CHAPTER 10: THE PHILLIPS CURVE, THE NATURAL RATE OF UNEMPLOYMENT AND INFLATION

The Natural Rate of Unemployment and the Phillips Curve

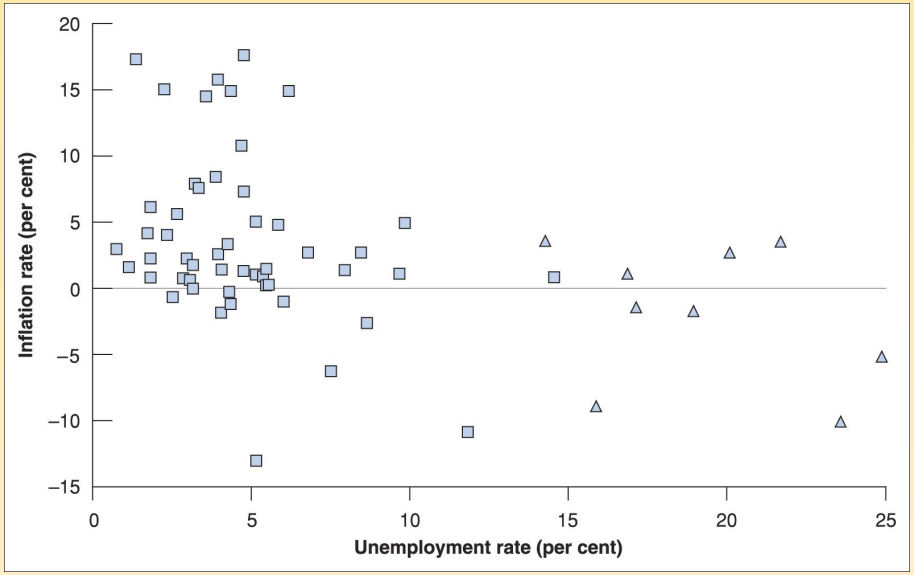

Figure 10.1 **Inflation versus unemployment in the USA, 1900–1960**
During the period 1900–1960 in the USA, a low unemployment rate was typically associated with a high inflation rate, and a high unemployment rate was typically associated with a low or negative inflation rate.

The Phillips curve, based on the data above, shows a negative relation between inflation and unemployment.

10.1 Inflation, Expected Inflation and Unemployment

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

The above equation is the aggregate supply relation derived in Chapter 8. This relation can be rewritten to establish a relation between inflation, expected inflation and the unemployment rate.

First, the function *F*, assumes the form:

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

Then, replace this function in the one above:

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

10.1 Inflation, Expected Inflation and Unemployment (Continued)

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

The appendix to this chapter shows how to go from the equation above to the relation between inflation, expected inflation and the unemployment rate below:

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

10.1 Inflation, Expected Inflation and Unemployment (Continued)

According to this equation:

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

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

10.1 Inflation, Expected Inflation and Unemployment (Continued)

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

- When referring to inflation, expected inflation or unemployment in a specific year, the equation above needs to include time indexes as follows:

$$\pi_t = \pi_t^{e} + (\mu + z) - \alpha u_t$$

- The variables π, π_t^e and u_t refer to inflation, expected inflation and unemployment in year t. μ and z are assumed constant and do not have time indexes.

10.2 The Phillips Curve

The early incarnation

If we set $\pi_t^e = 0$, then:

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

This is the negative relation between unemployment and inflation that Phillips found for the United Kingdom, and Solow and Samuelson found for the United States (or the original **Phillips curve**).

10.2 The Phillips Curve (Continued)

The early incarnation

The **wage–price spiral**:

Given $$P_t^e = P_{t-1} : \downarrow u_t \Rightarrow \uparrow W_t \Rightarrow P_t \uparrow \Rightarrow \frac{P_t - P_{t-1}}{P_{t-1}} \uparrow \Rightarrow \pi_t \uparrow$$

- Low unemployment leads to a higher nominal wage.
- In response to the higher nominal wage, firms increase their prices and the price level increases.
- In response, workers ask for a higher wage.
- Higher nominal wage leads firms to further increase prices. As a result, the price level increases further.
- This further increases wages asked for by workers.

And so the race between prices and wages results in steady wage and price inflation.

