9-1 Output, Unemployment, and Inflation

In Chapter 7, we examined the behavior of two variables: output and the price level. We characterized the economy by two relations: an aggregate supply relation and an aggregate demand relation. In this chapter, we extend the model of Chapter 7 to examine three variables: output, unemployment, and inflation. We characterize the economy by three relations:

- A relation between *output growth* and the *change in unemployment*, called Okun's law.
- A relation between *unemployment, inflation*, and *expected inflation*. This is the Phillips curve relation we developed in Chapter 8.
- An aggregate demand relation between *output growth, money growth*, and *inflation*. This relation follows from the aggregate demand relation we derived in Chapter 7.

In this section, we look at each of these relations on its own. In Section 9-2, we put them together and show their implications for movements in output, unemployment, and inflation.

Okun's Law

We discussed the relation between output and unemployment in Chapter 6. We did so, however, under two convenient but restrictive assumptions. We assumed that output moved one-for-one with employment, so changes in output led to equal changes in employment. We also assumed that the labor force was constant, so changes in employment were reflected one-for-one in opposite changes in unemployment.

We assumed that $Y = N$ was that L (the labor force) was constant.

We must now move beyond these assumptions. To see why, let's see what they imply for the relation between the rate of output growth and the unemployment rate. If output and employment moved together, a 1% increase in output would lead to a 1% increase in employment. And if movements in employment were reflected in opposite movements in unemployment, the 1% increase in employment would lead to a decrease of 1% in the unemployment rate. Let u_t denote the unemployment rate in year t, u_{t-1} the unemployment rate in year $t - 1$, and g_{yt} the growth rate of output from year $t - 1$ to year t. Then, under these two assumptions, the following relation would hold:

$$u_t - u_{t-1} = -g_{yt} \tag{9.1}$$

In words: The change in the unemployment rate would be equal to the negative of the growth rate of output. If output growth is, say, 4% for a year, then the unemployment rate should decline by 4% in that year.

Contrast this with the actual relation between output growth and the change in the unemployment rate, a relation called **Okun's law**. Figure 9-1 plots the change in the unemployment rate against the rate of output growth for each year since 1970. It also plots the regression line that best fits the scatter of points. The equation corresponding to the line is given by

The relation is named after Arthur Okun, an economist and an adviser to President Kennedy, who first characterized and interpreted this relation.

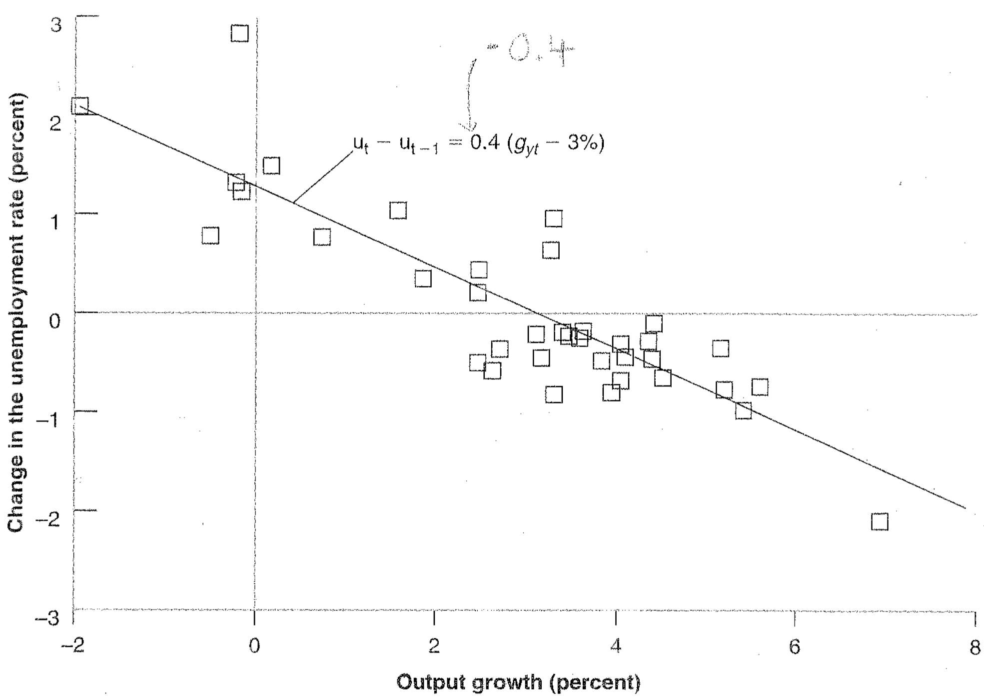
$$u_t - u_{t-1} = -0.4(g_{yt} - 3\%) \tag{9.2}$$

Like equation (9.1), equation (9.2) shows a negative relation between the change in unemployment and output growth. But it differs from equation (9.1) in two ways:

If $g_{yt} > 3\%$, then $u_t < u_{t-1}$
If $g_{yt} < 3\%$, then $u_t > u_{t-1}$
If $g_{yt} = 3\%$, then $u_t = u_{t-1}$

- Annual output growth has to be at least 3% to prevent the unemployment rate from rising. This is because of two factors we have neglected so far: labor force growth and labor productivity growth.

