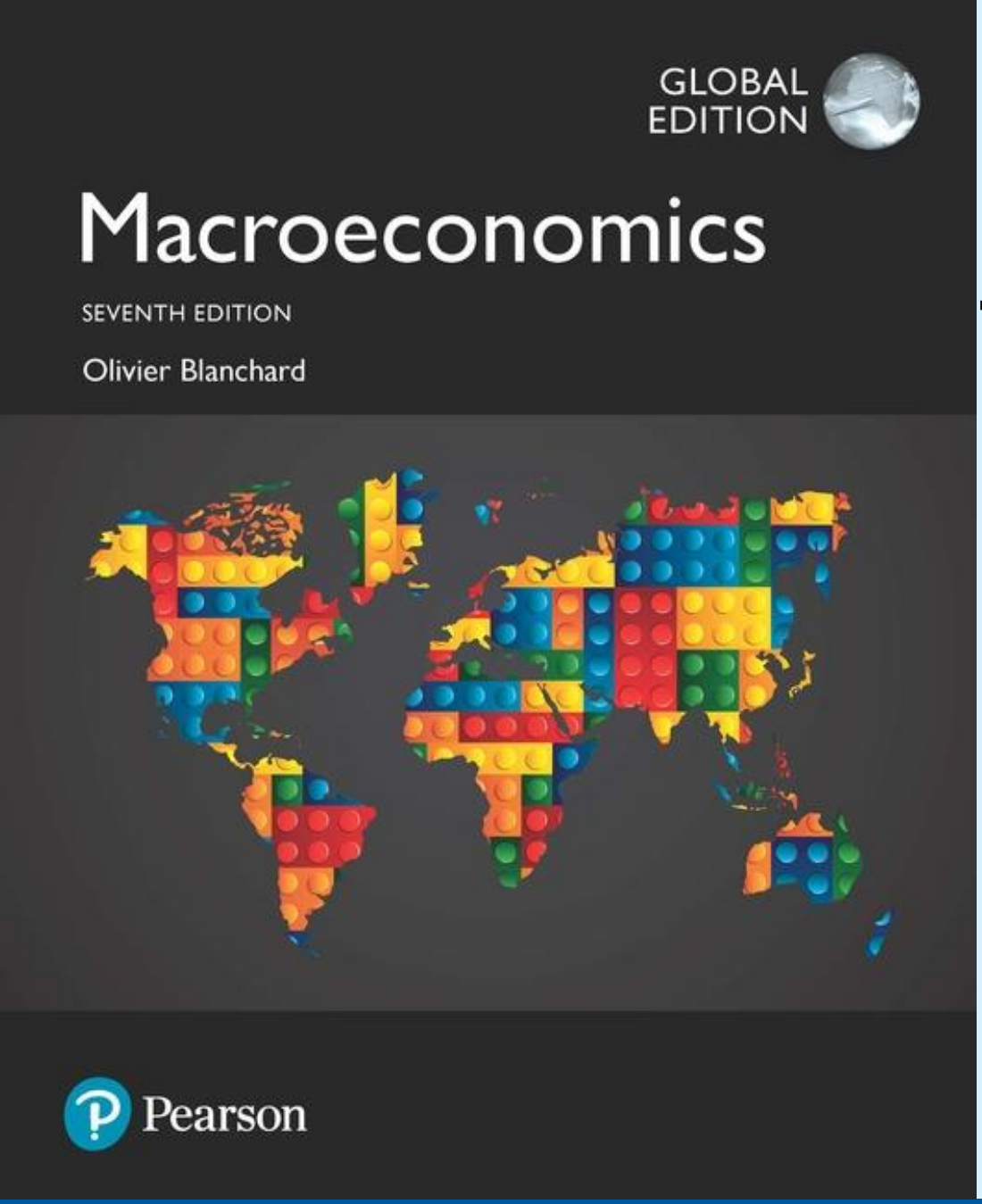


The Phillips Curve, the Natural Rate of Unemployment, and Inflation

Chapter 8

Chapter 8 Outline

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

8-1 Inflation, Expected Inflation, and Unemployment

8-2 The Phillips Curve and Its Mutations

8-3 The Phillips Curve and the Natural Rate of Unemployment

8-4 A Summary and Many Warnings

Purpose: **To understand the relation between inflation and unemployment**

We will derive the Phillips curve from the model of the labor market in Chapter 7.