10.2 The Phillips Curve (Continued)

Slide 10.9

Mutations

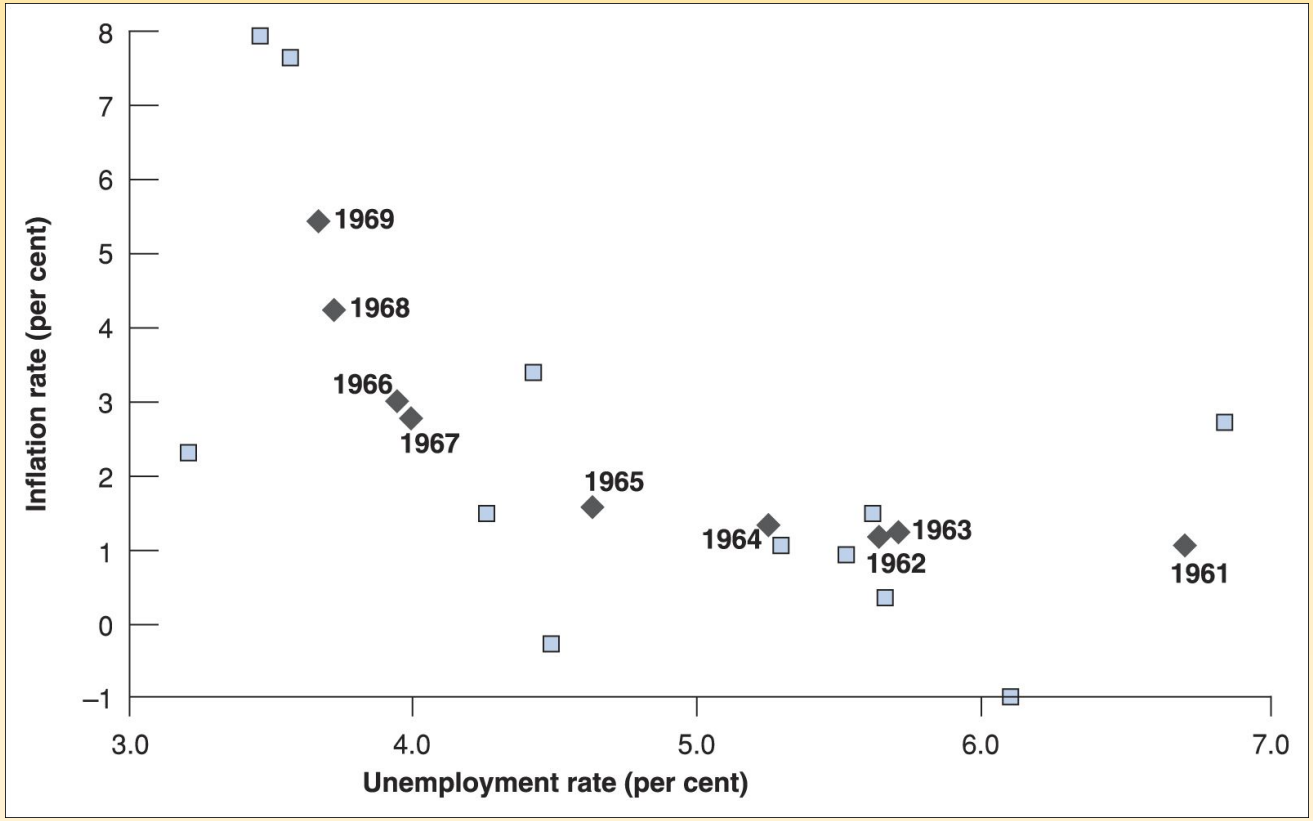

Figure 10.2 **Inflation versus unemployment in the USA, 1948–1969**

The steady decline in the US unemployment rate throughout the1960s was associated with a steady increase in the inflation rate.

