8

The Phillips Curve, the Natural Rate of Unemployment, and Inflation

In 1958, A. W. Phillips drew a diagram plotting the rate of inflation against the rate of unemployment in the United Kingdom for each year from 1861 to 1957. He found clear evidence of a negative relation between inflation and unemployment: When unemployment was low, inflation was high, and when unemployment was high, inflation was low, often even negative.

Two years later, Paul Samuelson and Robert Solow replicated Phillips's exercise for the United States, using data from 1900 to 1960. Figure 8-1 reproduces their findings using CPI inflation as a measure of the inflation rate. Apart from the period of very high unemployment during the 1930s (the years from 1931 to 1939 are denoted by triangles and are clearly to the right of the other points in the figure), there also appeared to be a negative relation between inflation and unemployment in the United States. This relation, which Samuelson and Solow labeled the **Phillips curve**, rapidly became central to macroeconomic thinking and policy. It appeared to imply that countries could choose between different combinations of unemployment and inflation. A country could achieve low unemployment if it were willing to tolerate higher inflation, or it could achieve price level stability—zero inflation—if it were willing to tolerate higher unemployment. Much of the discussion about macroeconomic policy became a discussion about which point to choose on the Phillips curve.

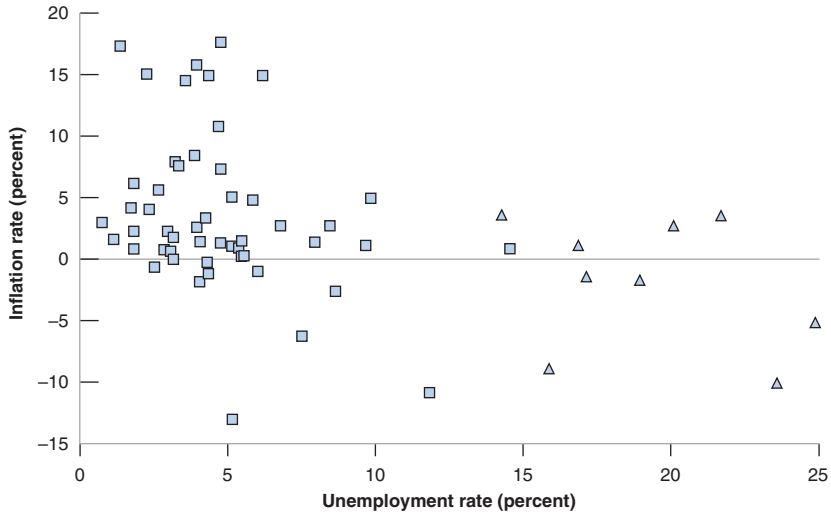
In the 1970s, however, this relation broke down. In the United States and most OECD countries, there was both high inflation *and* high unemployment, clearly contradicting the original Phillips curve. A relation reappeared, but it reappeared as a relation between the unemployment rate and the *change* in the inflation rate. Today in the United States, high unemployment typically

Figure 8-1

Inflation versus Unemployment in the United States, 1900–1960

During the period 1900–1960 in the United States, a low unemployment rate was typically associated with a high inflation rate, and a high unemployment rate was typically associated with a low or negative inflation rate.

Source: Historical Statistics of the United States. http://hsus.cambridge.org/HSUSWeb/index.do



leads not to low inflation, but to a decrease in inflation over time. Conversely, low unemployment doesn't lead to high inflation, but to an increase in inflation over time.

The purpose of this chapter is to explore the mutations of the Phillips curve and, more generally, to understand the relation between inflation and unemployment. You will see that what Phillips discovered was the aggregate supply relation, and that the mutations of the Phillips curve came from changes in the way people and firms formed expectations.

The chapter has three sections:

Section 8-1 shows how we can think of the aggregate supply relation as a relation between inflation, expected inflation, and unemployment.

Section 8-2 uses this relation to interpret the mutations in the Phillips curve over time. It shows the relation between the actual unemployment rate, the natural unemployment rate, and inflation. It then draws two central implications of the Phillips curve for the medium run: In the medium run, unemployment returns to the natural rate, independent of inflation. The inflation rate is determined by the rate of money growth.

Section 8-3 further discusses the relation between unemployment and inflation across countries and over time.

8-1 Inflation, Expected Inflation, and Unemployment

Our first step will be to show that the aggregate supply relation we derived in Chapter 7 can be rewritten as a relation between *inflation, expected inflation,* and the *unemployment rate.*

To rewrite, go back to the aggregate supply relation between the price level, the expected price level, and the unemployment rate we derived in Chapter 7 (equation (7.1)).

We then replaced the unemployment rate by its expression in terms of output to obtain a relation between the price level, the expected price level, and output. As our focus is on the relation between unemployment (rather than output) and inflation, we do not need to take this step here.

$$P = P^e (1 + m) F(u, z)$$

Recall that the function F captures the effects on the wage of the unemployment rate, u, and of the other factors that affect wage setting represented by the catchall variable z. m is the markup of prices over wages. It will be convenient here to assume a specific form for this function:

The function F comes from the wage-setting relation, equation (6.1):

$W = P^e F(u, z)$.

$$F(u, z) = 1 - \alpha u + z$$

This captures the notion that the higher the unemployment rate, the lower the wage; and the higher z (for example, the more generous unemployment benefits are), the higher the wage. The parameter α (the Greek lowercase letter alpha) captures the strength of the effect of unemployment on the wage.

Replace the function F by this specific form in the aggregate supply relation above:

$$P = P^e(1 + m)(1 - \alpha u + z) \tag{8.1}$$

Finally, let π denote the *inflation rate*, and π^e denote the expected inflation rate. Then equation (8.1) can be rewritten as

$$\pi = \pi^e + (m + z) - \alpha u \tag{8.2}$$

Deriving equation (8.2) from equation (8.1) is not difficult, but it is tedious, so it is left to an appendix at the end of this chapter. What is important is that you understand each of the effects at work in equation (8.2):

From now on, to lighten your reading, we shall often refer to "the inflation rate" simply as "inflation," and to "the unemployment rate" simply as "unemployment."

- *An increase in expected inflation, π^e, leads to an increase in actual inflation, π.*

  To see why, start from equation (8.1). An increase in the expected price level P^e leads, one for one, to an increase in the actual price level P: If wage setters expect a higher price level, they set a higher nominal wage, which leads to an increase in the price level.

  Now note that, given last period's price level, a higher price level this period implies a higher rate of increase in the price level from last period to this period—that is, higher inflation. Similarly, given last period's price level, a higher expected price level this period implies a higher expected rate of increase in the price level from last period to this period—that is, higher expected inflation. So the fact that an increase in the expected price level leads to an increase in the actual price level can be restated as: An increase in expected inflation leads to an increase in inflation.

  ◀ Increase in $\pi^e \Rightarrow$ Increase in π.

- *Given expected inflation, π^e, an increase in the markup m, or an increase in the factors that affect wage determination—an increase in z—leads to an increase in inflation, π.*

  From equation (8.1): Given the expected price level P^e, an increase in either m or z increases the price level P. Using the same argument as in the previous bullet to restate this proposition in terms of inflation and expected inflation: Given expected inflation π^e, an increase in either m or z leads to an increase in inflation π.

  ◀ Increase in m or $z \Rightarrow$ Increase in π.

- *Given expected inflation, π^e, an increase in the unemployment rate u leads to a decrease in inflation π.*

  From equation (8.1): Given the expected price level P^e, an increase in the unemployment rate u leads to a lower nominal wage, which leads to a lower price level P. Restating this in terms of inflation and expected inflation: Given expected inflation π^e, an increase in the unemployment rate u leads to a decrease in inflation π.

  ◀ Increase in $u \Rightarrow$ Decrease in π.

We need one more step before we return to a discussion of the Phillips curve: When we look at movements in inflation and unemployment in the rest of the chapter, it will often be convenient to use time indexes so that we can refer to variables like inflation, or expected inflation, or unemployment, in a specific year. So we rewrite equation (8.2) as:

$$\pi_t = \pi_t^e + (m + z) - \alpha u_t \tag{8.3}$$

The variables π_t, π_t^e, and u_t refer to inflation, expected inflation, and unemployment in year t. Be sure you see that there are no time indexes on m and z. This is because we

shall typically think of both m and z as constant while we look at movements in inflation, expected inflation, and unemployment over time.

8-2 The Phillips Curve

Let's start with the relation between unemployment and inflation as it was first discovered by Phillips, Samuelson, and Solow, around 1960.

The Early Incarnation

Imagine an economy where inflation is positive in some years, negative in others, and is on average equal to zero. This is not the way things have been for some time: Since 1960, inflation has been positive in all years but one, 2009, when it was negative, but small. But as we shall see later in this chapter, average inflation *was* close to zero during much of the period Phillips, Samuelson, and Solow were studying.

In such an environment, how will wage setters choose nominal wages for the coming year? With the average inflation rate equal to zero in the past, it is reasonable for wage setters to expect that inflation will be equal to zero over the next year as well. So, let's assume that expected inflation is equal to zero—that $\pi_t^e = 0$. Equation (8.3) then becomes

$$\pi_t = (m + z) - \alpha u_t \tag{8.4}$$

This is precisely the negative relation between unemployment and inflation that Phillips found for the United Kingdom and Solow and Samuelson found for the United States. The story behind it is simple: Given the expected price level, which workers simply take to be last year's price level, lower unemployment leads to a higher nominal wage. A higher nominal wage leads to a higher price level. Putting the steps together, lower unemployment leads to a higher price level this year relative to last year's price level—that is, to higher inflation. This mechanism has sometimes been called the **wage–price spiral**, an expression that captures well the basic mechanism at work:

- Low unemployment leads to a higher nominal wage.
- In response to the higher nominal wage, firms increase their prices. The price level increases.
- In response to the higher price level, workers ask for a higher nominal wage the next time the wage is set.
- The higher nominal wage leads firms to further increase their prices. As a result, the price level increases further.
- In response to this further increase in the price level, workers, when they set the wage again, ask for a further increase in the nominal wage.
- And so the race between prices and wages results in steady wage and price inflation.

