

# Course 7: The Phillips Curve, the Natural Rate of Unemployment, and Inflation

Intermediate Macroeconomics, Econ 102

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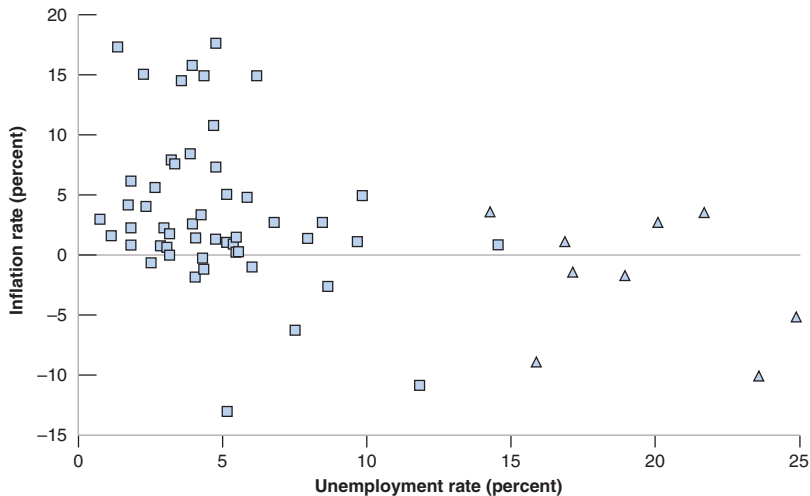
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# The birth of the Phillips Curve

- In 1958. A.W. Phillips uncovered a negative association between the rate of inflation and unemployment, in the **UK**, from 1861 to 1957. (Phillips (1958))
- Two years later, two US economists, Paul Samuelson and Robert Solow replicated the analysis for the US, using data from 1900 to 1960 (Samuelson and Solow 1960). Apart from the period 1931-1939 (triangles), they found a similar association.
- This relation was soon labeled the **Phillips curve**, and became central to macroeconomic thinking and policy (it is a central tenet of the **new-keynesian school**, which came to dominate academia in the US). However, the Phillips Curve was **not part** of Keynesian economics initially. In particular, Keynes (1936) made no mention of a trade-off between inflation and unemployment.
- Full disclosure: I am skeptical of the Phillips Curve (though i believe that output is demand-determined in the short-run). In my opinion, this lecture and the next are on shaky grounds. (see the bibliography)

# Inflation versus Unemployment in the United States, 1900–1960



# Outline

- 1 Inflation, Expected Inflation, and Unemployment
- 2 The Phillips Curve and Its Mutations
- 3 The Phillips Curve and the Natural Rate of Unemployment
- 4 A Summary and Many Warnings

1 Inflation, Expected Inflation, and Unemployment

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# Inflation, Expected Inflation, and Unemployment

- Recall the wage setting equation (WS):

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

which came from the fact that higher unemployment worsens one's bargaining power, while higher unemployment benefits raises it.

- Remember the price setting equation (PS):

$$P = (1 + m)W$$

- Substituting out the wage  $W$  in those two equations, this gives:

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

# Inflation, Expected Inflation, and Unemployment

- Let us assume a specific linear function form for  $F$ :

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

then, replacing out in the previous equation gives the relation between the price level, the expected price level, and the unemployment rate is:

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

- After some algebra, which is shown on the next slide, one can write this expression in terms of inflation rate  $\pi$  and the expected inflation rate  $\pi^e$ :

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

# Algebra

- The previous equation with time subscripts becomes:

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

- Dividing both sides by  $P_{t-1}$  yields:

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

- Rewrite  $P_t/P_{t-1} = 1 + \pi_t$  and do the same for the expected inflation rate  $P_t^e/P_{t-1} = 1 + \pi_t^e$ , the previous equation becomes:

$$\begin{aligned} 1 + \pi_t &= (1 + \pi_t^e) (1 + m) (1 - \alpha u_t + z) \\ \Rightarrow \frac{1 + \pi_t}{(1 + \pi_t^e) (1 + m)} &= 1 - \alpha u_t + z. \end{aligned}$$

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

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



# Inflation, Expected Inflation, and Unemployment

- The Phillips Curve thus writes as follows:

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

- Without the time subscript, for lighter notation:

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

- Some useful comparative statics are as follows:

- 1 An increase in  $\pi^e$  leads to an increase in  $\pi$ .
- 2 Given  $\pi^e$ , an increase in  $m$ , or an increase in  $z$ , leads to an increase in  $\pi$ .
- 3 Given  $\pi^e$ , a decrease in  $u$  leads to an increase in  $\pi$ .

