})$$

By some simple algebra, which we will spare the reader, you can show that

$$\frac{\Delta M}{M} - \frac{\Delta P}{P} = \frac{\Delta L}{L}.$$  

The term $\Delta P/P$ is just the inflation rate, and some slight rearrangement gives us

$$\frac{\Delta P}{P} = \frac{\Delta M}{M^*} - \frac{\Delta L}{L}.$$  

This equation says that inflation equals the difference between the rate of growth in the money supply and the rate of growth in money demand. For example, suppose that the money supply is growing at a rate of 10% and money demand is growing at a rate of 6%. Since the supply of money is growing 4% faster than the willingness of people to hold it, inflation settles at 4%. So, we have confirmed our guess.
The next step is to find out what determines the rates of growth in money demand and supply. The growth rate of the money supply is determined by the government, but what causes the demand for money to grow? The answer is again pretty simple. Just look back at what determines the level of the demand for real money balances. These are the levels of the interest rate, the expected rate of inflation, transactions cost, and real income. The rate of growth in money demand is just the result of growth in these variables.

**The Quantity Theory of Money**

It turns out that it is simpler to study the growth in money demand from the perspective of the quantity theory of money. This theory is one of the oldest and most venerable theories in economics, and would be worth studying in any case. It is equivalent to our model of the money market, but views this market from a different vantage point. The quantity theory is usually expressed by the quantity equation. This famous equation is

\[ M \times V = P \times Y \]

We are already familiar with three of the four variables in this equation. M is still the money supply, P is the price level, and Y is real output. The new term is V, and it stands for the velocity of money. The velocity of money is the number of times per period that the typical dollar changes hands in the purchase of a final good or service. It is the speed at which people are spending money to buy the nation's output.

A famous British economist named Dennis Robertson used the following story to explain the meaning of velocity. There were once two enterprising students who came up with a way to make some extra money when the fair came into town. They decided to sell beer. Their idea was to buy a keg of beer at the local brewery, haul it over to the entrance of the fair, and sell beer to the comers and goers.

After the two bought the keg of beer, call them Paul and Mary, they had $1 between them and it was Mary's. The keg had 30 glasses of beer in it- it was either a small keg or the glasses were quite large- and Paul and Mary decided to sell each glass for $1. Off to the fair they hauled the keg. But it was a hot summer day and a great thirst soon overcame Mary. "I have to
stop and refresh myself with a beer," she said. "You owe me $1 for that beer," Paul quickly replied. "Here's your $1," Mary said. She poured herself a beer, set down on the curb, and sipped her beer as she watched the street traffic. Finally finished, she was ready to go, but it is hard on a hot summer day to watch a friend enjoy a beer and not feel the urge yourself. Before they could move the keg, Paul said, "I have to have a beer now." "Then you owe me a $1," Mary said. Paul passed the $1 back to Mary, and poured himself a beer. No sooner had he finished his beer than Mary's mouth had again gone dry. Mary poured herself another beer, and Paul again insisted on being paid $1.

Needless to say, the two never made it to the fair. They consumed their profit before they arrived. But notice that every beer was bought and paid for even though there was only the $1 bill between them. The $1 was enough to buy $30 worth of beer because it was passed back and forth 30 times that afternoon. The velocity of that $1 bill was 30 times in an afternoon. Does our story correspond to the quantity equation? In this story the money supply was $1, the price level (just the price of beer) was $1, real output was 30 beers, and the velocity of money was 30. The quantity equation says that

\[ \$1 \times (30 \text{ per day}) = (\$1 \text{ per beer}) \times (30 \text{ beers per day}) \]
and it is verified for this example.

There are two points that Robertson's example illustrates. First, the velocity of money is the rate at which people are passing money back and forth. In this simple example there is only $1 that is passed between two people, but the idea easily extends to a more complex economy. Second, a small supply of money can support a high level of income, if the money supply can be passed back and forth fast enough.

Velocity is plotted in Figure 5. The trend of velocity has changed in the past decade. From 1959 until the early 1980s velocity followed a steady upward trend. From 1959 through 1981 velocity grew at an average annual rate of 2.5%. Since 1981 velocity has fallen at a rate of 1.7% per year.