Mutations

The combination of an apparently reliable empirical relation, together with a plausible story to explain it, led to the adoption of the Phillips curve by macroeconomists and policy makers. During the 1960s, U.S. macroeconomic policy was aimed at maintaining unemployment in the range that appeared consistent with moderate inflation. And, throughout the 1960s, the negative relation between unemployment and inflation provided a reliable guide to the joint movements in unemployment and inflation.

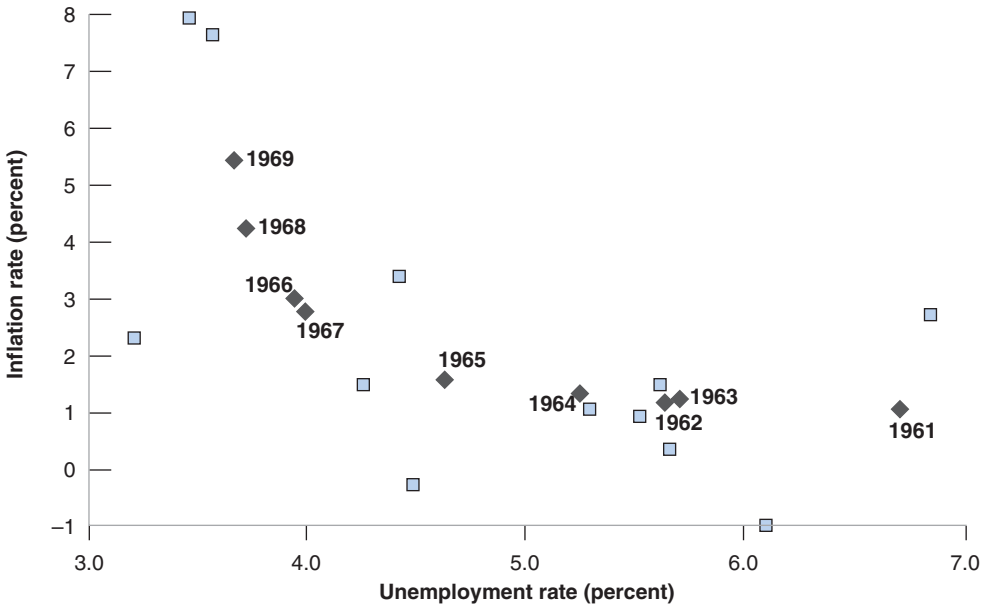


Figure 8-2

Inflation versus Unemployment in the United States, 1948–1969

The steady decline in the U.S. unemployment rate throughout the 1960s was associated with a steady increase in the inflation rate.

Source: Series UNRATE, CPIAUSCL Federal Reserve Economic Data (FRED) http://research.stlouisfed.org/fred2/

Figure 8-2 plots the combinations of the inflation rate and the unemployment rate in the United States for each year from 1948 to 1969. Note how well the Phillips relation held during the long economic expansion that lasted throughout most of the 1960s. During the years 1961 to 1969, denoted by black diamonds in the figure, the unemployment rate declined steadily from 6.8% to 3.4%, and the inflation rate steadily increased, from 1.0% to 5.5%. Put informally, from 1961 to 1969, the U.S. economy moved up along the Phillips curve.

Around 1970, however, the relation between the inflation rate and the unemployment rate, so visible in Figure 8-2, broke down. Figure 8-3 shows the combination of the inflation rate and the unemployment rate in the United States for each year since 1970. The points are scattered in a roughly symmetric cloud: There is no visible relation between the unemployment rate and the inflation rate.

Why did the original Phillips curve vanish? There are two main reasons:

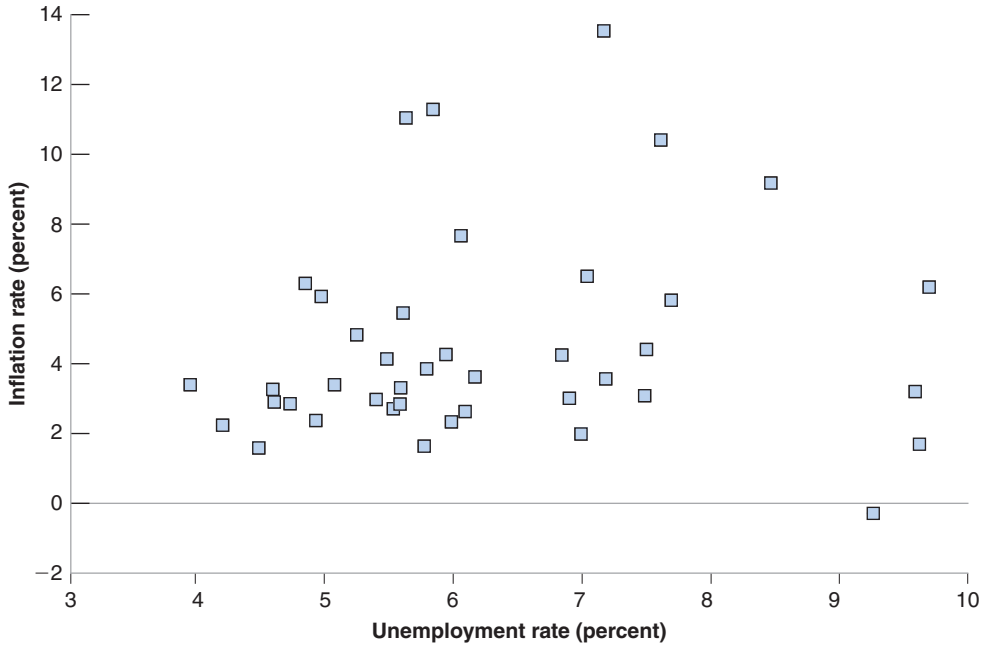
- The United States was hit twice in the 1970s by a large increase in the price of oil (see Chapter 7). The effect of this increase in nonlabor costs was to force firms to increase their prices relative to the wages they were paying—in other words, to increase the markup m. As shown in equation (8.3), an increase in m leads to an increase in inflation, even at a given rate of unemployment, and this happened twice in the 1970s. The main reason for the breakdown of the Phillips curve relation, however, lay elsewhere:
- Wage setters changed the way they formed their expectations. This change came, in turn, from a change in the behavior of inflation. Look at Figure 8-4, which shows the U.S. inflation rate since 1914. Starting in the 1960s (the decade shaded in the figure), you can see a clear change in the behavior of the rate of inflation. First, rather than being sometimes positive and sometimes negative, as it had for the first part of the century, the rate of inflation became consistently positive. Second, inflation became more persistent: High inflation in one year became more likely to be followed by high inflation the next year.
- The persistence of inflation led workers and firms to revise the way they formed their expectations. When inflation is consistently positive year after year, expecting

Figure 8-3

Inflation versus Unemployment in the United States, 1970–2010

Beginning in 1970, the relation between the unemployment rate and the inflation rate disappeared in the United States.

Source: See Figure 8-2.



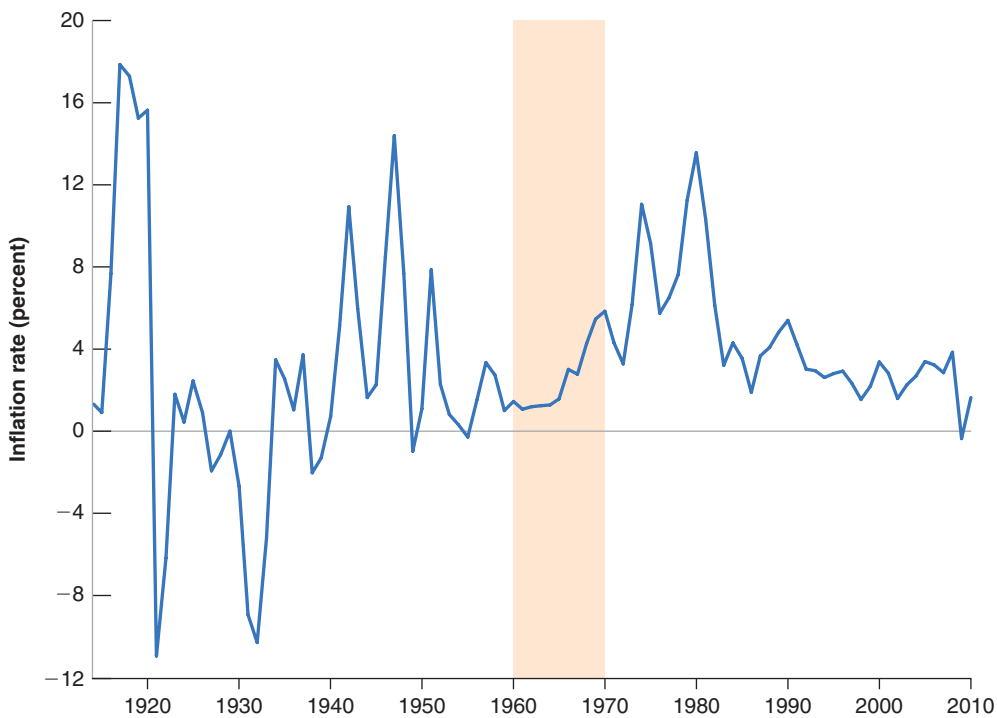
that the price level this year will be the same as the price level last year—which is the same as expecting zero inflation—becomes systematically incorrect; worse, it becomes foolish. People do not like to make the same mistake repeatedly. So, as inflation became consistently positive and more persistent, people, when forming expectations, started to take into account the presence and the persistence of inflation. This change in expectation formation changed the nature of the relation between unemployment and inflation.