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

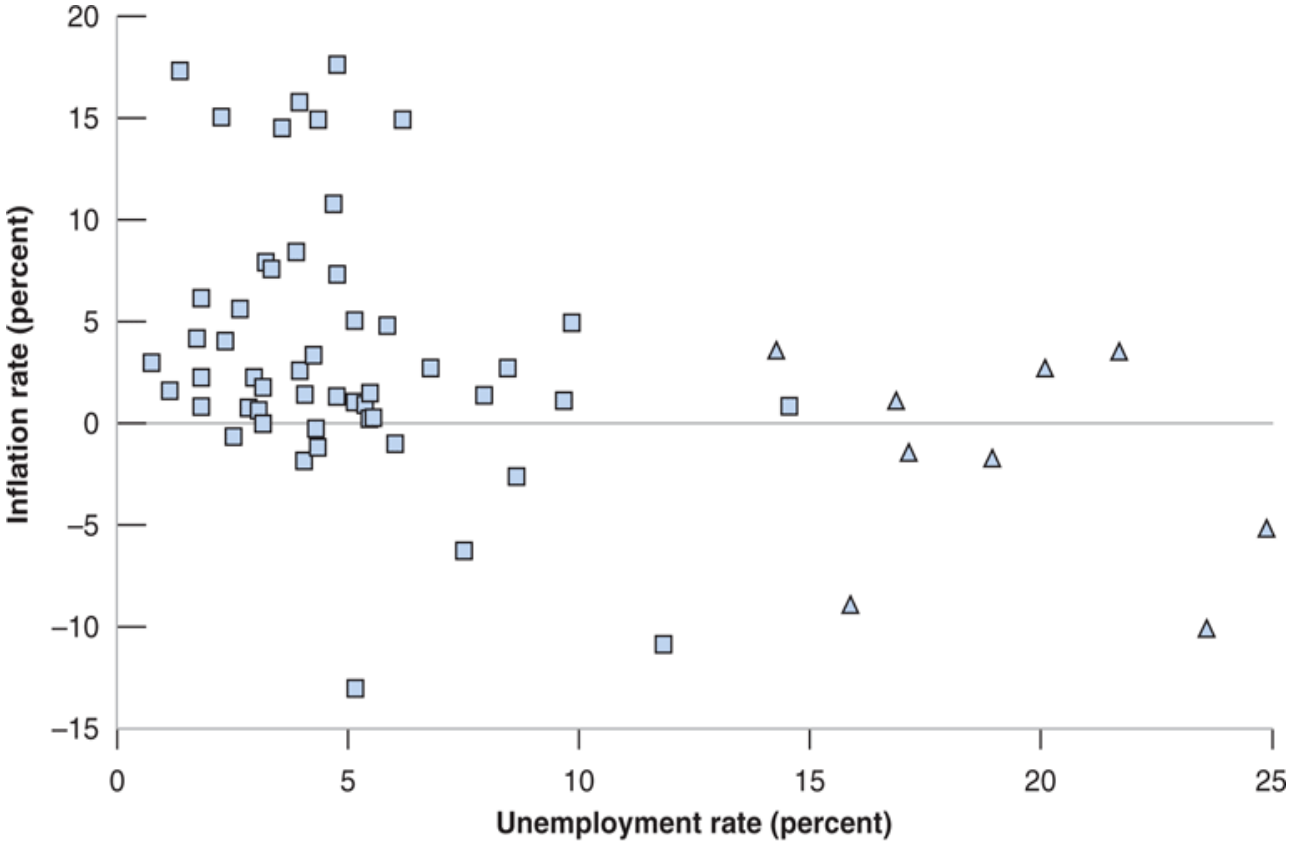
- In 1958. A.W. Phillips found a negative relation between inflation and unemployment using U.K. data for 1861-1957.

- Two years later, Paul Samuelson and Robert Solow replicated the Philip's exercise for the U.S. Using data from 1900-1960.
- They labeled this relation the **Phillips curve**, which became central to macroeconomic thinking and policy.

Figure 8-1 Inflation versus Unemployment in the United States, 1900–1960

During the period 1900-1960 in the U.S., 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.

(Δ: represent the high unemployment years from 1931 to 1939)



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

8-1 Inflation, Expected Inflation, and Unemployment

- Recall the wage determination equation (7.1):

$$W = P^e F(u, z) \qquad (7.1)$$

and the price determination equation (7.3):

$$P = (1 + m)W \qquad (7.3)$$

- Substitute equation (7.1) for W in equation (7.3):

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

An increase in expected price level leads to an increase in nominal wages, which in turn leads firms to increase their prices, and thus leads to an increase in the price level. $P^e \uparrow \rightarrow$ W$\uparrow \rightarrow P\uparrow$

8-1 Inflation, Expected Inflation, and Unemployment

Assume a specific form for *F*:

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

α: captures the strength of the effect of unemployment on the wage

so that the *relation between the price level, the expected price level, and the unemployment rate* is:

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

or in terms of inflation rate π and the expected inflation rate π^e:

$$\pi = \pi^e + (m + z) - \alpha u \qquad (8.2)$$

APPENDIX: How to go from the Relation between the Price Level, the Expected Price Level, and Unemployment to a Relation between Inflation, Expected Inflation, and Unemployment

