# Lecture 9. The Phillips Curve, the Natural Rate of Unemployment, and Inflation

Reading: Blanchard, Chapter 8.

# In the previous lecture…

- The equilibrium (or natural) rate of unemployment $u$ when $P^e = P$.

- The Wage-Setting Relation:

$$W = \mathcal{A} P^e F(u, z)$$

- The Price-Setting Relation:

$$P = (1 + m)\frac{W}{\mathcal{A}}$$

based on the production function $Y = \mathcal{A}N$.

# The Natural Rate of Unemployment ($P = P^e$)

- WS Relation: $W/P = \mathcal{A}F(u, z)$
- PS Relation: $W/P = \mathcal{A}/(1 + m)$

- The natural rate of unemployment $u_n$ satisfies the following condition:

$$F(u_n, z) = \frac{1}{1 + m}$$

- It depends on $z$ and $m$.

# Outline

- Derivation of the Phillips curve (PC)
  - Version 1: the original Phillips curve
  - Version 2: the accelerationist Phillips curve

- The Natural Rate of Unemployment, $u_n$

- A recent debate: Is the Phillips curve dead or alive?

# Outline

- Derivation of the Phillips curve (PC)
  - Version 1: the original Phillips curve
  - Version 2: the accelerationist Phillips curve

- The Natural Rate of Unemployment, $u_n$

- A recent debate: Is the Phillips curve dead or alive?

# Markets and curves

- Goods (and services) Market + Financial Markets + Labor Market

| | Keynesian cross | Money market | PS and WS |
|---|---|---|---|
| | ↓ | ↓ | ↓ |
| • (Y, i or r) | IS | LM | ↓ |
| • $(u, \pi)$ | | | PC |
| | | | ↓ |
| • (Y, $\pi$) | | | PC (relation) |

- We introduce price, wage, (un)employment, and production to our framework.

# A big picture: What are we going to learn?

- So far, we have focused on the ‘demand’ side of the economy. For example, in the goods market, the equilibrium output follows from the demand Z. When we add the financial market and monetary policy to the framework, we have an additional channel from the MP to $i$ to $I$, which is a component of Z.
- Now, we add the ‘supply’ side of the economy to the model and allow prices to change.
- We can think about how firms’ production decision.

# Deriving the Phillips curve

- Labor market equilibrium expressed in terms of $\pi$ and $u$
- Wage-Setting Relation: $W = \mathcal{A} P^e F(u, z)$
- Price-Setting Relation: $P = (1 + m)\frac{W}{\mathcal{A}}$

- $P = (1 + m)\frac{W}{\mathcal{A}} =$

- Assume that $F(u, z) =$

# Deriving the Phillips curve, continued

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

- Divide both hand sides by $P_{t-1}$ and take the logarithm.
- Remember that $\frac{P_t}{P_{t-1}} =$

  and that $\ln(1+x) \approx x$ for $x \approx 0$.

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

  $\Rightarrow$

# The Phillips curve

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

- Interpretation
- $\pi_t^e$: Given $P_{t-1}$, workers expecting a high rate of inflation, $\pi_t^e$, also expect a high price level, $P_t^e$.

  $\rightarrow$ (WS Relation)

  $\rightarrow$ marginal costs of production

  $\rightarrow$ (PS Relation)

  $\rightarrow$ Given $P_{t-1}$, $P_t \uparrow$ implies $\pi_t$.

# The Phillips curve, continued.

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

- Interpretation
- $u_t$: As $u_t \uparrow$, the bargaining power of workers decreases.
  - $\rightarrow$ $W_t \downarrow$ (WS Relation)
  - $\rightarrow$ marginal costs of production $\downarrow$
  - $\rightarrow$ $P_t \downarrow$ (PS Relation)
  - $\rightarrow$ Given $P_{t-1}$, $P_t \downarrow$ implies $\pi_t \downarrow$.
- (Exercise) How about $m$ and $z$?

# Outline

- Derivation of the Phillips curve (PC)
  - Version 1: the original Phillips curve
  - Version 2: the accelerationist Phillips curve

- The Natural Rate of Unemployment, $u_n$

- A recent debate: Is the Phillips curve dead or alive?