The Quantity Theory in Rates of Change Form

The quantity theory is usually discussed in terms of levels and we have done this also. But, if we want to analyze inflation, we must put the theory in terms of growth rates. Moving to growth rates again involves some simple algebra and again we won't reproduce it. The quantity theory in rates of change form is

\[ \frac{\Delta M}{M^*} + \frac{\Delta V}{V} = \frac{\Delta P}{P} + \frac{\Delta Y}{Y} \]

We can rearrange this equation to get

\[ \frac{\Delta P}{P} = \frac{\Delta M}{M^*} + \frac{\Delta V}{V} - \frac{\Delta Y}{Y} \]

This equation says that the inflation rate equals the rate of growth in the money supply plus the rate of growth in velocity less the rate of growth in real income. This is a very important equation for understanding the long run or core rate of inflation.

Let us now look at each of the growth rates that determine the inflation rate. In the long run, say a period of several years, the government, in the U.S. the Fed, sets the money growth rate. Real growth in the economy is determined by growth in real variables. The most
important of these are the rates of growth in the quantity and quality of work effort, the quality and quantity of the nation's physical capital, and the rate of technical progress. Real growth does not depend on the rate of growth of the money supply or the inflation rate. The rate of growth in the velocity of money doesn't depend on inflation or money growth either. It depends primarily on the growth rate of real income, and the rate of growth of what we earlier called transactions costs.

The simplest case occurs when the rate of growth of velocity is zero. This implies that

$$\Delta P/P = \Delta M'/M^* - \Delta Y/Y$$

In the long run inflation is the difference between the rate of growth in the money supply and the rate of growth of real output. Real growth averages roughly 3% per year and it has been fairly stable. For example, if the average rate of growth moved by one percentage point, down to 2% or up to 4%, it would be considered quite a large change. This means that the cause of any large, sustained increase in inflation is likely to be found in more rapid money growth.

Many economists believe that a stable price level, which is to say a zero rate of inflation, is a desirable goal. How should the growth rate of the money supply be set according to the above equation to attain this goal? Since real growth, $\Delta Y/Y$, is about 3%, a long run average growth rate of the money supply of 3% will yield stable prices over the long haul. This is sometimes called the 3% rule, and is associated with the economist Milton Friedman. Of course, the 3% rule depends on the assumption that over the long haul the average rate of growth in velocity is zero, and we know from Figure 5 that this is not true. From 1959 to 1981 velocity grew at a rate of about 2.5%. To obtain a zero rate of inflation money growth should have averaged about .5% per year. However, the behavior of velocity changed in the 1980s. From 1981 to 1992 velocity fell at a rate of 1.7% per year, so over the past decade money growth should have averaged about 4.7% per year to achieve price stability. Proponents of the 3% rate recognize the problem of changing velocity. They argue that the precise target for money growth is not the most important issue, and indeed the target may change over time to account for changes in the behavior of velocity. Instead, they insist that a fairly low rate of growth of the money supply, say between 1% and 5%, will give us modest and perhaps negligible inflation in the long run.
The Costs of Inflation

People do not like inflation. Given a choice most, maybe all, people would prefer less inflation to more inflation. What is it about inflation that makes it costly? You may want to say that inflation makes the goods we buy more expensive, and no one wants to pay more for the goods that they buy. But this looks at only half the story. If prices go up, then someone must be receiving the higher prices and their incomes are rising. The rise in dollar incomes offsets the increase in prices. This was our conclusion about a one time increase in the money supply and the price level. What makes inflation different than a one-time jump in the price level?

We will break our discussion into two parts. First we look at the effects of an anticipated increase in inflation. Then, we examine the consequences of unanticipated inflation. Every inflation is partly anticipated and partly unanticipated so the cost of an actual inflation is some combination of the two.

a. anticipated inflation

When people expect a higher rate of inflation, they will tend to hold less money, trying to spend it before its purchasing power falls. From our analysis of the demand for money we know that holding smaller money balances means you have to make more trips to the bank, and going to the bank is costly. It requires time, energy, and other real resources. The real resources are called shoe leather costs (because more frequent trips to the bank will wear out your shoes faster) and they represent the inconvenience of more frequently transferring funds from one type of asset to another. Many economists believe that these shoe leather costs of inflation are small in moderate inflations like that of the U.S. in the post war period.

Shoe leather costs may become very large in so-called hyperinflations. For example, in Germany in 1923 inflation averaged over 400% per month. During this period factories would stop work several times a day to pay their workers. The worker's wives would be at the factory gate waiting for the deutsch marks. They would then hurry to stores to spend them before prices rose further. In a hyperinflation transactions costs are enormous.
The second cost of an anticipated inflation is the cost of changing prices, so-called menu costs. These costs not only include the physical cost of changing prices, for example reprinting menus, but also the costs of announcing the price change and any adverse reaction from customers. Again many economists think that these costs are small for moderate inflations.