- Equation (8.1) with time subscripts becomes: $\Pi_t=(P_t-P_{t-1})/P_{t-1}$

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

- Divide both sides by P_{t-1}:

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

- Rewrite P_t/P_{t-1} as $1+\pi_t$ and do the same for the expected inflation rate, equation (8A.1) becomes:

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

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

- If the left side is not large, it becomes $1 + \pi_t - \pi_t^e - m$ and so:

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

8-1 Inflation, Expected Inflation, and Unemployment

$$\pi = \pi^e + (m + z) - \alpha u \qquad (8.2)$$

- *An increase in π^e leads to an increase in π.*
- *Given π^e, an increase in m, or an increase in z, leads to an increase in π.*
- *Given π^e, a decrease in u leads to an increase in π.*

- Equation (2.2) with a time index *t*:

$$\pi_t = \pi_t^e + (m + z) - \alpha u_t \qquad (8.3)$$

(We use the time index in order to refer to variables in a specific year)

*NOTE: No time indexes for m and z. Although **m** and **z** might move over time they are likely to move slowly, especially relative to movement in unemployment and inflation*

8-2 The Phillips Curve and Its Mutations

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

•Assume $\pi_t^e = \bar{\pi}$, so that equation (8.3) becomes:

$$\pi_t = \bar{\pi} + (m + z) - \alpha u_t \qquad (8.4)$$

which is a negative relation between unemployment and inflation.

•This Phillips curve relation was observed in the United States in the 1960s.

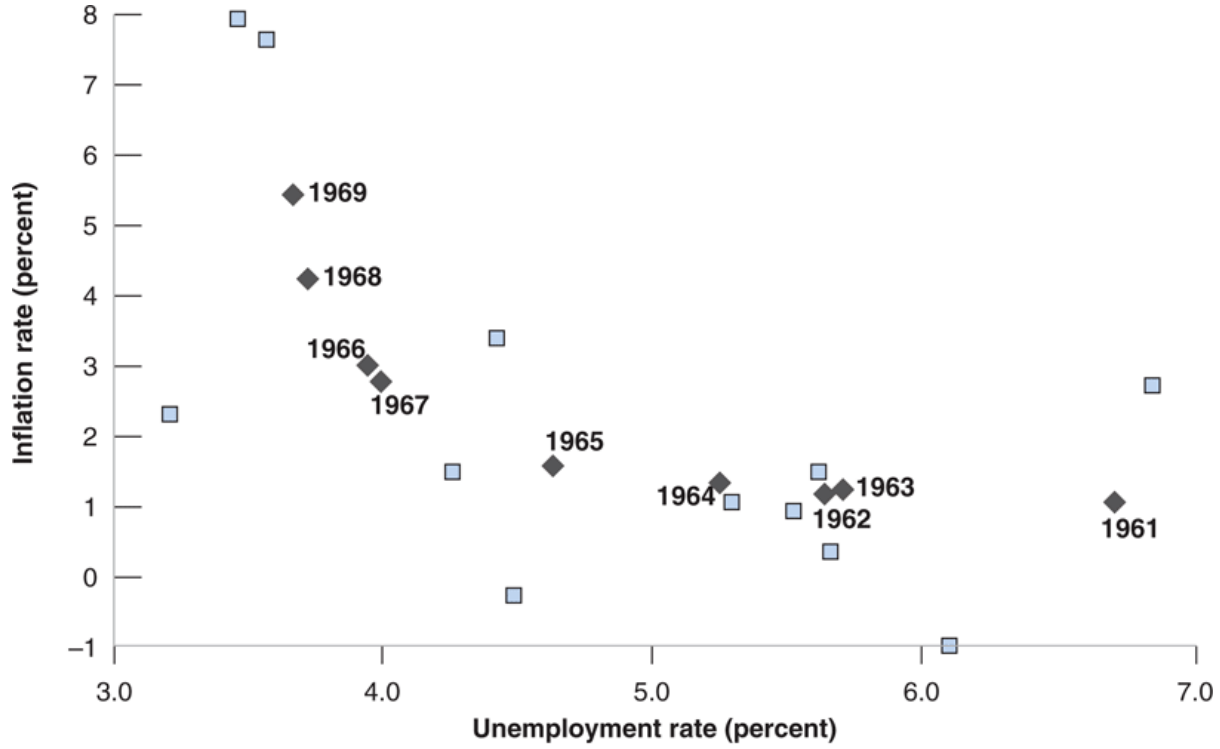
•The relation vanished in the 1970s because **wage setters changed the way they formed inflation expectations.**

8-2 The Phillips Curve and Its Mutations

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.