Figure 8-4

U.S. Inflation, since 1914

Since the 1960s, the U.S. inflation rate has been consistently positive. Inflation has also become more persistent: A high inflation rate this year is more likely to be followed by a high inflation rate next year.

Source: Years 1900–1914, Historical Statistics of the United States. After 1914: Series CPIAUNS, Federal Reserve Economic Data (FRED) http://research.stlouisfed.org/fred2/



Let's look at the argument in the previous paragraph more closely. First, suppose expectations of inflation are formed according to

$$\pi_t^e = \theta\, \pi_{t-1} \tag{8.5}$$

The value of the parameter θ (the Greek lowercase theta) captures the effect of last year's inflation rate, π_{t-1}, on this year's expected inflation rate, π_t^e. The higher the value of θ, the more last year's inflation leads workers and firms to revise their expectations of what inflation will be this year, and so the higher the expected inflation rate is. We can think of what happened in the 1970s as an increase in the value of θ over time:

- As long as inflation was low and not very persistent, it was reasonable for workers and firms to ignore past inflation and to assume that the price level this year would be roughly the same as price level last year. For the period that Samuelson and Solow had looked at, θ was close to zero, and expectations were roughly given by $\pi_t^e = 0$.
- But, as inflation became more persistent, workers and firms started changing the way they formed expectations. They started assuming that if inflation had been high last year, inflation was likely to be high this year as well. The parameter θ, the effect of last year's inflation rate on this year's expected inflation rate, increased. The evidence suggests that, by the mid-1970s, people expected this year's inflation rate to be the same as last year's inflation rate—in other words, that θ was now equal to 1.

◀ Think about how you form expectations. What do you expect inflation to be next year? How did you come to this conclusion?

Now turn to the implications of different values of θ for the relation between inflation and unemployment. To do so, substitute equation (8.5) for the value of π_t^e into equation (8.3):

$$\pi_t = \overbrace{\theta\pi_{t-1}}^{\pi_t^e} + (m + z) - \alpha u_t$$

- When θ equals zero, we get the original Phillips curve, a relation between the inflation rate and the unemployment rate:

$$\pi_t = (m + z) - \alpha u_t$$

- When θ is positive, the inflation rate depends not only on the unemployment rate but also on last year's inflation rate:

$$\pi_t = \theta\pi_{t-1} + (m + z) - \alpha u_t$$

- When θ equals 1, the relation becomes (moving last year's inflation rate to the left side of the equation)

$$\pi_t - \pi_{t-1} = (m + z) - \alpha u_t \tag{8.6}$$

So, when $\theta = 1$, the unemployment rate affects not *the inflation rate*, but rather the *change in the inflation rate*: High unemployment leads to decreasing inflation; low unemployment leads to increasing inflation.

This discussion is the key to what happened from 1970 onward. As θ increased from 0 to 1, the simple relation between the unemployment rate and the inflation rate disappeared. This disappearance is what we saw in Figure 8-3. But a new relation emerged, this time between the unemployment rate and the change in the inflation

rate—as predicted by equation (8.6). This relation is shown in Figure 8-5, which plots the change in the inflation rate versus the unemployment rate observed for each year since 1970. The figure shows a negative relation between the unemployment rate and the change in the inflation rate. The line that best fits the scatter of points for the period 1970–2010 is given by

This line, called a regression line, is obtained using econometrics. (See Appendix 3 at the end of the book.) Note the line does not fit the cloud of points very tightly. There are years when the change in inflation is much larger than implied by the line and years when the change in inflation is much smaller than implied by the line. We return to this point later.

$$\pi_t - \pi_{t-1} = 3.3\% - 0.55\, u_t \tag{8.7}$$

The line is drawn in Figure 8-5. For low unemployment, the change in inflation is positive. For high unemployment, the change in inflation is negative. This is the form the Phillips curve relation between unemployment and inflation takes today.

To distinguish it from the original Phillips curve (equation (8.4)), equation (8.6) or its empirical counterpart, equation (8.7) is often called the **modified Phillips curve**, or the **expectations-augmented Phillips curve** (to indicate that π_{t-1} stands for expected inflation), or the **accelerationist Phillips curve** (to indicate that a low unemployment rate leads to an increase in the inflation rate and thus *an acceleration* of the price level). We shall simply call equation (8.6) the Phillips curve and refer to the earlier incarnation, equation (8.4), as the *original* Phillips curve.

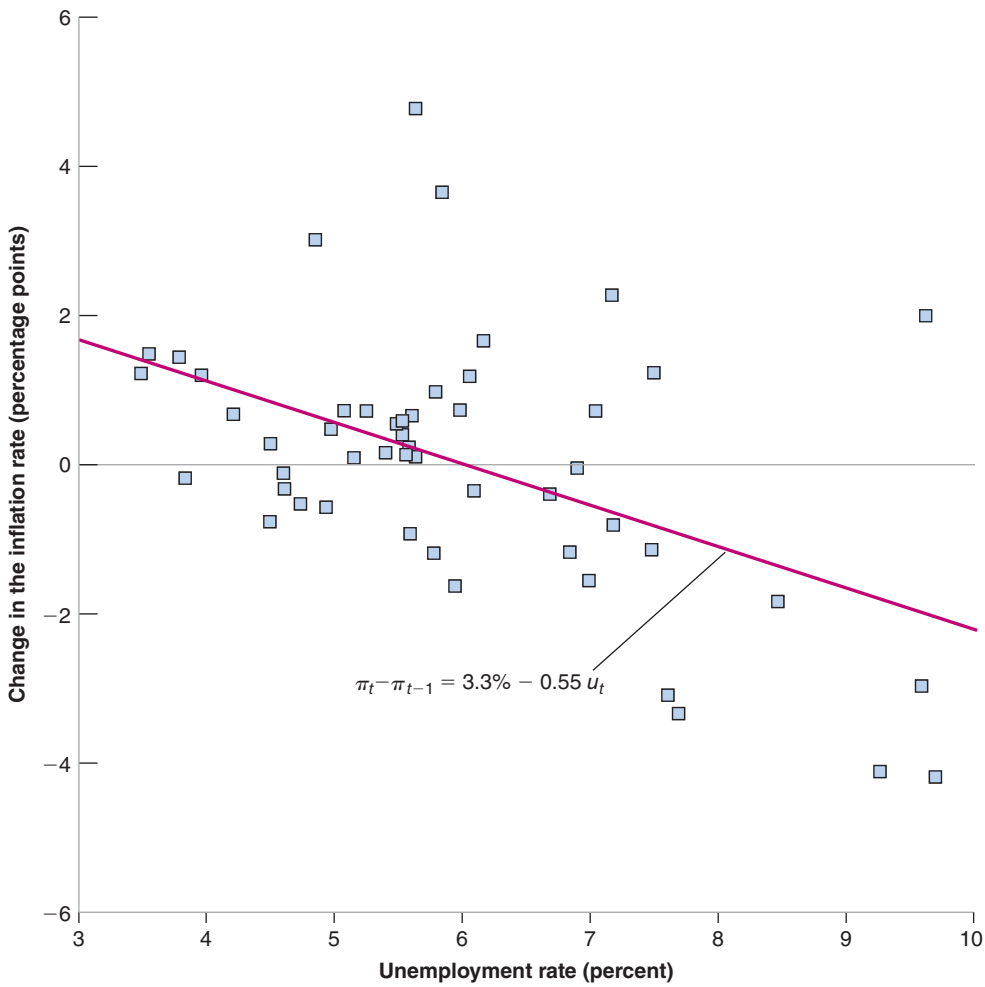
Original Phillips curve: Increase in $u_t \Rightarrow$ Lower inflation.
(Modified) Phillips curve: Increase in $u_t \Rightarrow$ Decreasing inflation.

Figure 8-5

Change in Inflation versus Unemployment in the United States, 1970–2010

Since 1970, there has been a negative relation between the unemployment rate and the change in the inflation rate in the United States.

Source: Series CPIUNSCL, UNRATE: Federal Reserve Economic Data (FRED) http://research.stlouisfed.org/fred2/



The Phillips Curve and the Natural Rate of Unemployment

The history of the Phillips curve is closely related to the discovery of the concept of the natural unemployment rate that we introduced in Chapter 6.

The original Phillips curve implied that there was no such thing as a natural unemployment rate: If policy makers were willing to tolerate a higher inflation rate, they could maintain a lower unemployment rate forever.

In the late 1960s, while the original Phillips curve still gave a good description of the data, two economists, Milton Friedman and Edmund Phelps, questioned the existence of such a trade-off between unemployment and inflation. They questioned it on logical grounds, arguing that such a trade-off could exist only if wage setters systematically underpredicted inflation, and that they were unlikely to make the same mistake forever. Friedman and Phelps also argued that if the government attempted to sustain lower unemployment by accepting higher inflation, the trade-off would ultimately disappear; the unemployment rate could not be sustained below a certain level, a level they called the "natural rate of unemployment." Events proved them right, and the trade-off between the unemployment rate and the inflation rate indeed disappeared. (See the Focus box "Theory ahead of the Facts: Milton Friedman and Edmund Phelps.") Today, most economists accept the notion of a *natural rate of unemployment*—subject to the many caveats we will see in the next section.