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# Inflation, Expected Inflation, and Unemployment

- Assume that inflation varies from year to year around some value  $\pi_t^e = \bar{\pi}$ , so that the previous equation becomes:

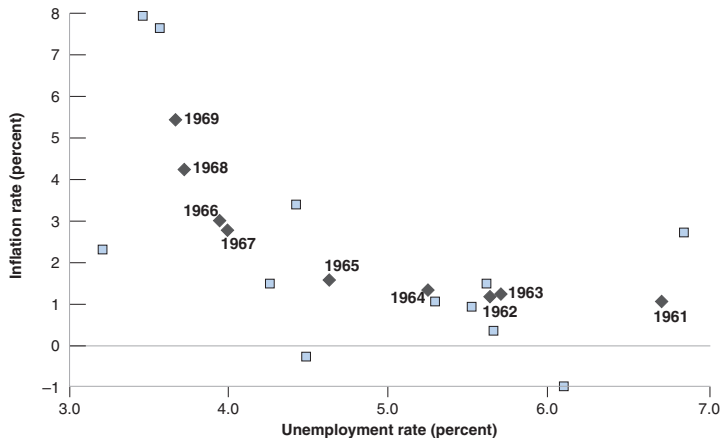
$$\pi_t = \bar{\pi} + (m + z) - \alpha u_t$$

which is a negative relation between unemployment and inflation.

- In this case, we shall observe a negative relation between unemployment and inflation:
  - ▶ This relation was observed in the United States in the 1960s, by Samuelson and Solow (1960).
  - ▶ It was also observed in the United Kingdom by Phillips (1958).

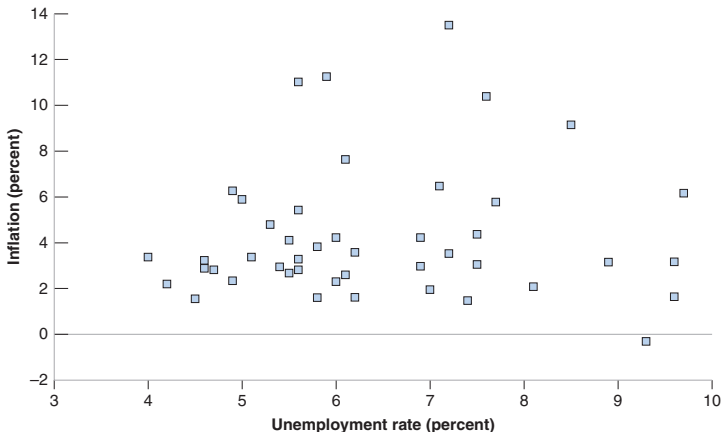
# Inflation versus Unemployment in the United States, 1948–1969

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



# 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 broke down. There is no longer any visible relation between the unemployment rate and the inflation rate.



# The Phillips Curve and Its Mutations

- What happened? The usual story is that **wage setters changed the way they formed their expectations about inflation.**
- Suppose expected inflation this year depends on a constant value  $\bar{\pi}$  with weight  $1 - \theta$ , and partly on inflation last year with weight  $\theta$ :

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

- When the weight on last year's inflation is  $\theta = 0$ , then we observe a stable Phillips curve:

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

- When  $\theta > 0$ :

$$\pi_t = [(1 - \theta)\bar{\pi} + (m + z)] + \theta\pi_{t-1} - \alpha u_t.$$

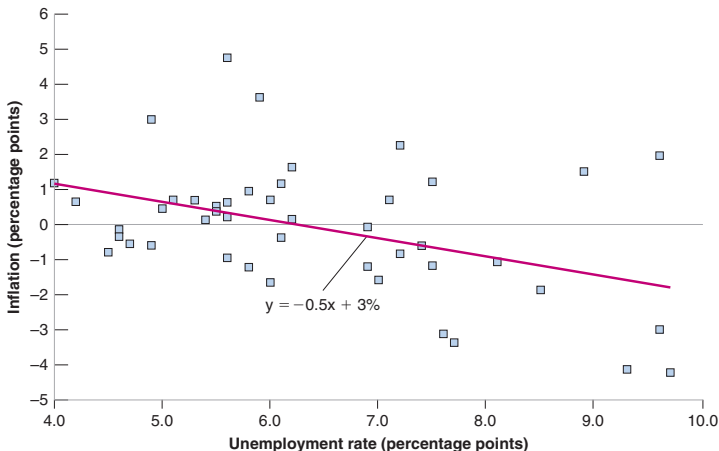
- When  $\theta = 1$ :

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

so the unemployment rate affects not the inflation rate, but rather the change in the inflation rate.

# Change in Inflation versus Unemployment in the United States, 1974–2014

And indeed: since 1970, there has been a negative relation between the unemployment rate and the change in the inflation rate in the US.