u↓ → π↑



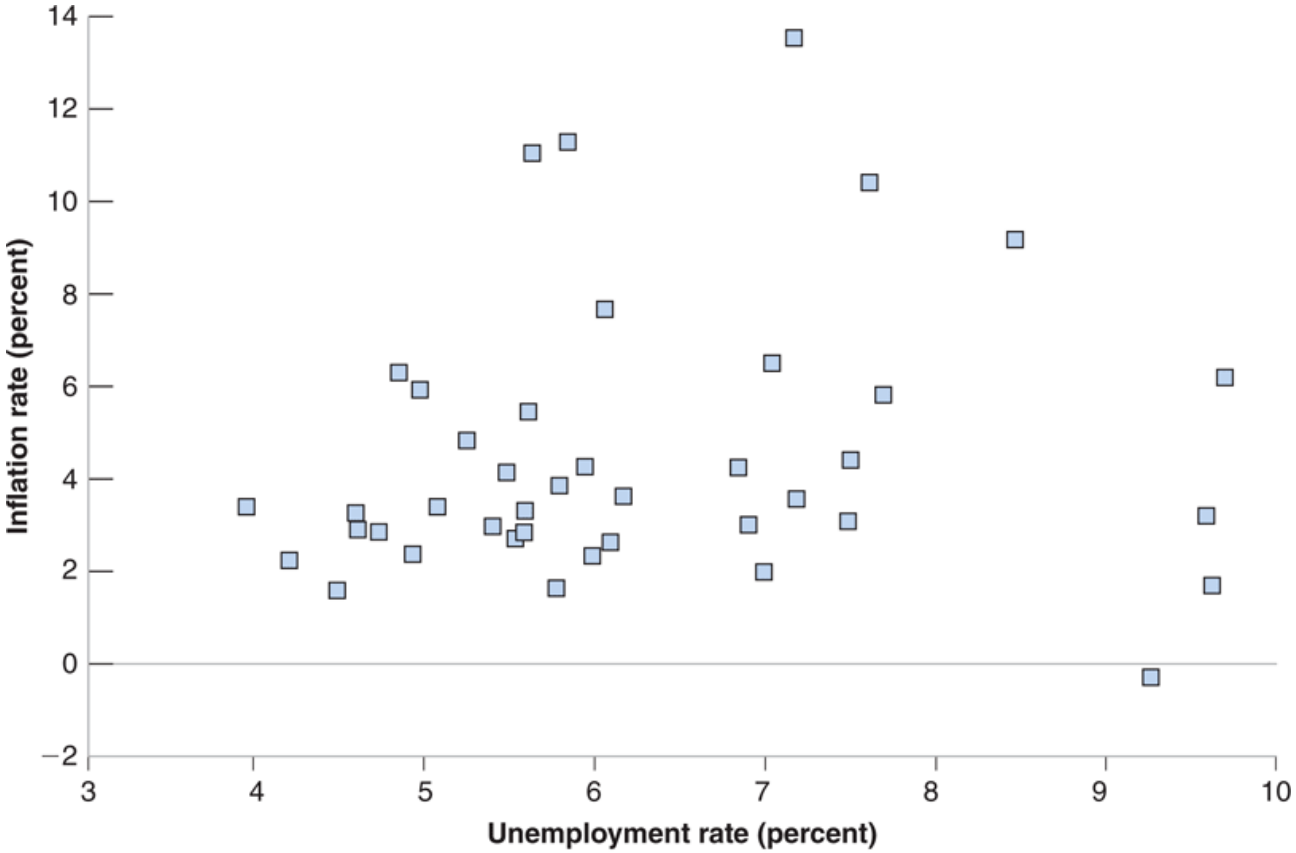
Source: Series UNRATE, CPIAUSCL Federal Reserve Economic Data (FRED) http://research.stlouisfed.org/fred2/

8-2 The Phillips Curve and Its Mutations

Figure 8-3 Inflation versus Unemployment in the United States, 1970–2010

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

?? Why??



Source: See Figure 8-2.