There are also some tax considerations. For example, a firm is allowed to deduct the depreciation of its capital from its taxable income. However, depreciation is often based on historical cost with no adjustment for inflation. This means that when prices rise depreciation does not keep pace. This results in an increase in the firm's tax liabilities, a reduction in its after-tax profit, and a decline in the attractiveness of investment projects. Another tax implication of inflation is bracket creep. With a progressive income tax system and in the absence of indexation, inflation pushes income into higher tax brackets and raises average tax rates, and perhaps marginal rates as well.

b. unanticipated inflation

Unanticipated inflation redistributes wealth. For example, suppose you lend money at a nominal interest rate of 8% and you expect inflation to be 5%. This means that you expect a real return of about 3%. Now suppose that inflation turns out to be 7% instead of 5%. The real return you actually receive is 1%, two percentage points less than you had expected. You have suffered a loss, while the borrower has enjoyed a gain. If inflation is higher than anticipated, wealth is redistributed in the other direction from lenders to borrowers. The reverse occurs when inflation is lower than had been anticipated. In this case creditors gain at the expense of debtors.

Unanticipated inflation may also lead to greater uncertainty about future inflation and relative prices. If this happens firms will be less willing to borrow to invest in new plant and equipment. This slows the process of capital accumulation and lowers output in the future. In general, greater uncertainty makes it more difficult for trades to take place, and this reduces welfare.

Why Inflation?
If inflation is costly, why do we have it? One explanation relies on money creation as a source of revenue for governments. Some countries raise revenue through money creation even though it causes inflation. Collecting taxes is costly. It requires laws and resources to enforce the laws. Sometimes governments do not expect to be in power long enough to justify large expenditures on a tax collection infrastructure. Other times, there is little choice. For example, after World War I, the victors demanded very high reparations from Germany. However, in Germany the government that replaced the Kaiser was not stable and this made it very difficult for the German government to enforce tax laws or to borrow funds. The only recourse was to print marks, and in 1923 the printing of marks to pay reparations and payments to striking workers was rapid enough to generate an inflation of over 400% per month.

The U.S. revolution also produced very rapid inflation. From January of 1777 to April of 1780 the currency issued by the Continental Congress, called continentals, increased at a rate that produced an inflation of about 170% per year. Again, money creation to raise revenue was the culprit. The new country did not have the ability to collect taxes and revolutionaries have a difficult time finding lenders. There are many similar examples; among them are Russia after the 1917 revolution and in the 1990s, both the North and the South during the Civil War, and Poland, Hungary, and Austria after World War I. To understand inflation it is essential to keep in mind that money creation is a source of government revenue.

Summary

In this chapter we examine the determinants of the core or long run rate of inflation. The quantity theory in rates of change form is a very useful framework for studying this problem. It reveals that the long run rate of inflation depends on the rates of growth in the money supply, real output, and velocity. Since output and velocity growth do not vary dramatically, large
variations in the long run rate of inflation are primarily due to variations in the money growth rate.

Inflation is costly. Anticipated inflation increases menu costs, shoe leather costs, and distortions from the failure to index the tax code. Unanticipated inflation redistributes wealth and may face decision makers with additional uncertainty.

Review Questions

1) Which of the following would cause jumps in the price level and which would change the core rate of inflation?

   a) an increase in the money growth rate
   b) a decrease in the rate of growth in real output
   c) an increase in transactions costs
   d) a permanent positive shock

2) Find the money growth rate that will yield stable prices when

   \[
   \Delta V/V \quad \Delta Y/Y
   \begin{array}{cc}
   2\% & 4\% \\
   -1\% & 2\% \\
   3\% & 3\%
   \end{array}
   \]

3) Find the inflation rate given the following information

   \[
   \begin{array}{ccc}
   \Delta V/V & \Delta Y/Y & \Delta M^*/M^* \\
   6\% & 3\% & 2\% \\
   2\% & 3\% & 7\% \\
   -1\% & 4\% & 12\%
   \end{array}
   \]

4) In the 1960s the standard mortgage loan was a loan with a fixed nominal rate of interest that was paid out over a 30-year period (a so-called fixed rate, 30-year mortgage). These loans were made primarily by savings and loan associations. The interest rates on these
loans were under 6% in the early '60s, for example, they were 5.9% in 1964. The average annual rate of inflation from 1964 to 1994 was about 5.5%. This is a rate of inflation far higher than the roughly 1.5% that had been experienced from 1954 to 1964. Given this information, did home buyers or the owners of S&Ls gain over the past 30 years? Explain.