# The Phillips Curve and Its Mutations

- The line that best fits the scatter of points in the previous figure is:

$$\pi_t - \pi_{t-1} = 3.0\% - 0.5u_t$$

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

- This is meant 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 this equation the *Phillips curve*, as opposed to *the original Phillips curve*.
- Note however that this relationship is far from tight. Lately, the accelerationist version of the Phillips Curve has not been working very well. The Phillips Curve may be broken for good?



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# The Phillips Curve and the Natural Rate of Unemployment

- The history of the Phillips curve is closely related to the concept of the Natural Rate of Unemployment.
- With the original Phillips curve, there was **no such a thing as a natural unemployment rate**: with a higher inflation rate, one could forever maintain low unemployment.
- 1960s: pretty much right. However, Milton Friedman and Edmund Phelps argued that the trade-off between inflation and unemployment in the late 1960s was an illusion. (Friedman (1968), Phelps (1968))
- According to them, 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.
- The usual story is that the failure of the Phillips curve at the beginning of the 1970s proved them right.

## Theory ahead of facts? (Friedman (1968))

“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 will be reflected in a less rapid rise in nominal wages than in anticipated prices, not in an absolute decline in wages.”

“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.**”

# The Phillips Curve and the Natural Rate of Unemployment

- By definition, the natural rate of unemployment is the unemployment rate at which the actual price level is equal to the expected price level.
- 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. Thus, the natural rate of unemployment  $u_n$  is such that  $\pi = \pi^e$  and therefore:

$$0 = (m + z) - \alpha u_n \quad \Rightarrow \quad u_n = \frac{m + z}{\alpha}.$$

- The higher the markup  $m$ , the higher the factors that affect wage setting  $z$ , the higher the natural rate of unemployment. Now, rewriting the previous equation:

$$\pi_t - \pi_{t-1} = (m + z) - \alpha u_t \quad \Rightarrow \quad \pi_t - \pi_t^e = -\alpha \left( u_t - \frac{m + z}{\alpha} \right)$$

so it can be rewritten as:

$$\boxed{\pi_t - \pi_t^e = -\alpha (u_t - u_n)}.$$

# The Phillips Curve and the Natural Rate of Unemployment

- If  $\pi^e$  is well approximated by  $\pi_{t-1}$ , then:

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

and therefore:

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

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

- The change in the inflation rate depends on the difference between the actual and the natural unemployment rates.
- 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 (NAIRU).

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## A Summary and Many Warnings

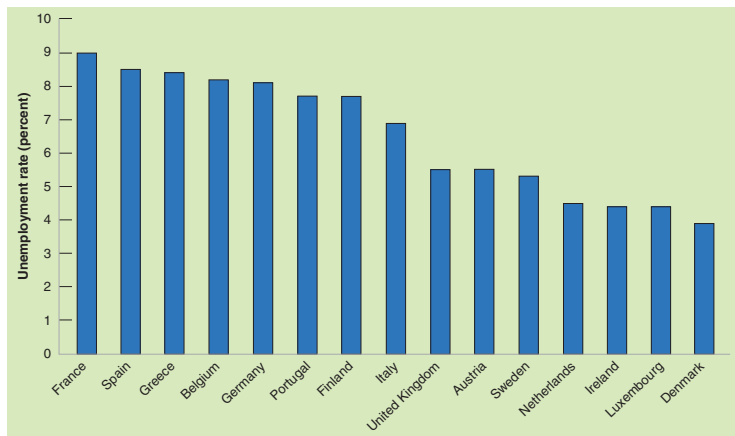
- The relation between unemployment and inflation in the United States today is well captured by a relation between the change in the inflation rate and the deviation of the unemployment rate from the natural rate of unemployment. (disclaimer however: this is probably less true in recent years !)
- When the unemployment rate is above (below) the natural rate of unemployment, the inflation rate typically decreases (increases).
- Even if one accepts this theory of the Phillips Curve, it is hardly a universal law of physics.
- In particular, the natural rate of unemployment differs across countries due to, e.g., **labor-market rigidities**, and also over time.

# What Explains European Unemployment?

- 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 countries actually had low unemployment prior to the start of the current crisis.



# Unemployment Rates in 15 European Countries, 2006



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

- Possible explanations for the decrease of the U.S. natural rate of unemployment from 7 to 8% in the 1980s to about 5% today:
  - ▶ Increased globalization and stronger competition between U.S. and foreign firms may have lowered the markup.
  - ▶ Increases in employment by temporary help agencies.
  - ▶ The aging U.S. population and a decrease in the proportion of young workers and thus the unemployment rate.
  - ▶ An increase in the incarceration rate.
  - ▶ The increase in the number of workers on disability.