Friedman was awarded the Nobel Prize in 1976. Phelps was awarded the Nobel Prize in 2006.

Let's make explicit the connection between the Phillips curve and the natural rate of unemployment.

By definition (see Chapter 6), the natural rate of unemployment is the unemployment rate such that the actual price level is equal to the expected price level. Equivalently, and more conveniently here, the natural rate of unemployment is the unemployment rate such that the actual inflation rate is equal to the expected inflation rate. Denote the natural unemployment rate by u_n (the index n stands for "natural"). Then, imposing the condition that actual inflation and expected inflation be the same ($\pi_t = \pi_t^e$) in equation (8.3) gives

$$0 = (m + z) - \alpha u_n$$

Solving for the natural rate u_n,

$$u_n = \frac{m + z}{\alpha} \tag{8.8}$$

The higher the markup, m, or the higher the factors that affect wage setting, z, the higher the natural rate of unemployment.

Now rewrite equation (8.3) as

$$\pi_t - \pi_t^e = -\alpha\left(u_t - \frac{m + z}{\alpha}\right)$$

Note from equation (8.8) that the fraction on the right side is equal to u_n, so we can rewrite the equation as

$$\pi_t - \pi_t^e = -\alpha(u_t - u_n) \tag{8.9}$$

If—as is the case in the United States today—the expected rate of inflation, π_t^e, is well approximated by last year's inflation rate, π_{t-1}, the equation finally becomes

$$\pi_t - \pi_{t-1} = -\alpha(u_t - u_n) \tag{8.10}$$

FOCUS

Theory Ahead of Facts: Milton Friedman and Edmund Phelps

Economists are usually not very good at predicting major changes before they happen, and most of their insights are derived after the fact. Here is an exception.

In the late 1960s—precisely as the original Phillips curve relation was working like a charm—two economists, Milton Friedman and Edmund Phelps, argued that the appearance of a trade-off between inflation and unemployment was an illusion.

Here are a few quotes from Milton Friedman. About the Phillips curve, he said:

> **"Implicitly, Phillips wrote his article for a world in which everyone anticipated that nominal prices would be stable and in which this anticipation remained unshaken and immutable whatever happened to actual prices and wages. Suppose, by contrast, that everyone anticipates that prices will rise at a rate of more than 75% a year—as, for example, Brazilians did a few years ago. Then, wages must rise at that rate simply to keep real wages unchanged. An excess supply of labor [by this, Friedman means high unemployment] will be reflected in a less rapid rise in nominal wages than in anticipated prices, not in an absolute decline in wages."**

He went on:

> **"To state [my] conclusion differently, there is always a temporary trade-off between inflation and unemployment; there is no permanent trade-off. The temporary trade-off comes not from inflation per se, but from a rising rate of inflation."**

He then tried to guess how much longer the apparent trade-off between inflation and unemployment would last in the United States:

> **"But how long, you will say, is "temporary"? . . . I can at most venture a personal judgment, based on some examination of the historical evidence, that the initial effect of a higher and unanticipated rate of inflation lasts for something like two to five years; that this initial effect then begins to be reversed; and that a full adjustment to the new rate of inflation takes as long for employment as for interest rates, say, a couple of decades."**

Friedman could not have been more right. A few years later, the original Phillips curve started to disappear, in exactly the way Friedman had predicted.

Source: **Milton Friedman, "The Role of Monetary Policy," American Economic Review 1968 58(1): pp. 1–17. (The article by Phelps, "Money-Wage Dynamics and Labor-Market Equilibrium," *Journal of Political Economy* 1968 76(4–part 2): pp. 678–711, made many of the same points more formally.)**

Equation (8.10) is an important relation, for two reasons:

- It gives us another way of thinking about *the Phillips curve*, as a relation between the actual unemployment rate u_t, the natural unemployment rate u_n, and the change in the inflation rate $\pi_t - \pi_{t-1}$:

  The change in the inflation rate depends on the difference between the actual and the natural unemployment rates. When the actual unemployment rate is higher than the natural unemployment rate, the inflation rate decreases; when the actual unemployment rate is lower than the natural unemployment rate, the inflation rate increases.

  $u_t < u_n \Rightarrow \pi_t > \pi_{t-1}$
  $u_t > u_n \Rightarrow \pi_t < \pi_{t-1}$

- It also gives us another way of thinking about the *natural rate of unemployment*:

  The natural rate of unemployment is the rate of unemployment required to keep the inflation rate constant. This is why the natural rate is also called the **non-accelerating inflation rate of unemployment**, or **NAIRU**.

Calling the natural rate "the non-accelerating inflation rate of unemployment" is actually wrong: It should be called "the non-increasing inflation rate of unemployment," or NIIRU. But NAIRU has now become so standard that it is too late to change it.

What has been the natural rate of unemployment in the United States since 1970? Put another way: What has been the unemployment rate that, on average, has led to constant inflation?

To answer this question, all we need to do is to return to equation (8.7), the estimated relation between the change in inflation and the unemployment rate since 1970. Setting the change in inflation equal to zero in that equation implies a value for the natural unemployment rate of $3.3\%/0.55 = 6\%$. In words: The evidence suggests that, since 1970 in the United States, the average rate of unemployment required to keep inflation constant has been equal to 6%.

The Neutrality of Money, Revisited

In Chapter 7, we looked at the effects of a change in the *level of nominal money* on output and on the price level in the medium run. We derived two propositions. First, output returned to its natural level, unaffected by the level of nominal money. Second, the price level moved in proportion to the nominal money stock, leaving the real money stock unchanged. We are now ready to extend these results and look at the effects of changes in the *rate of growth of nominal money* on unemployment and on inflation in the medium run.

Let us first look at unemployment and go back to equation (8.9). In the medium run, expected inflation must be equal to actual inflation. Thus the unemployment rate must be equal to the natural rate, which is clearly independent of the rate of growth of money.

Recall the derivation of the natural rate in Chapter 6. The natural rate depends on such factors as the markup of firms and the nature of bargaining in the labor market. Nowhere does the growth rate of money appear in the determination of the natural rate.

Now turn to inflation, and go back to the aggregate demand relation we derived in Chapter 7, equation (7.3):

$$Y = Y\left(\frac{M}{P}, G, T\right)$$

If unemployment returns to the natural rate, u_n, it follows that output must return to its natural level, Y_n. So the relation becomes:

As we have done in previous chapters, we continue to ignore output growth, and thus assume that output is constant in the medium run.

$$Y_n = Y\left(\frac{M}{P}, G, T\right)$$

If Y_n is constant, for this equality to hold (that is, for aggregate demand to be equal to the natural level of output), the right-hand side of the equation must be constant. If we assume unchanged fiscal policy (that is, constant G and constant T), this implies that the real money stock must also be constant. This implies in turn that the rate of inflation must be equal to the rate of money growth.

$$\pi = g_M$$

See Proposition 8 in Appendix 2. g_M is the notation for the rate of growth of the nominal money stock.

This is an important result: In the medium run, the rate of inflation is determined by the rate of money growth. Milton Friedman put it this way: *Inflation is always and everywhere a monetary phenomenon*. As we have seen, factors such as the monopoly power of firms, strong unions, strikes, fiscal deficits, and increases in the price of oil do affect the price level and, by implication, do affect inflation in the short run. But, unless they affect the rate of money growth, they have no effect on inflation in the medium run.

The "unless" is important here. It could be, for example, that some of these shocks lead to a change in the rate of money growth. For example, a wage explosion or a large budget deficit may lead to higher money creation (more on deficits and inflation in Chapter 24). If this is the case, these shocks will, indirectly, affect inflation even in the medium run.

8-3 A Summary and Many Warnings

Let's take stock of what we have learned about the relation between inflation and unemployment:

- The aggregate supply relation is well captured in the United States today by a relation between the change in the inflation rate and the deviation of the unemployment rate from the natural rate of unemployment (equation (8.8)).
- When the unemployment rate exceeds the natural rate of unemployment, the inflation rate typically decreases. When the unemployment rate is below the natural rate of unemployment, the inflation rate typically increases.

This relation has held quite well since 1970. But evidence from its earlier history, as well as the evidence from other countries, points to the need for a number of warnings.

All of them are on the same theme: The relation between inflation and unemployment can and does vary across countries and time.

Variations in the Natural Rate across Countries

Recall from equation (8.8) that the natural rate of unemployment depends on: all the factors that affect wage setting, represented by the catchall variable z; the markup set by firms m; and the response of inflation to unemployment, represented by α. If these factors differ across countries, there is no reason to expect all countries to have the same natural rate of unemployment. And natural rates indeed differ across countries, sometimes considerably.

Take, for example, the unemployment rate in the Euro area, which has averaged close to 9% since 1980. A high unemployment rate for a few years may well reflect a deviation of the unemployment rate from the natural rate. A high average unemployment rate for 30 years surely reflects a high natural rate. This tells us where we should look for explanations: in the factors determining the wage-setting and the price-setting relations.

Go back and look at Table 1-3 in Chapter 1.

Is it easy to identify the relevant factors? One often hears the statement that one of the main problems of Europe is its **labor-market rigidities**. These rigidities, the argument goes, are responsible for its high unemployment. While there is some truth to this statement, the reality is more complex. The Focus box, "What Explains European Unemployment?" discusses these issues further.

Variations in the Natural Rate over Time

In writing equation (8.6) and estimating equation (8.7), we treated $m + z$ as a constant. But there are good reasons to believe that m and z vary over time. The degree of monopoly power of firms, the structure of wage bargaining, the system of unemployment benefits, and so on are likely to change over time, leading to changes in either m or z and, by implication, changes in the natural rate of unemployment.