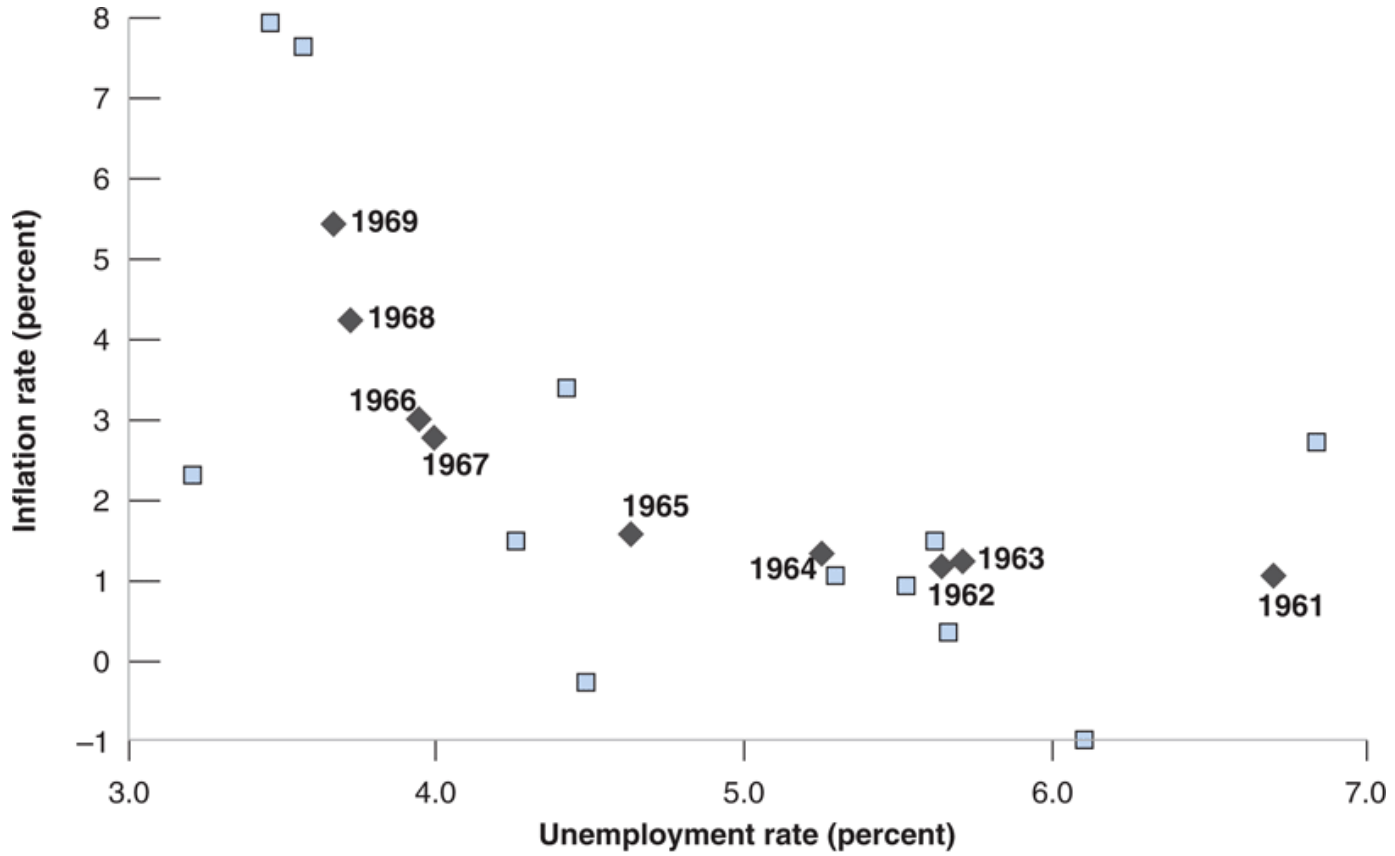
# Version 1: the original Phillips curve