8-2 The Phillips Curve and Its Mutations

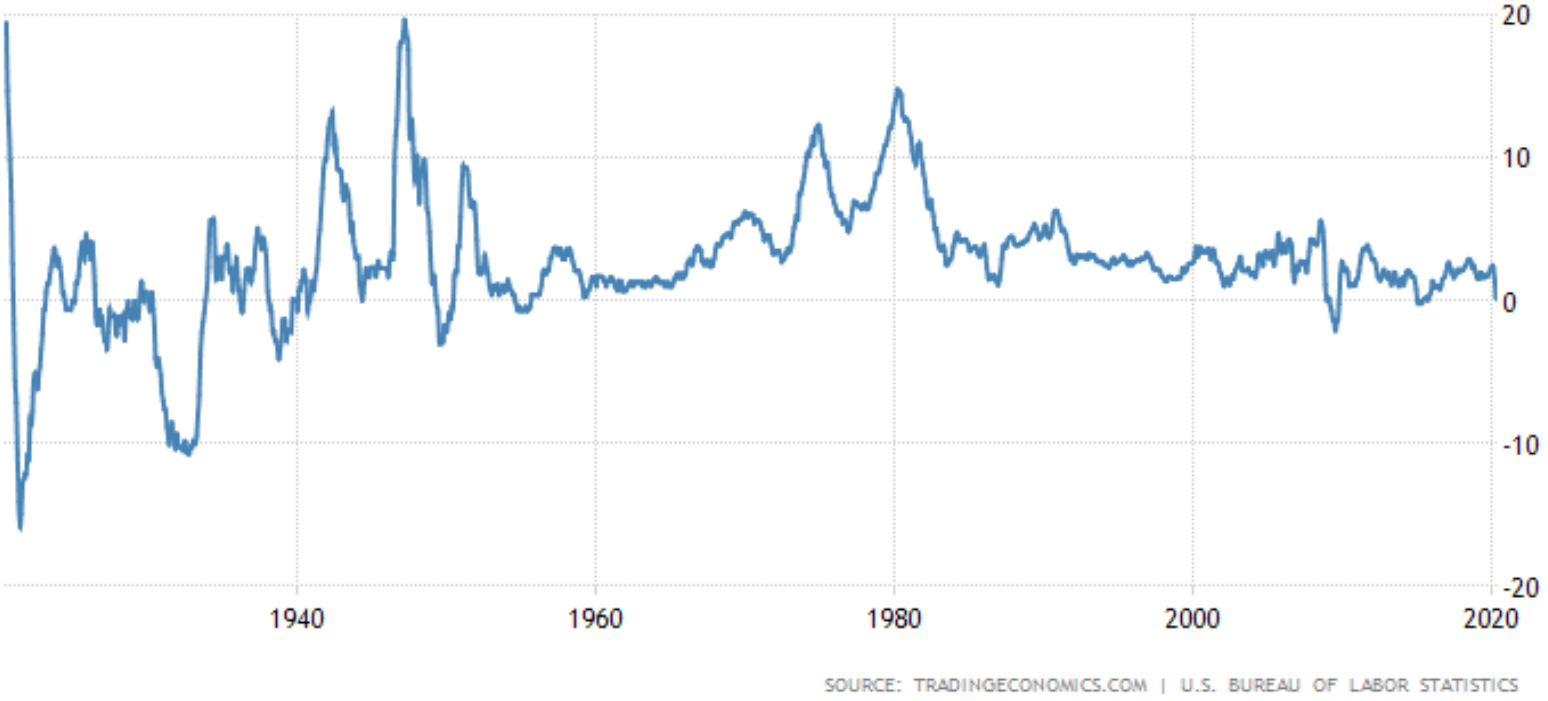
$$\pi_t = \pi^e{}_t + (m + z) - \alpha u_t \qquad (8.3)$$

- Suppose expected inflation this year depends on a constant value $\bar{\pi}$ with weight $1-\theta$, and partly on inflation last year with weight θ:

$$\pi_t^e = (1 - \theta)\bar{\pi} + \theta\pi_{t-1} \qquad (8.5)$$

- When $\theta = 0$, $\pi_t = \bar{\pi} + (m + z) - \alpha u_t$
- When $\theta > 0$, $\pi_t = [(1 - \theta)\bar{\pi} + (m + z)] + \theta\pi_{t-1} - \alpha u_t$
- When $\theta = 1$, $\pi_t - \pi_{t-1} = (m + z) - \alpha u_t$, so the unemployment rate affects not the inflation rate, but rather the change in the inflation rate.