Changes in the natural unemployment rate over time are hard to measure. Again, the reason is that we do not observe the natural rate, only the actual rate. But broad evolutions can be established by comparing average unemployment rates, say across decades. Using this approach, the Focus box "What Explains European Unemployment?" discusses how and why the natural rate of unemployment had increased in Europe since the 1960s. The U.S. natural rate has moved much less than that in Europe. Nevertheless, it is also far from constant. Go back and look at Figure 6-3. You can see that, from the 1950s to the 1980s, the unemployment rate fluctuated around a slowly increasing trend: Average unemployment was 4.5% in the 1950s, and 7.3% in the 1980s. Then, from 1990 on, and until the crisis, the trend was reversed, with an average unemployment rate of 5.7% in the 1990s, and an average unemployment rate of 5.0% from 2000 to 2007. In 2007, the unemployment rate was 4.6%, and inflation was roughly constant, suggesting that unemployment was close to the natural rate. Why the U.S. natural rate of unemployment fell from the early 1990s on and what the effects of the crisis may be for the future are discussed in the Focus box "Changes in the U.S. Natural Rate of Unemployment since 1990". We draw two conclusions from the behavior of the U.S. unemployment rate since 1990 and these conclusions parallel the conclusion from our look at European unemployment in the earlier box: The determinants of the natural rate are many. We can identify a number of them, but knowing their respective role and drawing policy lessons is not easy.

Disinflation, Credibility, and Unemployment

In 1979, U.S. unemployment was 5.8%, roughly equal to the natural rate at the time. But the inflation rate, measured using the CPI, was running above 13%. Some of this

What Explains European Unemployment?

FOCUS

What do critics have in mind when they talk about the "labor-market rigidities" afflicting Europe? They have in mind in particular:

- A generous system of unemployment insurance. The replacement rate—that is, the ratio of unemployment benefits to the after-tax wage—is often high in Europe, and the duration of benefits—the period of time for which the unemployed are entitled to receive benefits—often runs in years.

  Some unemployment insurance is clearly desirable. But generous benefits are likely to increase unemployment in at least two ways: They decrease the incentives the unemployed have to search for jobs. They may also increase the wage that firms have to pay. Recall our discussion of efficiency wages in Chapter 6. The higher unemployment benefits are, the higher the wages firms have to pay in order to motivate and keep workers.
- A high degree of employment protection. By employment protection, economists have in mind the set of rules that increase the cost of layoffs for firms. These range from high severance payments, to the need for firms to justify layoffs, to the possibility for workers to appeal the decision and have it reversed.

  The purpose of employment protection is to decrease layoffs, and thus to protect workers from the risk of unemployment. What it also does, however, is to increase the cost of labor for firms and thus to reduce hires and make it harder for the unemployed to get jobs. The evidence suggests that, while employment protection does not necessarily increase unemployment, it changes its nature: The flows in and out of unemployment decrease, but the average duration of unemployment increases. Such long duration increases the risk that the unemployed lose skills and morale, decreasing their employability.
- Minimum wages. Most European countries have national minimum wages. And in some countries, the ratio of the minimum wage to the median wage can be quite high. High minimum wages clearly run the risk of decreasing employment for the least-skilled workers, thus increasing their unemployment rate.
- Bargaining rules. In most European countries, labor contracts are subject to extension agreements. A contract agreed to by a subset of firms and unions can be automatically extended to all firms in the sector. This considerably reinforces the bargaining power of unions, as it reduces the scope for competition by nonunionized firms. As we saw in Chapter 6, stronger bargaining power on the part of the unions may result in higher unemployment: Higher unemployment is needed to reconcile the demands of workers with the wages paid by firms.

Do these labor-market institutions really explain high unemployment in Europe? Is the case open and shut? Not quite. Here it is important to recall two important facts:

Fact 1: Unemployment was not always high in Europe. In the 1960s, the unemployment rate in the four major continental European countries was lower than that in the United States, around 2–3%. U.S. economists would cross the ocean to study the "European unemployment miracle"! The natural rate in these countries today is around 8–9%. How do we explain this increase?

One hypothesis is that institutions were different then, and that labor-market rigidities have only appeared in the last 40 years. This turns out not to be the case, however. It is true that, in response to the adverse shocks of the 1970s (in particular the two recessions following the increases in the price of oil), many European governments increased the generosity of unemployment insurance and the degree of employment protection. But, even in the 1960s, European labor-market institutions looked nothing like U.S. labor-market institutions. Social protection was much higher in Europe; yet unemployment was lower.

A more convincing line of explanation focuses on the interaction between institutions and shocks. Some labor-market institutions may be benign in some environments, yet very costly in others. Take employment protection. If competition between firms is limited, the need to adjust employment in each firm may be limited as well, and so the cost of employment protection may be low. But if competition, either from other domestic firms or from foreign firms, increases, the cost of employment protection may become very high. Firms that cannot adjust their labor force quickly may simply be unable to compete and go out of business.

Fact 2: Until the current crisis started, a number of European countries actually had low unemployment. This is shown in Figure 1, which gives the unemployment rate for 15 European countries (the 15 members of the European Union before the increase in membership to 27) in 2006. We chose 2006 because, in all these countries, inflation was stable, suggesting that the unemployment rate was roughly equal to the natural rate.

As you can see, the unemployment rate was indeed high in the large four continental countries: France, Spain, Germany, and Italy. But note how low the unemployment rate was in some of the other countries, in particular Denmark, Ireland, and the Netherlands.

Is it the case that these low unemployment countries had low benefits, low employment protection, weak unions? Things are unfortunately not so simple: Countries such as Ireland or the United Kingdom indeed have labor-market institutions that resemble those of the United States: limited benefits, low employment

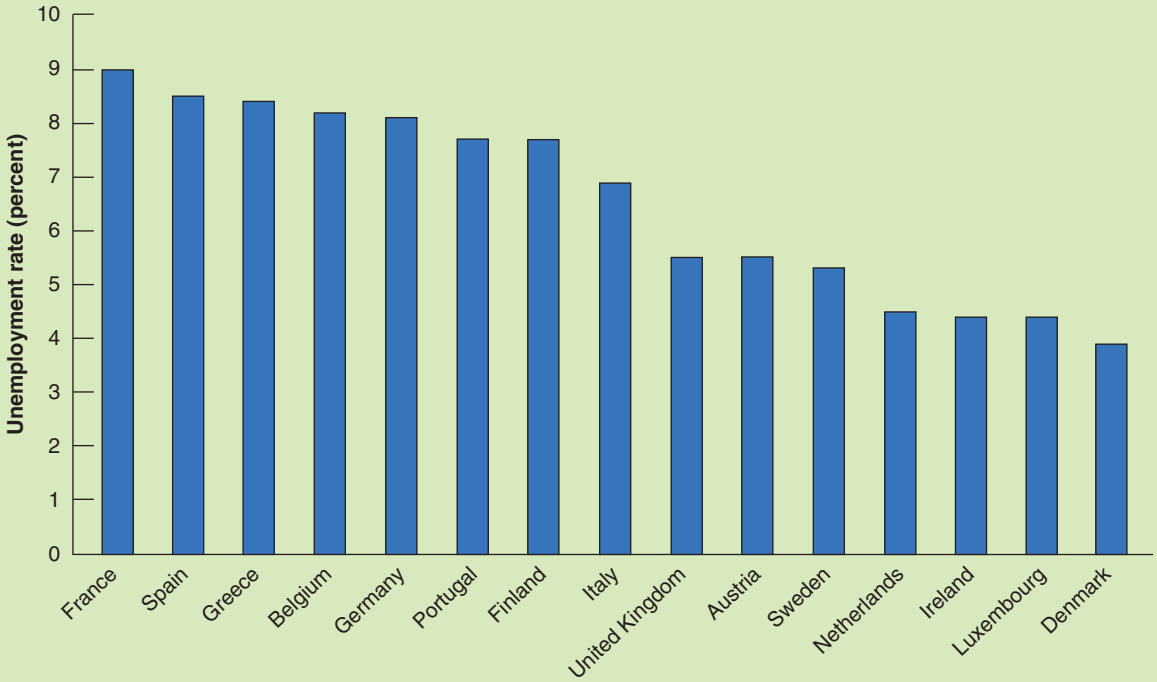


Figure 1 ***Unemployment Rates in 15 European Countries, 2006***

protection, and weak unions. But countries like Denmark or the Netherlands have a high degree of social protection (in particular high unemployment benefits) and strong unions.

So what is one to conclude? An emerging consensus among economists is that the devil is in the details: Generous social protection is consistent with low unemployment. But it has to be provided efficiently. For example, unemployment benefits can be generous, so long as the unemployed are, at the same time, forced to take jobs if such jobs are available. Some employment protection (for example, in the form of generous severance payments) may be consistent with low unemployment, so long as firms do not face the prospect of long administrative or judicial uncertainty when they lay off workers. Countries such as Denmark appear to have been more successful in achieving these goals. Creating incentives for the unemployed to take jobs and simplifying the rules of employment protection are on the reform agenda of many European governments. One may hope they will lead to a decrease in the natural rate in the future.

For more information on European unemployment, read Olivier Blanchard, "European Unemployment. The Evolution of Facts and Ideas," Economic Policy, 2006 (1): pp. 1–54.

was due to the large increase in oil prices, but, leaving this effect aside, underlying inflation was running at close to 10%. The question the Federal Reserve faced was no longer whether or not it should reduce inflation, but how fast it should reduce it. In August 1979, President Carter appointed Paul Volcker as Chairman of the Federal Reserve Board. Volcker, who had served in the Nixon administration, was considered an extremely qualified chairman who would and could lead the fight against inflation.