10.2 The Phillips Curve (Continued)

Slide 10.10

Mutations

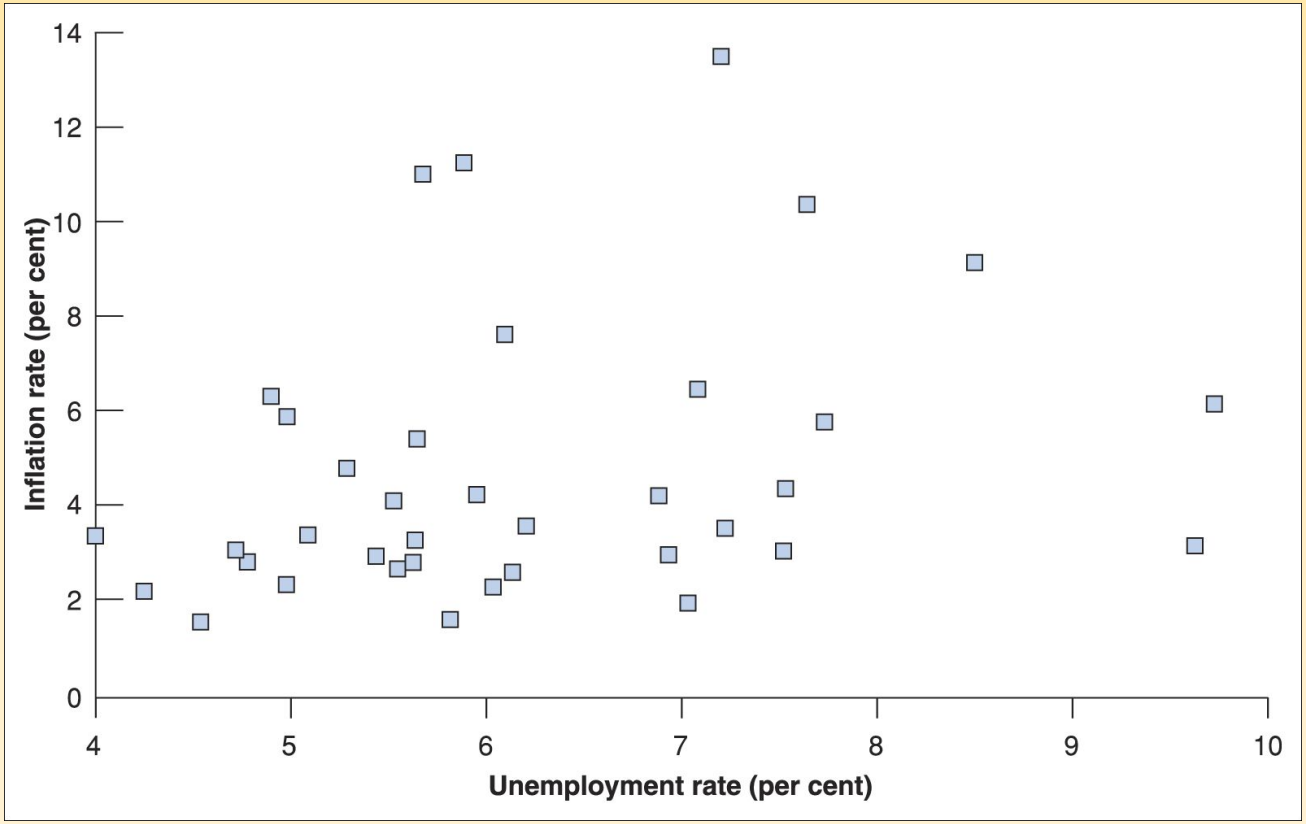

Figure 10.3 **Inflation versus unemployment in the USA since 1970**

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

10.2 The Phillips Curve (Continued)

Mutations

The negative relation between unemployment and inflation held throughout the 1960s, but it vanished after that for two reasons:

- An increase in the price of oil, but more importantly,
- Change in the way wage setters formed expectations due to a change in the behaviour of the rate of inflation.
  - The inflation rate became consistently positive and
  - Inflation became more persistent.