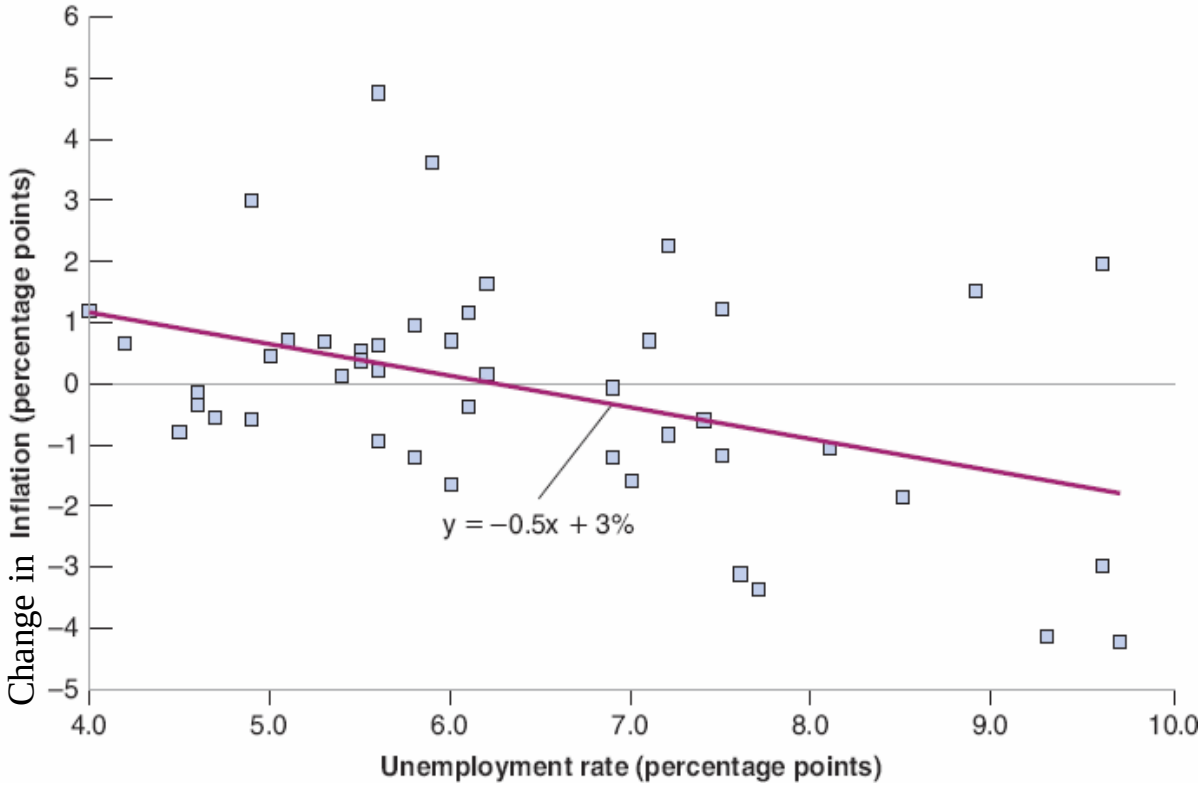
Figure 2-3 U.S. Inflation Rate, 1920−2020



8-2 The Phillips Curve and Its Mutations

Figure 8-4 Change in Inflation versus Unemployment in the United States, 1974–2014

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



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

8-2 The Phillips Curve and Its Mutations

- The line that best fits the scatter of points in Figure 8-4 is:

$$\pi_t - \pi_{t-1} = 3.0\% - 0.5u_t \qquad (8.7)$$

which is called the **modified Phillips curve**, or the **expectations-augmented Phillips curve**, or the **accelerationist Phillips curve**.

- We shall simply called equation (8.7) the Phillips curve, as opposed to the *original* Phillips curve (8.4).

8-3 The Phillips Curve and the Natural Rate of Unemployment

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

- Suppose $\pi = \pi^e$ and solve for u_n in equation (8.3):

$$u_n = \frac{m + z}{\alpha} \qquad (8.8)$$

- Rewrite equation (8.3) as

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

so equation (8.8) can be rewritten as

$$\pi_t - \pi_t^e = -\alpha(u_t - u_n) \qquad (8.9)$$

8-3 The Phillips Curve and the Natural Rate of Unemployment

- If π^e is well approximated π_{t-1}, then

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

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

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

- So the natural rate of unemployment is also called the **non-accelerating inflation rate of unemployment (NAIRU)**.

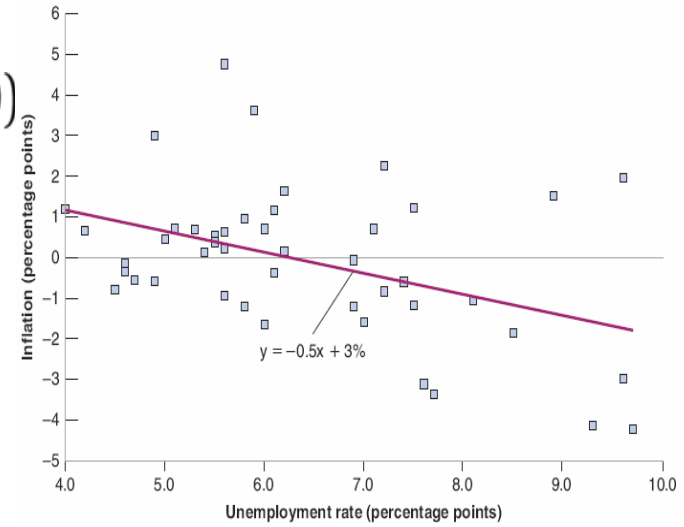
8-3 The Phillips Curve and the Natural Rate of Unemployment