Fighting inflation implied tightening monetary policy, decreasing output growth, and thus accepting higher unemployment for some time. The question arose of how much unemployment, and for how long, would likely be needed to achieve a lower level of inflation, say 4%—which is the rate Volcker wanted to achieve.

Make sure to distinguish between deflation: a decrease in the price level (equivalently, negative inflation), and disinflation: a decrease in the inflation rate.

Some economists argued that such a **disinflation** would likely be very costly. Their starting point was equation (8.10):

$$\pi_t - \pi_{t-1} = -\alpha(u_t - u_n)$$

Changes in the U.S. Natural Rate of Unemployment since 1990

FOCUS

From 2000 to 2007, the average unemployment rate was under 5%, and inflation was stable. It thus appeared that the natural rate was around 5%, so roughly 2% lower than it had been in the 1980s. Since the beginning of the crisis, the unemployment rate has increased to reach more than 9% and is forecast to remain high for many years. While most of this increase clearly reflects an increase in the actual unemployment rate over the natural rate, the long period of high actual unemployment raises the issue of whether we can hope to go back to the pre-crisis rate.

Start with the first issue, namely why the natural rate decreased from the 1980s on. Researchers have offered a number of explanations:

- Increased globalization and stronger competition between U.S. and foreign firms may have led to a decrease in monopoly power and a decrease in the markup. Also, the fact that firms can more easily move some of their operations abroad surely makes them stronger when bargaining with their workers. The evidence that unions in the U.S. economy are becoming weaker: The unionization rate in the United States, which stood at 25% in the mid 1970s, is below 15% today. As we saw, weaker bargaining power on the part of workers is likely to lead to lower unemployment.
- The nature of the labor market has changed. In 1980, employment by temporary help agencies accounted for less than 0.5% of total U.S. employment. Today, it accounts for more than 2%. This is also likely to have reduced the natural rate of unemployment. In effect, it allows many workers to look for jobs while being employed rather than unemployed. The increasing role of Internet-based job sites, such as Monster.com, has also made matching of jobs and workers easier, leading to lower unemployment.

Some of the other explanations may surprise you. For example, researchers have also pointed to:

- The aging of the U.S. population. The proportion of young workers (workers between the ages of 16 and 24) fell from 24% in 1980 to 14% in 2006. This reflects the end of the baby boom, which ended in the mid-1960s. Young workers tend to start their working life by going from job to job and typically have a higher unemployment rate. So, a decrease in the proportion of young workers leads to a decrease in the overall unemployment rate.
- An increase in the incarceration rate. The proportion of the population in prison or in jail has tripled in the last 20 years in the United States. In 1980, 0.3% of the U.S. population of working age was in prison. In 2006, the proportion had increased to 1.0%. Because many of those in prison would likely have been unemployed were they not incarcerated, this is likely to have had an effect on the unemployment rate.
- The increase in the number of workers on disability. A relaxation of eligibility criteria since 1984 has led to a steady increase in the number of workers receiving disability insurance, from 2.2% of the working age population in 1984 to 3.8% in 2006. It is again likely that, absent changes in the rules, some of the workers on disability insurance would have been unemployed instead.

Will the natural rate of unemployment remain low in the future? Globalization, aging, prisons, temporary help agencies, and the increasing role of the Internet are probably here to stay, suggesting that the natural rate should indeed remain low. Since the beginning of the crisis, however, there is an increasing worry, that the increase in the actual unemployment rate may eventually translate into an increase in the natural unemployment rate. The mechanism through which this may happen is known as **hysteresis** (in economics, hysteresis is used to mean that, after a shock, a variable does not return to its initial value, even when the shock has gone away):

Workers who have been unemployed for a long time may lose their skills, or their morale, and become, in effect, unemployable, leading to a higher natural rate. This is a very relevant concern. As we saw in Chapter 6, in 2010, the average duration of unemployment was 33 weeks, an exceptionally high number by historical standards. Forty-three percent of the unemployed had been unemployed for more than six months, 28% for more than a year. This raises two important questions. First, when the economy picks up, how many of them will be scarred by their unemployment experience and hard to reemploy? Second, are there policies which should be put in place now to help the long-term unemployed get back to work?

For more on the decrease in the natural rate, read "The High-Pressure U.S. Labor Market of the 1990s," by Lawrence Katz and Alan Krueger, *Brookings Papers on Economic Activity*, 1999 (1): pp. 1–87.

According to this equation, the only way to bring down inflation is to accept unemployment above the natural rate for some time. We saw earlier that α is estimated to be equal to 0.55. The equation therefore implies that, to decrease inflation by one percentage point, the unemployment rate has to be higher than the natural

unemployment rate by 1/0.55, or about 1.8 percentage points for a year. Or to decrease inflation from 10% to 4%, the unemployment rate has to be higher than the natural rate by about 10 ((10 − 4)/0.55) percentage points for a year, or, more realistically, if inflation was decreased from 10% to 6% in five years, by about 2 (10/5) percentage points for five years. The natural conclusion was that it would make sense to go slowly, so as not to increase unemployment by too much in a given year.

■ Some economists argued that disinflation might in fact be much less costly. In what has become known as the **Lucas critique**, Lucas pointed out that when trying to predict the effects of a major policy change—like the change considered by too much the Fed at the time—it could be very misleading to take as given the relations estimated from past data. In the case of the Phillips curve, taking equation (8.10) as given was equivalent to assuming that wage setters would keep expecting inflation in the future to be the same as it was in the past, that the way wage setters formed their expectations would not change in response to the change in policy. This was an unwarranted assumption, Lucas argued: Why shouldn't wage setters take policy changes directly into account? If wage setters believed that the Fed was committed to lower inflation, they might well expect inflation to be lower in the future than in the past. They argued that the relevant equation was not equation (8.10) but equation (8.9). And equation (8.9) implied that, if the Fed was fully credible, the decrease in inflation might not require *any* increase in the unemployment rate. If wage setters expected inflation to now be 4%, then actual inflation would decrease to 4%, with unemployment remaining at the natural rate:

Robert Lucas was awarded the Nobel Prize in 1995 and teaches at the University of Chicago. ▶

$$\pi_t = \pi_t^e - \alpha(u_t - u_n)$$
$$4\% = 4\% - \quad 0\%$$

Lucas did not believe that disinflation could really take place without some increase in unemployment. But Thomas Sargent, looking at the historical evidence on the end of several very high inflations, concluded that the increase in unemployment could be small. The essential ingredient of successful disinflation, he argued, was **credibility** of monetary policy—the belief by wage setters that the central bank was truly committed to reducing inflation. Only credibility would cause wage setters to change the way they formed their expectations. Furthermore, he argued, a clear and quick disinflation program was more likely to be credible than a protracted one that offered plenty of opportunities for reversal and political infighting along the way.

Thomas Sargent was awarded the Nobel Prize in 2011 and now teaches at New York University. ▶

Who turned out to be right? In September 1979, Paul Volcker started increasing the interest rate so as to slow down the economy and reduce inflation. From 9% in 1979, the three-month Treasury bill rate was increased to 15% in August 1981. The effects on inflation, output growth, and unemployment are shown in Table 8-1. The table makes clear that there was no credibility miracle: Disinflation was associated with a sharp recession, with negative growth in both 1980 and 1982, and with a large and long-lasting increase in unemployment. The average unemployment rate was above 9% in both 1982 and 1983,

Table 8-1 Inflation and Unemployment, 1979–1985

	1979	1980	1981	1982	1983	1984	1985
CPI inflation (%)	13.3	12.5	8.9	3.8	3.8	3.9	3.8
GDP growth (%)	2.5	–0.5	1.8	–2.2	3.9	6.2	3.2
Unemployment rate (%)	5.8	7.1	7.6	9.7	9.6	7.5	7.2

peaking at 10.8% in the month of December 1982. If we assume a natural rate of 6% and add the excess of unemployment above the natural rate (so 7.1% − 6.0% = 1.1% for 1980, 7.6% − 6.0% = 1.6% for 1981, etc.), total excess unemployment from 1979 to 1985 was 12.7%, a number no better than what equation (8.10) predicted.

Does this settle the issue of how much credibility matters? Not really. Those who argued before the fact that credibility would help argued after the fact that Volcker had not been fully credible. After increasing the interest rate from September 1979 to April 1980 and inducing a sharp decrease in growth, he appeared to have second thoughts, reversing course and sharply decreasing the interest rate from April to September, only to increase it again in 1981. This lack of consistency, some argued, reduced his credibility and increased the unemployment cost of the disinflation. A larger lesson still stands: The behavior of inflation depends very much on how people and firms form expectations. The Lucas critique still stands: The past relation between unemployment and inflation may be a poor guide to what happens when policy changes.

High Inflation and the Phillips Curve Relation

Recall how, in the 1970s, the U.S. Phillips curve changed as inflation became more persistent and wage setters changed the way they formed inflation expectations. The lesson is a general one: The relation between unemployment and inflation is likely to change with the level and the persistence of inflation. Evidence from countries with high inflation confirms this lesson. Not only does the way workers and firms form their expectations change, but so do institutional arrangements:

When the inflation rate becomes high, inflation also tends to become more variable. As a result, workers and firms become more reluctant to enter into labor contracts that set nominal wages for a long period of time: If inflation turns out higher than expected, real wages may plunge and workers will suffer a large cut in their living standard. If inflation turns out lower than expected, real wages may go up sharply. Firms may not be able to pay their workers. Some may go bankrupt.