10.2 The Phillips Curve (Continued)

Slide 10.12

Mutations

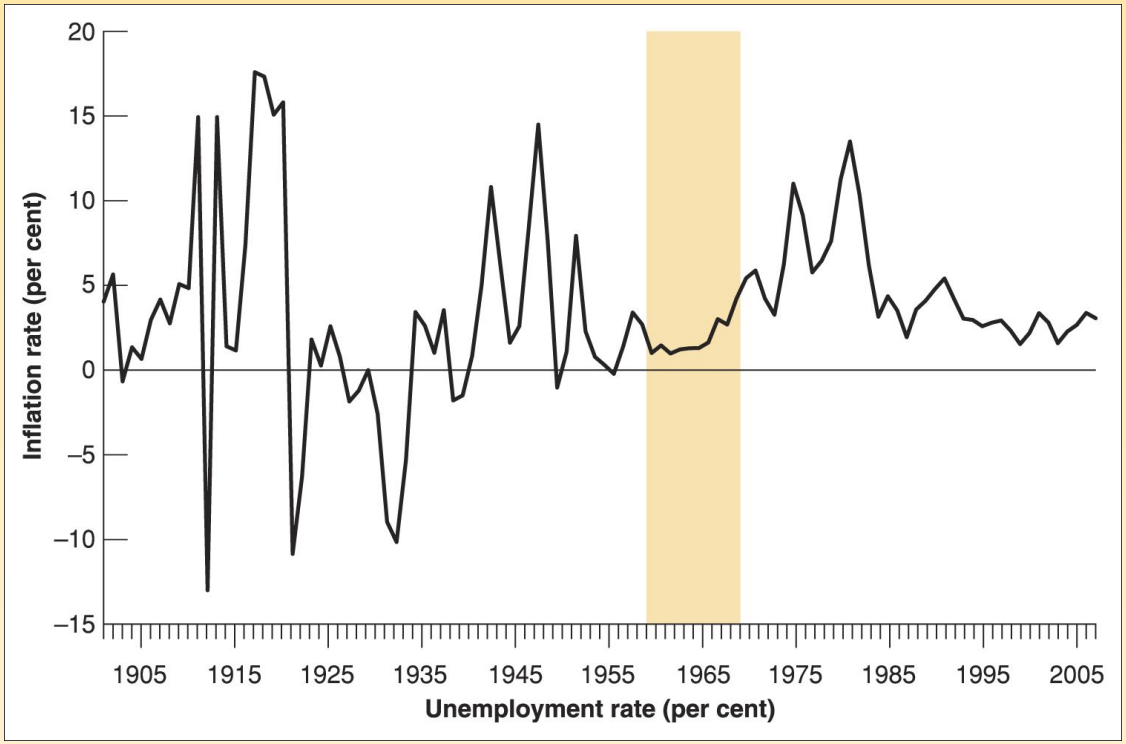

Figure 10.4 **US inflation since 1900**

Since the 1960s, the US 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.

10.2 The Phillips Curve (Continued)

Mutations

Suppose expectations of inflation are formed according to

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

The parameter θ captures the effect of last year's inflation rate, π_{t-1}, on this year's expected inflation rate, π_t^e.

The value of θ steadily increased in the 1970s, from zero to one.

10.2 The Phillips Curve (Continued)

Mutations

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 the price level last year.
- But, as inflation became more persistent, workers and firms started changing the ways they formed expectations.

10.2 The Phillips Curve (Continued)

Mutations

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

- 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 on both the unemployment rate and last year's inflation rate:

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

10.2 The Phillips Curve (Continued)

Mutations

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

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

- When $\theta = 1$, the unemployment rate affects not the *inflation rate*, but the *change in the inflation rate.*

- Since 1970, a clear negative relation emerged between the unemployment rate and the change in the inflation rate.

10.2 The Phillips Curve (Continued)

Slide 10.17

Mutations

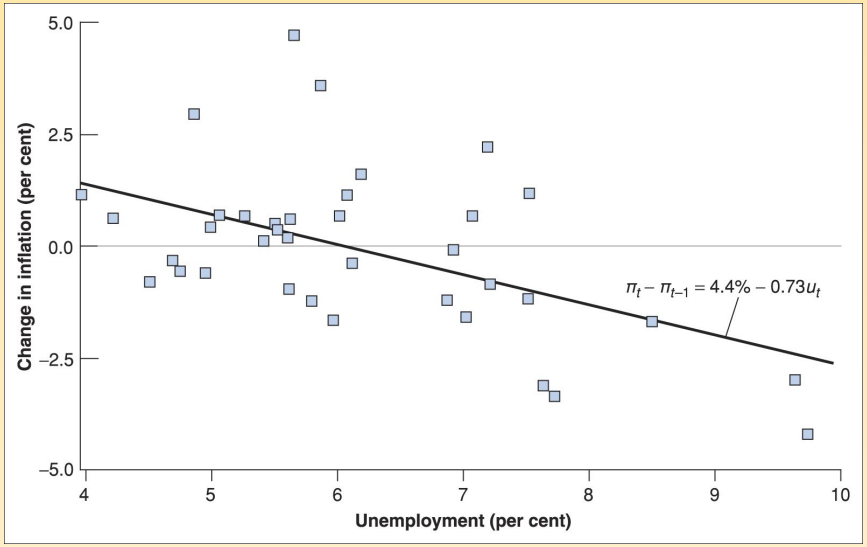

Figure 10.5 **Change in inflation versus unemployment in the USA since 1970**
Since 1970, there has been a negative relation between the unemployment rate and the change in the inflation rate in the USA.