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

$$u_n = \frac{m + z}{\alpha} \qquad (8.8)$$

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

$$\pi_t - \pi_t^e = -\alpha(u_t - u_n) \qquad (8.9)$$



When $\pi^e{}_t = \pi_{t-1}$ ***we get the modified P.C***

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

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

Example :

For US 1974-2014 (figure 8-4) $\pi_t - \pi_{t-1} = 3.0\% - 0.5\,u_t$ (8.7)

Hence $m+z=3.0\%$ and $\alpha=0.5$, *therefore* $u_n = 3.0\% / 0.5 = 6\%$

FOCUS: Theory ahead of Facts: Milton Friedman and Edmund Phelps

- Milton Friedman and Edmund Phelps argued that the trade-off between inflation and unemployment in the late 1960s was an illusion.

- Accordingly, the Phillips curve is a temporary, rather than a permanent, trade-off between inflation and unemployment that comes not from inflation per se, but from a rise rate of inflation, which results in unanticipated inflation.

→ Read the focus box !!

8-4 A Summary and Many Warnings

- The relation between unemployment and inflation in the United States today is well captured by a relation between the change in the inflation rate and the deviation of the unemployment rate from the natural rate of unemployment.

- When the unemployment rate is above (below) the natural rate of unemployment, the inflation rate typically decreases (increases).

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

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

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

FOCUS: What Explains European Unemployment?

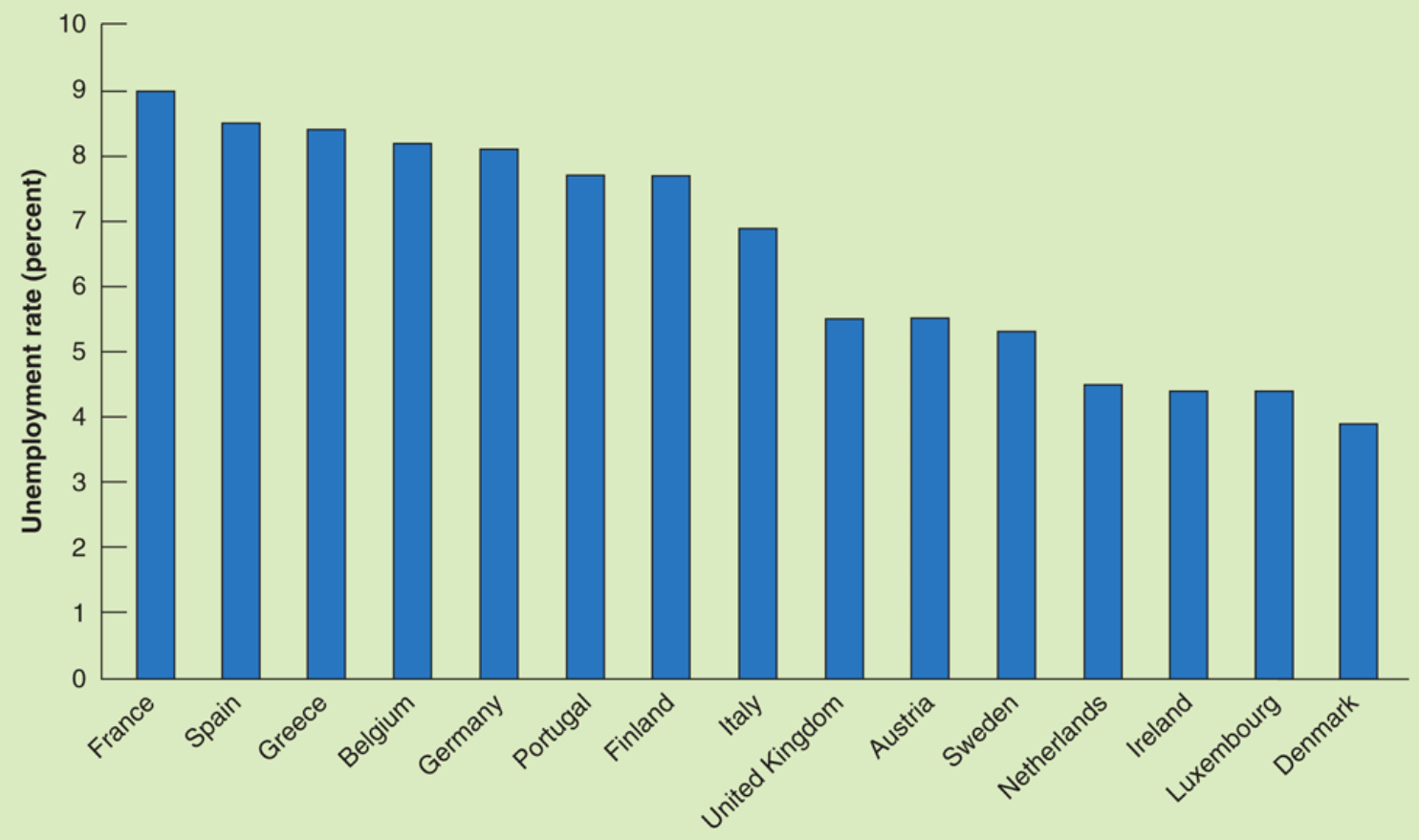
The natural rate of unemployment differ across counties due to, e.g., **labor-market rigidities**, and also over time.