  To maintain a constant unemployment rate, employment must grow at the same rate as the labor force. Suppose the labor force grows at 1.7% per year; then



Changes in the Unemployment Rate versus Output Growth in the United States since 1970

High output growth is associated with a reduction in the unemployment rate; low output growth is associated with an increase in the unemployment rate.

employment must grow at 1.7% per year. If, in addition, labor productivity—output per worker—grows at 1.3% per year, this implies that output must grow at 1.7% + 1.3% = 3% per year. In other words, just to maintain a constant unemployment rate, output growth must be equal to the sum of labor force growth and labor productivity growth.

In the United States, the sum of the rate of labor force growth and of labor productivity growth has been roughly equal to 3% per year on average since 1960, and this is why the number 3% appears on the right side of equation (9.2). I shall call the rate of output growth needed to maintain a constant unemployment rate the **normal growth rate** in the following text.

Suppose productivity growth increases from 1.3% to 2.3%. What is now the growth rate of output required to maintain a constant unemployment rate? More on this when we discuss the U.S. "jobless recovery" of 2002 to 2004 in Chapter 13.

- The coefficient on the right side of equation (9.2) is −0.4, compared to −1.0 in equation (9.1). Put another way, output growth 1% above normal leads only to a 0.4% reduction in the unemployment rate in equation (9.2) rather than a 1% reduction in equation (9.1). There are two reasons:

1. Firms adjust employment less than one-for-one in response to deviations of output growth from normal. More specifically, output growth 1% above normal for one year leads to only a 0.6% increase in the employment rate.

   One reason is that some workers are needed, no matter what the level of output. The accounting department of a firm, for example, needs roughly the same number of employees whether the firm is selling more or less than normal.

   Another reason is that training new employees is costly; for this reason, firms prefer to keep current employees rather than lay them off when output is lower than normal and to ask them to work overtime rather than hire new employees when output is higher than normal. In bad times, firms in effect hoard labor—the labor they will need when times are better; this behavior of firms is therefore called **labor hoarding**.

Employment responds less than one-for-one to movements in output.

2. An increase in the employment rate does not lead to a one-for-one decrease in the unemployment rate. More specifically, a 0.6% increase in the employment rate leads to only a 0.4% decrease in the unemployment rate. The reason is that

Employment responds less than one-for-one to movements in output.

labor force participation increases. When employment increases, not all the new jobs are filled by the unemployed. Some of the jobs go to people who were classified as *out of the labor force*, meaning they were not actively looking for jobs. Also, as labor market prospects improve for the unemployed, some discouraged workers—who were previously classified as out of the labor force—decide to start actively looking for jobs and become classified as unemployed. For both reasons, unemployment decreases less than employment increases.

Putting the two steps together: Unemployment responds less than one-for-one to movements in employment, which itself responds less than one-for-one to movements in output.

Let's write equation (9.2) using letters rather than numbers. Let $\bar{g}_y$ denote the normal growth rate (about 3% per year for the United States). Let the coefficient β (the Greek lowercase beta) measure the effect of output growth above normal on the change in the unemployment rate. As you saw in equation (9.2), in the United States, β equals 0.4. The evidence for other countries is given in the Focus box "Okun's Law across Countries." We can then write:

$$u_t - u_{t-1} = -\beta(g_{yt} - \bar{g}_y) \tag{9.3}$$

Output growth above normal leads to a decrease in the unemployment rate; output growth below normal leads to an increase in the unemployment rate.

Okun's law:
$g_{yt} > \bar{g}_y \Rightarrow u_t < u_{t-1}$
$g_{yt} < \bar{g}_y \Rightarrow u_t > u_{t-1}$

The Phillips Curve

We saw in Chapter 8 that the aggregate supply relation can be expressed as a relation between inflation, expected inflation, and unemployment [equation (8.7)], the *Phillips curve*:

$$\pi_t = \pi_t^e - \alpha(u_t - u_n) \tag{9.4}$$

Inflation depends on expected inflation and on the deviation of unemployment from the natural rate of unemployment.

We then argued that in the United States today, expected inflation is well approximated by last year's inflation. This means we can replace π_t^e with π_{t-1}. With this assumption, the relation between inflation and unemployment takes the form

$$\pi_t - \pi_{t-1} = -\alpha(u_t - u_n) \tag{9.5}$$

Unemployment below the natural rate leads to an increase in inflation; unemployment above the natural rate leads to a decrease in inflation. The parameter α gives the effect of unemployment on the change in inflation. We saw in Chapter 8 that, since 1970 in the United States, the natural unemployment rate has been on average equal to 6%, and α has been equal to 0.73. This value of α means that an unemployment rate of 1% above the natural rate for one year leads to a decrease in the inflation rate of about 0.73%.

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

The Aggregate Demand Relation

The third relation we will need is a relation between output growth, money growth, and inflation. We will now see that it follows from the aggregate demand relation we derived in Chapter 7.

In Chapter 7, we derived the aggregate demand relation as a relation between the level of output and the real money stock, government spending, and taxes [equation (7.3)], based on equilibrium in both goods and financial markets:

$$Y_t = Y\left(\frac{M_t}{P_t}, G_t, T_t\right)$$

Note that I have added time indexes, which we did not need in Chapter 7 but will need in this chapter. To simplify things, we will make two further assumptions here.