The line that best fits the scatter of points for the period 1970–2006 is:

$$\pi_t - \pi_{t-1} = 4.4\% - 0.73u_t$$

10.2 The Phillips Curve (Continued)

Mutations

The original Phillips curve is:

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

The modified Phillips curve, or the expectations-augmented Phillips curve or the accelerationist Phillips curve is:

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

10.2 The Phillips Curve (Continued)

Slide 10.19

Back to the natural rate of unemployment

- **Friedman and Phelps questioned the trade-off between unemployment and inflation. They argued that the unemployment rate could not be sustained below a certain level, a level they called the '*natural rate of unemployment*'.**
- **The natural rate of unemployment is the unemployment rate such that the actual inflation rate is equal to the expected inflation rate.**

$$0 = (\mu + z) - \alpha u_n \qquad \text{then,} \qquad u_n = \frac{\mu + z}{\alpha}$$

10.2 The Phillips Curve (Continued)

Back to the natural rate of unemployment

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

Then,

$$\pi_t - \pi_t^e = -\alpha(u_t - u_n)$$

Finally, assuming that π_t^e is well approximated by π_{t-1}, then:

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

This is an important relation because it gives another way of thinking about the Phillips curve in terms of the actual and the natural unemployment rates and the change in the inflation rate.

10.2 The Phillips Curve (Continued)

Slide 10.21

Back to the natural rate of unemployment

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

The equation above 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

$$\pi_t - \pi_{t-1}$$

- It also gives us another way of thinking about the *natural rate of unemployment*. The *non-accelerating inflation rate of unemployment, (or NAIRU),* is the rate of unemployment required to keep the inflation rate constant.

10.2 The Phillips Curve (Continued)

A summary and many warnings

Let's summarize what we have learned so far:

- **When the unemployment rate exceeds the natural rate of unemployment, the inflation rate decreases. When the unemployment rate is below the natural rate of unemployment, the inflation rate increases.**

10.3 The Phillips Curve and the Natural Rate of Unemployment in Europe

Variations in the natural rate across countries

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

The factors that affect the natural rate of unemployment above differ across countries. Therefore, there is no reason to expect all countries to have the same natural rate of unemployment.

10.3 The Phillips Curve and the Natural Rate of Unemployment in Europe (Continued)

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

- In the equation above, the terms μ and z may not be constant but, in fact, vary over time, leading to changes in the natural rate of unemployment.

- In Europe, the natural unemployment rate has increased a lot since the 1960s. In the United States, the natural unemployment rate increased by 1–2% from the 1960s to the 1980s, and appears to have decreased since then.

10.3 The Phillips Curve and the Natural Rate of Unemployment in Europe (Continued)

What explains European unemployment?

Labour market rigidities:

- A generous system of unemployment insurance
- A high degree of employment protection
- Minimum wages
- Bargaining rules

10.3 The Phillips Curve and the Natural Rate of Unemployment in Europe (Continued)

Slide 10.26

High inflation and the Phillips curve relation

- The relation between unemployment and inflation is likely to change with the level and the persistence of inflation.
- When inflation is high, it is also more variable.
- The form of wage agreements also changes with the level of inflation. Wage indexation, a rule that automatically increases wages in line with inflation, becomes more prevalent when inflation is high.

10.3 The Phillips Curve and the Natural Rate of Unemployment in Europe (Continued)

Slide 10.27

High inflation and the Phillips curve relation

Let λ denote the proportion of labour contracts that is indexed, and $(1-\lambda)$ the proportion that is not indexed.

Then, $$\pi_t - \pi_t^e = -\alpha(u_t - u_n)$$

becomes: $$\pi_t = [\lambda\pi_t + (1-\lambda)\pi^e{}_t] - \alpha(u_t - u_n)$$

The proportion of contracts that is indexed responds to π_t, while the proportion that is not responds to π_t^e. When $\lambda = 0$, all wages are set on the basis of expected inflation (equal to last year's inflation), then:

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

10.3 The Phillips Curve and the Natural Rate of Unemployment in Europe (Continued)

High inflation and the Phillips curve relation

When λ is positive,

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

According to this equation, the higher the proportion of wage contracts that is indexed—the higher λ—the larger the effect of the unemployment rate on the change in inflation.

When λ is closer to 1, small changes in unemployment can lead to very large changes in inflation.