# Wage indexation

- 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  $\lambda$  a proportion of labor contracts that is indexed, so nominal wages move one-for-one with changes in the actual price level, the previous equation becomes:

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

## A Summary and Many Warnings

- When  $\lambda = 0$ , the previous equation is:

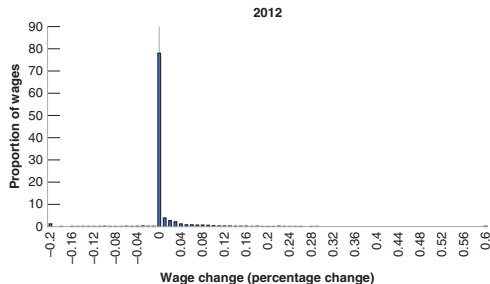
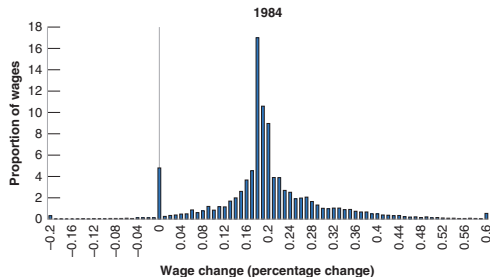
$$\pi_t - \pi_{t-1} = -\alpha (u_t - u_n).$$

- When  $\lambda > 0$ , the previous equation is:

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

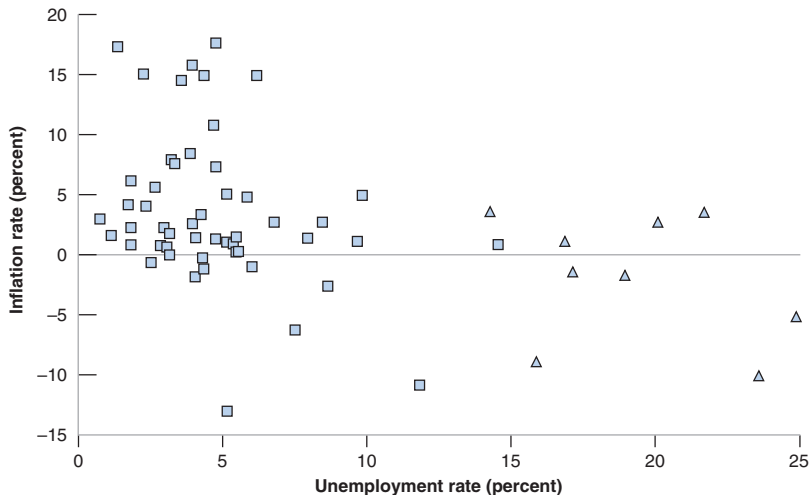
- Wage indexation increases the effect of unemployment on inflation.
- Without wage indexation, lower unemployment increases wages, which in turn increases prices.
- When low inflation or deflation occurs, the Phillips curve relation breaks down.
- One possible reason is the reluctance of workers to accept cuts in nominal wages.

# Unemployment Rates in 15 EU Countries, 2006



# Inflation VS Unemployment in the US, 1900–1960

Triangles: 1930s



# Deflation and the Phillips Curve relation

- 1930s: given the high unemployment rate, the inflation rate was surprisingly high in the 1930s. We would have expected a large rate of deflation.
- From **1934-1937**, despite still high unemployment, **inflation actually turned positive**.
- One explanation: reluctance of workers to accept decreases in their nominal wages.
- Another example, closer from our times, which allows us to access more data – Portugal in 1984 versus 2012:
  - ▶ 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.
- Explanation for the “missing deflation” during the last crisis? Again, I am skeptical; the discussion is still ongoing. Central banking faces tough questions.

# Readings

👉 Chapter 8, *Macroeconomics*, 7th Edition, Olivier Blanchard.

📖 Phillips, A. W. “The Relation Between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957.” *Economica* 25, no. 100 (November 1, 1958): 283–99. [Link](#)

📖 Samuelson, Paul A., and Robert M. Solow. “Analytical Aspects of Anti-Inflation Policy.” *The American Economic Review* 50, no. 2 (1960): 177–94. [Link](#)

📖 Friedman, Milton. “The Role of Monetary Policy.” *The American Economic Review* 58, no. 1 (1968): 1–17. [Link](#)

Phillips Curve Doesn't Help Forecast Inflation, Fed Study Finds, *Bloomberg Markets*, August 24, 2017. [Link](#)

The Phillips curve may be broken for good, *The Economist*, November 1, 2017. [Link](#)

The Phillips hydraulic machine. [Link](#)



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**Phillips, A. W.**, “The Relation Between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957,” *Economica*, November 1958, 25 (100), 283–299.

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