More concretely: When inflation runs on average at 3% a year, wage setters can be reasonably confident inflation will be between 1% and 5%. When inflation runs on average at 30% a year, wage setters can be confident inflation will be between 20% and 40%. In the first case, the real wage may end up 2% higher or lower than they expected when they set the nominal wage. In the second case, it may end up 10% higher or lower than they expected. There is much more uncertainty in the second case.

For this reason, the terms of wage agreements change with the level of inflation. Nominal wages are set for shorter periods of time, down from a year to a month or even less. **Wage indexation**, a provision that automatically increases wages in line with inflation, becomes more prevalent.

These changes lead in turn to a stronger response of inflation to unemployment. To see this, an example based on wage indexation will help. Imagine an economy that has two types of labor contracts. A proportion λ (the Greek lowercase letter lambda) of labor contracts is indexed: Nominal wages in those contracts move one for one with variations in the actual price level. A proportion $1 - \lambda$ of labor contracts is not indexed: Nominal wages are set on the basis of expected inflation.

Under this assumption, equation (8.9) becomes

$$\pi_t = [\lambda \pi_t + (1 - \lambda)\pi_t^e] - \alpha(u_t - u_n)$$

The term in brackets on the right reflects the fact that a proportion λ of contracts is indexed and thus responds to actual inflation, π_t, and a proportion, $1 - \lambda$, responds to expected inflation, π_t^e. If we assume that this year's expected inflation is equal to last year's actual inflation, $\pi_t^e = \pi_{t-1}$, we get

$$\pi_t = [\lambda \pi_t + (1 - \lambda)\pi_{t-1}] - \alpha(u_t - u_n) \qquad (8.11)$$

When $\lambda = 0$, all wages are set on the basis of expected inflation—which is equal to last year's inflation, π_{t-1}—and the equation reduces to equation (8.10):

$$\pi_t - \pi_{t-1} = -\alpha(u_t - u_n)$$

When λ is positive, however, a proportion λ of wages is set on the basis of actual inflation rather than expected inflation. To see what this implies, reorganize equation (8.11): Move the term in brackets to the left, factor $(1 - \lambda)$ on the left of the equation, and divide both sides by $1 - \lambda$ to get

$$\pi_t - \pi_{t-1} = -\frac{\alpha}{(1 - \lambda)}(u_t - u_n)$$

Wage indexation increases the effect of unemployment on inflation. The higher the proportion of wage contracts that are indexed—the higher λ—the larger the effect the unemployment rate has on the change in inflation—the higher the coefficient $\alpha/(1 - \lambda)$.

The intuition is as follows: Without wage indexation, lower unemployment increases wages, which in turn increases prices. But because wages do not respond to prices right away, there is no further increase in prices within the year. With wage indexation, however, an increase in prices leads to a further increase in wages within the year, which leads to a further increase in prices, and so on, so that the effect of unemployment on inflation within the year is higher.

If, and when, λ gets close to 1—which is when most labor contracts allow for wage indexation—small changes in unemployment can lead to very large changes in inflation. Put another way, there can be large changes in inflation with nearly no change in unemployment. This is what happens in countries where inflation is very high: The relation between inflation and unemployment becomes more and more tenuous and eventually disappears altogether.

Deflation and the Phillips Curve Relation

We have just looked at what happens to the Phillips curve when inflation is very high. Another issue is what happens when inflation is low, and possibly negative—when there is deflation.

The motivation for asking this question is given by an aspect of Figure 8-1 we mentioned at the start of the chapter but then left aside. In that figure, note how the points corresponding to the 1930s (they are denoted by triangles) lie to the right of the others. Not only is unemployment unusually high—this is no surprise because we are looking at the years corresponding to the Great Depression—but, *given the high unemployment rate*, the inflation rate is surprisingly high. In other words, given the very high unemployment rate, we would have expected not merely deflation, but a large rate of deflation. In fact, deflation was limited, and from 1934 to 1937, despite still very high unemployment, inflation actually turned positive.

How do we interpret this fact? There are two potential explanations.

One is that the Great Depression was associated with an increase not only in the actual unemployment rate, but also in the natural unemployment rate. This seems unlikely. Most economic historians see the Great Depression primarily as the result of a large adverse shift in aggregate demand leading to an increase in the actual unemployment rate over the natural rate of unemployment, rather than an increase in the natural rate of unemployment itself.

The other is that, when the economy starts experiencing deflation, the Phillips curve relation breaks down. One possible reason: The reluctance of workers to accept decreases in their nominal wages. Workers will unwittingly accept a cut in their real wages that occurs when their nominal wages increase more slowly than inflation. However, they are likely to fight the same cut in their real wages if it results from an overt cut in their nominal wages. If this argument is correct, this implies that the Phillips curve

Consider two scenarios. In one, inflation is 4%, and your nominal wage goes up by 2%. In the other, inflation is 0%, and your nominal wage is cut by 2%. Which do you dislike most? You should be indifferent between the two: In both cases, your real wage goes down by 2%. There is some evidence, however, that most people find the first scenario less painful, and thus suffer from money illusion, a term made more explicit in Chapter 24.

relation between the change in inflation and unemployment may disappear, or at least become weaker, when the economy is close to zero inflation.

This issue is not just of historical interest: In many countries today, unemployment is very high, and inflation is low. Whether inflation will turn into deflation is one of the developments closely watched by macroeconomists today.

Why deflation is potentially dangerous, and why policy makers want to avoid it, will have to wait until we introduce the distinction between nominal and real interest rates. We shall do this and return to this issue in Chapter 14.

Summary

- The aggregate supply relation can be expressed as a relation between inflation, expected inflation, and unemployment. Given unemployment, higher expected inflation leads to higher inflation. Given expected inflation, higher unemployment leads to lower inflation.
- When inflation is not very persistent, expected inflation does not depend very much on past inflation. Thus, the aggregate supply relation becomes a relation between inflation and unemployment. This is what Phillips in the United Kingdom and Solow and Samuelson in the United States discovered when they looked, in the late 1950s, at the joint behavior of unemployment and inflation.
- As inflation became more persistent in the 1970s and 1980s, expectations of inflation became based more and more on past inflation. In the United States today, the aggregate supply relation takes the form of a relation between unemployment and the change in inflation. High unemployment leads to decreasing inflation; low unemployment leads to increasing inflation.
- The natural unemployment rate is the unemployment rate at which the inflation rate remains constant. When the actual unemployment rate exceeds the natural rate of unemployment, the inflation rate typically decreases; when the actual unemployment rate is less than the natural unemployment rate, the inflation rate typically increases.
- The natural rate of unemployment depends on many factors that differ across countries and can change over time. This is why the natural rate of unemployment varies across countries: It is higher in Europe than in the United States. Also, the natural unemployment rate varies over time: In Europe, the natural unemployment rate has greatly increased since the 1960s. In the United States, the natural unemployment rate increased from the 1960s to the 1980s and appears to have decreased since.
- Changes in the way the inflation rate varies over time affect the way wage setters form expectations and also affects how much they use wage indexation. When wage indexation is widespread, small changes in unemployment can lead to very large changes in inflation. At high rates of inflation, the relation between inflation and unemployment disappears altogether.
- At very low or negative rates of inflation, the Phillips curve relation appears to become weaker. During the Great Depression even very high unemployment led only to limited deflation. The issue is important because many countries have both high unemployment and low inflation today.

Key Terms

Phillips curve, 161
wage–price spiral, 164
modified, or expectations-augmented, or accelerationist Phillips curve, 168
non-accelerating inflation rate of unemployment (NAIRU), 170
labor-market rigidities, 172
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Questions and Problems

QUICK CHECK

All Quick Check questions and problems are available on MyEconLab.

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

a. The original Phillips curve is the negative relation between unemployment and inflation that was first observed in the United Kingdom.
b. The original Phillips curve relation has proven to be very stable across countries and over time.
c. The aggregate supply relation is consistent with the Phillips curve as observed before the 1970s, but not since.
d. Policy makers can exploit the inflation–unemployment trade-off only temporarily.
e. In the late 1960s, the economists Milton Friedman and Edmund Phelps said that policy makers could achieve as low a rate of unemployment as they wanted.
f. The expectations-augmented Phillips curve is consistent with workers and firms adapting their expectations after the macroeconomic experience of the 1960s.
g. The natural rate of unemployment is constant over time within a country.
h. The natural rate of unemployment is the same in all countries.
i. Disinflation means that the rate of inflation is negative.
j. If Lucas was right, and if monetary policy was fully credible, there would be no relation between inflation and unemployment (i.e., no Phillips curve relation).

2. Discuss the following statements.

a. The Phillips curve implies that when unemployment is high, inflation is low, and vice versa. Therefore, we may experience either high inflation or high unemployment, but we will never experience both together.
b. As long as we do not mind having high inflation, we can achieve as low a level of unemployment as we want. All we have to do is increase the demand for goods and services by using, for example, expansionary fiscal policy.

3. Mutations of the Phillips curve

Suppose that the Phillips curve is given by

$$\pi_t = \pi_t^e + 0.1 - 2u_t$$

a. What is the natural rate of unemployment?

Assume

$$\pi_t^e = \theta \pi_{t-1}$$

and suppose that θ is initially equal to 0. Suppose that the rate of unemployment is initially equal to the natural rate. In year t*, the authorities decide to bring the unemployment rate down to 3% and hold it there forever.*

b. Determine the rate of inflation in years t, $t + 1$, $t + 2$, and $t + 5$.
c. Do you believe the answer given in (b)? Why or why not? (*Hint*: Think about how people are likely to form expectations of inflation.)

Now suppose that in year t + 5, *θ increases from 0 to 1. Suppose that the government is still determined to keep* u *at 3% forever.*

d. Why might θ increase in this way?
e. What will the inflation rate be in years $t + 5$, $t + 6$, and $t + 7$?
f. Do you believe the answer given in (e)? Why or why not?