- Factors for labor-market rigidities:
  - A generous system of unemployment insurance
  - A high degree of employment protection
  - Minimum wages
  - Bargaining rules, such as extension agreements

- Key facts of unemployment in Europe:
  - Unemployment was not always high
  - Some European counties actually had low unemployment prior to the start of the current crisis

FOCUS: What Explains European Unemployment?

Figure 1 Unemployment Rates in 15 European Countries, 2006



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

- Possible explanations for the decrease of the European natural rate of unemployment to 8 - 9% today:
  - Institutions were different earlier and labor-market rigidities only appeared in the last 40 years.
  - Interaction between institutions and shocks; firms that cannot adjust their labor force quickly may be unable to compete and will go out of business.

8-4 A Summary and Many Warnings

- When the inflation rate becomes high, the terms of wage agreements tend to change with the level of inflation.

- **Wage indexation** is a provision that automatically increases wages in line with inflation.

- Suppose λ a proportion of labor contracts that is indexed, so nominal wages move one-for-one with changes in the actual price level, equation (8.9) becomes

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

8-4 A Summary and Many Warnings

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

- When λ=0, equation (8.11) becomes equations (8.10).

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

- When λ>0, equation (8.11) becomes:

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

- ***Wage indexation increases the effect of unemployment on inflation***.
- Without wage indexation, lower unemployment increases wages, which in turn increases prices.

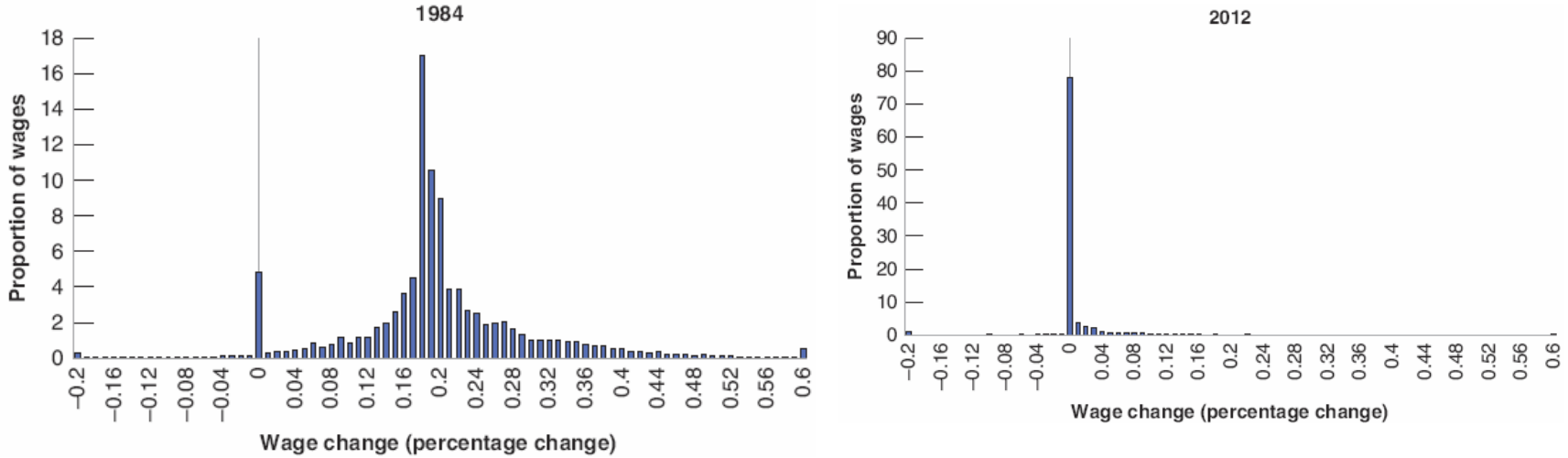
8-4 A Summary and Many Warnings

- When low inflation or deflation occurs, the Phillips curve relation breaks down.

- One possible reason is the reluctance of workers to accept cuts in nominal wages.

8-4 A Summary and Many Warnings

Figure 8-5 Distribution of wage changes in Portugal, in times of high and low inflation



- In 1984, the inflation rate was 27%, and the distribution of wage wages was roughly symmetric.
- In 2012, the inflation rate was just 2.1%, and the distribution of wages was bunched at zero with nearly no negative wage changes.