Chapter 8: The Phillips Curve, the Natural Rate of Unemployment, and Inflation

Inflation, Expected Inflation, and Unemployment

The first step will be to show that the aggregate supply relation can be rewritten as a relation between inflation, expected inflation, and the unemployment rate.

Go back to the aggregate supply relation between the price level, the exp price level, and the unemployment rate we derived in Chapter 7.

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

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. It will be convenient here to assume a specific form for this function:

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

This captures the notion that the higher the unemployment rate, the lower is the wage; and the higher z (for example, the more generous unemployment benefits are), the higher is the wage. The parameter a (the Greek lowercase 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 we began with

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

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

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

- An increase in expected inflation (π^e) leads to an increase in inflation, π.

  To see why, return to equation. 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.

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*.

- Given expected inflation, (π^e) an increase in the markup, μ or an increase in the factors that affect wage determination–an increase in z–lead to an increase in inflation rate (π).

  Given the expected price level (P^e), an increase in either μ, 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 μ or z lead to an increase in inflation, (π).

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

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).

When we look at movements in inflation and unemployment below, it will be convenient to use time indexes, so that we can refer to variables such as inflation, or expected inflation, or unemployment, in a specific year. So we rewrite equation as:

$$\pi_t = \pi^e_t + (\mu + z) - \alpha u_t$$

The variables π_t, π_t^e and u_t refer to inflation, expected inflation, and unemployment in year t. Note that there are no time indexes on μ and z. This is because we shall typically think of both μ and z as constant.

The Phillips Curve

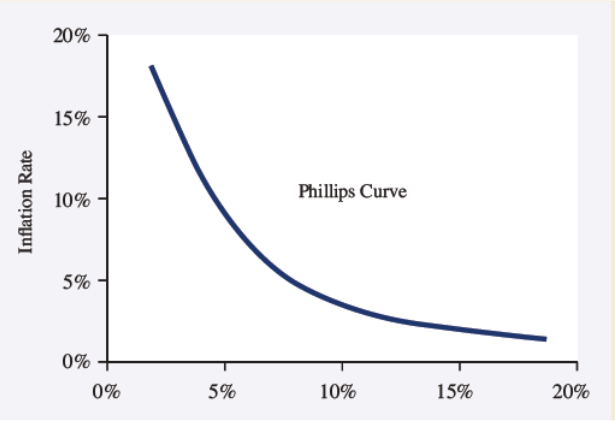
William Phillips, a British economist, published a paper in 1958 titled "The Relation between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957". In this paper he described how he observed the inverse relationship between money wage changes and unemployment in the British economy during the period examined. Similar patterns were found in other countries. In 1960 Paul Samuelson and Robert Solow took Phillips' work and applied it on the relation between inflation and unemployment and found that when inflation was high, unemployment was low, and vice versa.

Phillips Curve shows a negative relation between inflation and unemployment.

Think of wage setters choosing nominal wages for the coming year and thus having to forecast what inflation will be over the 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 they set $\pi_t^e = 0$.

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

This is precisely the negative relation between unemployment and inflation that Phillips found for the United Kingdom and Solow and Samuelson found for United States.



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

The original Phillips curve

Let's look at the argument that the high inflation in one year became more likely: to be followed by high inflation the next year. First, suppose expectations of inflation are formed according to:

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

The value of the parameter θ (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.

Assume that this year's price level would be roughly the same as last year's price level. For the period θ was close to zero, and expectations were roughly given by $\pi_t^e = 0$.

Now turn to the implications of different values of θ for the relation between inflation and unemployment. To do so, substitute equation $\pi_t^e = \theta\, \pi_{t-1}$ for the value of pet into equation:

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

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

  $\pi_t = (\mu + z) - \alpha\, u_t$

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

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

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

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

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.

Example

Suppose that the Phillips curve is given by

$\pi_t - \pi^e{}_t = 0.1 - 2\, u_t$
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. Compute the rate of inflation for year's t, $t + 1$, and $t + 2$.

$\pi_t - 0 = 0.1 - 2(4\%) \rightarrow \pi_t = 0.1 - 0.08 = 2\%$

$\pi_{t+1} - \pi_t = 0.1 - 2\, u_{t+1} \rightarrow \pi_{t+1} - 2\% = 0.1 - 2(4\%) \rightarrow \pi_{t+1} = 2\% + 2\% = 4\%$

$\pi_{t+2} - \pi_{t+1} = 0.1 - 2\, u_{t+2} \rightarrow \pi_{t+2} - 4\% = 0.1 - 2(4\%) \rightarrow \pi_{t+2} = 2\% + 4\% = 6\%$

The Phillips Curve and the Natural Rate of Unemployment

Let's make explicit the connection between the Phillips curve and the natural rate of unemployment.
By definition, 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 ($\pi_t = \pi^e_t$) in equation gives:

$$\pi_t = \pi^e_t + (\mu + z) - \alpha u_t$$

$$0 = (\mu + z) - \alpha u_t$$

Solving for the natural rate u_n,

$$u_n = \frac{\mu + z}{\alpha}$$

The higher the markup, μ, or the higher the factors that affect wage setting, z, the higher the natural rate of unemployment. Now rewrite equation as

$$\pi_t - \pi^e_t = -\alpha \left(u_t - \frac{\mu + z}{\alpha}\right)$$

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

$$\pi_t - \pi^e_t = -\alpha (u_t - u_n)$$

If the expected rate of inflation, π^e_t is well approximated by last year's inflation rate, π_{t-1}, the equation finally becomes

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

This equation 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.

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

  $u_t > u_n \quad \rightarrow \quad \pi_t > \pi_{t-1}$

- 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 nonaccelerating inflation rate of unemployment, or NAIRU.