4. The neutrality of money revisited

a. Fill in the empty spaces after Year 1 in the chart below:

Year	*M* Nominal Money Supply (billions)	g_M Growth Rate of Nominal Money Supply (percent)	*P* Price Level (index) Year 2 = 100	Inflation (percent)
1	380.95		95.2	
2	400			
3	420		105.0	
4	441		110.25	

b. What is the growth rate of the nominal money supply between years 1 and 2, 2 and 3, and 3 and 4?
c. What is the rate of inflation between years 1 and 2, 2 and 3, and 3 and 4?
d. What is the change in the real money supply between years 1 and 2, 2 and 3, and 3 and 4?
e. What assumption has been made about real output growth if this data describe the medium run?

5. The effects of a permanent decrease in the rate of nominal money growth

Suppose that the economy can be described by the following three equations:

$$u_t - u_{t-1} = -0.4(g_{yt} - 3\%) \quad \textit{Okun's law}$$
$$\pi_t - \pi_{t-1} = -(u_t - 5\%) \quad \textit{Phillips curve}$$
$$g_{yt} = g_{mt} - \pi_t \quad \textit{Aggregate demand}$$

a. Reduce the three equations to two by substituting g_{yt} from the aggregate demand equation into Okun's law. (Okun's law was presented in Chapter 2.)

Assume initially that $u_t = u_{t-1} = 5\%$, $g_{mt} = 13\%$, and $\pi_t = 10\%$.

b. Explain why these values are consistent with the statement *"Inflation is always and everywhere a monetary phenomenon."*

Now suppose that money growth is permanently reduced from 13% to 3%, starting in year *t*.

c. Compute (using a calculator or a spreadsheet program) unemployment and inflation in years t, $t + 1$, . . . , $t + 10$.
d. Does inflation decline smoothly from 10% to 3%? Why or why not?

e. Compute the values of the unemployment rate and the inflation rate in the medium run.
f. Is the statement that *"Inflation is always and everywhere a monetary phenomenon"* a statement that refers to the medium run or the short run?

DIG DEEPER

All Dig Deeper questions and problems are available on MyEconLab.

6. The macroeconomic effects of the indexation of wages

Suppose that the Phillips curve is given by

$$\pi_t - \pi_t^e = 0.1 - 2u_t$$

where

$$\pi_t^e = \pi_{t-1}$$

Suppose that inflation in year $t - 1$ is zero. In year t, the authorities decide to keep the unemployment rate at 4% forever.

a. Compute the rate of inflation for years t, $t + 1$, $t + 2$, and $t + 3$. *Now suppose that half the workers have indexed labor contracts.*
b. What is the new equation for the Phillips curve?
c. Based on your answer to part (b), recompute your answer to part (a).
d. What is the effect of wage indexation on the relation between π and u?

7. Supply shocks and wage flexibility

Suppose that the Phillips curve is given by

$$\pi_t - \pi_{t-1} = -\alpha(u_t - u_n)$$

where

$$u_n = (m + z)/\alpha.$$

Recall that this Phillips curve was derived in this chapter under the assumption that the wage-bargaining equation took the form

$$W = P^e(1 - \alpha u_t + z)$$

We can think of α as a measure of wage flexibility—the higher α the greater the response of the wage to a change in the unemployment rate, u_t.

a. Suppose $m = 0.03$ and $z = 0.03$. What is the natural rate of unemployment if $\alpha = 1$? if $\alpha = 2$? What is the relation between α and the natural rate of unemployment? Interpret your answer.

In Chapter 7, the text suggested that a reduction in the bargaining power of workers may have something to do with the economy's relatively mild response to the increases in oil prices in the past few years as compared to the economy's response to increases in oil prices in the 1970s. One manifestation of a reduction in worker bargaining power could be an overall increase in wage flexibility (i.e., an increase in α).

b. Suppose that as a result of an oil price increase, m increases to 0.06. What is the new natural rate of unemployment if $\alpha = 1$? if $\alpha = 2$? Would an increase in wage flexibility tend to weaken the adverse effect of an oil price increase?

EXPLORE FURTHER

8. Estimating the natural rate of unemployment

*To answer this question, you will need data on the annual U.S. unemployment and inflation rates since 1970, which can be obtained very easily from the Economic Report of the President Web site http://**www.gpoaccess.gov**/eop/index.html Excel tables of the values can be downloaded.*

Retrieve the annual data for the civilian unemployment rate from Table B-35. In addition, retrieve the annual percentage increase for the consumer price index (CPI), all urban consumers from Table B-63. You can access the same data at the Federal Reserve Bank of St. Louis FRED Web site.

a. Plot the data for all the years since 1970 on a diagram, with the change in inflation on the vertical axis and the rate of unemployment on the horizontal axis. Is your graph similar to Figure 8-5?
b. Using a ruler, draw the line that appears to fit best the points in the figure. Approximately what is the slope of the line? What is the intercept? Write down your equation.
c. According to your analysis in (b), what has been the natural rate of unemployment since 1970?

9. Changes in the natural rate of unemployment

a. Repeat Problem 8 but now draw separate graphs for the period 1970 to 1990 and the period since 1990.
b. Do you find that the relation between inflation and unemployment is different in the two periods? If so, how has the natural rate of unemployment changed?

10. Money growth and the growth in real output over time

a. Fill in the empty spaces after Year 1 in the chart. This economy is in medium-run equilibrium in every year:

Year	*M* Nominal Money Supply (billions)	g_M Growth Rate of Nominal Money Supply (percent)	*P* Price level (index) Year 2 = 100	Inflation	Real GDP (billions of Year 2 dollars)
1	367		95.2		1500
2	400				1560
3	436		105.0		1622.4
4	475.3		110.25		1687.3

b. What is the growth rate of the nominal money supply between years 1 and 2, years 2 and 3, and years 3 and 4?
c. What is the rate of inflation between years 1 and 2, 2 and 3, and 3 and 4?
d. What is the change in the real money supply between years 1 and 2, 2 and 3, and 3 and 4?
e. Why does the equation that says that the rate of inflation and the rate of growth of money must be equal NOT hold in this case? (*Hint*: Think about what must happen to real money growth if real output, and thus the demand for real money is increasing over time? If real money growth must be positive, what does this imply about the relation between nominal money growth and inflation?)

APPENDIX: From the Aggregate Supply Relation to a Relation between Inflation, Expected Inflation, and Unemployment

This appendix shows how to go from the relation between the price level, the expected price level, and the unemployment rate given by equation (8.1),

$$P = P^e(1 + m)(1 - \alpha u + z)$$

to the relation between inflation, expected inflation, and the unemployment rate given by equation (8.2),

$$\pi = \pi^e + (m + z) - \alpha u$$

First, introduce time subscripts for the price level, the expected price level, and the unemployment rate, so P_t, P_t^e, and u_t refer to the price level, the expected price level, and the unemployment rate in year t. Equation (8.1) becomes

$$P_t = P_t^e(1 + m)(1 - \alpha u_t + z)$$

Next, go from an expression in terms of price levels to an expression in terms of inflation rates. Divide both sides by last year's price level, P_{t-1}:

$$\frac{P_t}{P_{t-1}} = \frac{P_t^e}{P_{t-1}}(1 + m)(1 - \alpha u_t + z) \qquad (8A.1)$$

Take the fraction P_t/P_{t-1} on the left side and rewrite it as

$$\frac{P_t}{P_{t-1}} = \frac{P_t - P_{t-1} + P_{t-1}}{P_{t-1}} = 1 + \frac{P_t - P_{t-1}}{P_{t-1}} = 1 + \pi_t$$

where the first equality follows from actually subtracting and adding P_{t-1} in the numerator of the fraction, the second equality follows from the fact that $P_{t-1}/P_{t-1} = 1$, and the third follows from the definition of the inflation rate ($\pi_t \equiv (P_t - P_{t-1})/P_{t-1}$).

Do the same for the fraction P_t^e/P_{t-1} on the right side, using the definition of the expected inflation rate ($\pi_t^e \equiv (P_t^e - P_{t-1})/P_{t-1}$):

$$\frac{P_t^e}{P_{t-1}} = \frac{P_t^e - P_{t-1} + P_{t-1}}{P_{t-1}} = 1 + \frac{P_t^e - P_{t-1}}{P_{t-1}} = 1 + \pi_t^e$$

Replacing P_t/P_{t-1} and P_t^e/P_{t-1} in equation (8A.1) by the expressions we have just derived,

$$(1 + \pi_t) = (1 + \pi_t^e)(1 + m)(1 - \alpha u_t + z)$$

This gives us a relation between inflation, π_t, expected inflation, π_t^e, and the unemployment rate, u_t. The remaining steps make the relation look more friendly:

Divide both sides by $(1 + \pi_t^e)(1 + m)$:

$$\frac{(1 + \pi_t)}{(1 + \pi_t^e)(1 + m)} = 1 - \alpha u_t + z$$

So long as inflation, expected inflation, and the markup are not too large, a good approximation to the left side of this equation is given by $1 + \pi_t - \pi_t^e - m$ (see Propositions 3 and 6 in Appendix 2 at the end of the book). Replacing in the equation above and rearranging gives

$$\pi_t = \pi_t^e + (m + z) - \alpha u_t$$

Dropping the time indexes, this is equation (8.2) in the text. With the time indexes kept, this is equation (8.3) in the text.

The inflation rate π_t depends on the expected inflation rate π_t^e and the unemployment rate u_t. The relation also depends on the markup, m, on the factors that affect wage setting, z, and on the effect of the unemployment rate on wages, α.