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

- When $\pi_t^e = \bar{\pi}$ (constant), Equation (*) reduces to

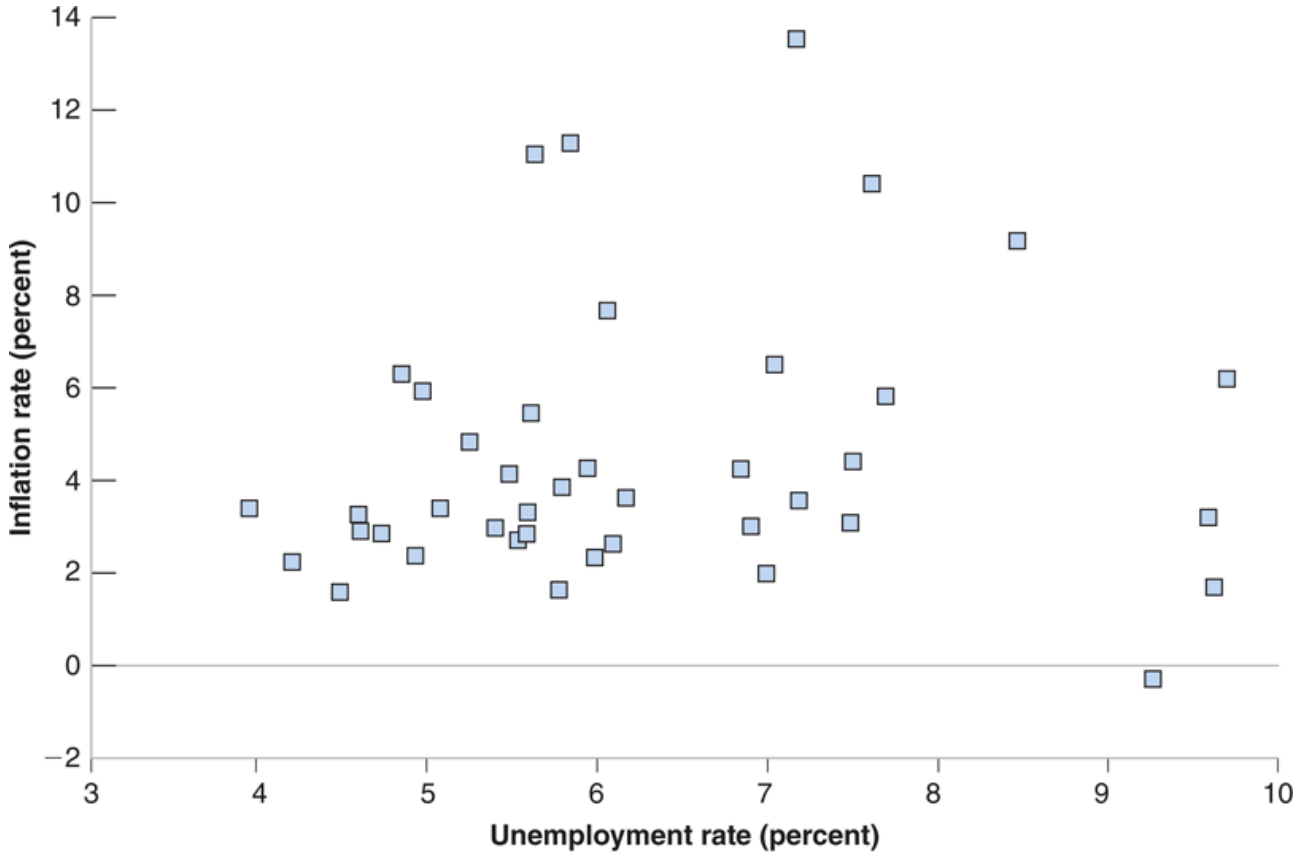
$$\pi_t =$$

- This is the version studied by Phillips (1958) and Samuelson and Solow (1960) using the UK and the US data, respectively.
- $\pi_t^e = \bar{\pi}$: It means that $\pi_{t-1}$, $\pi_{t-2}$, … are not informative when forming an expectation on $\pi_t$. That is, inflation is not *persistent*.



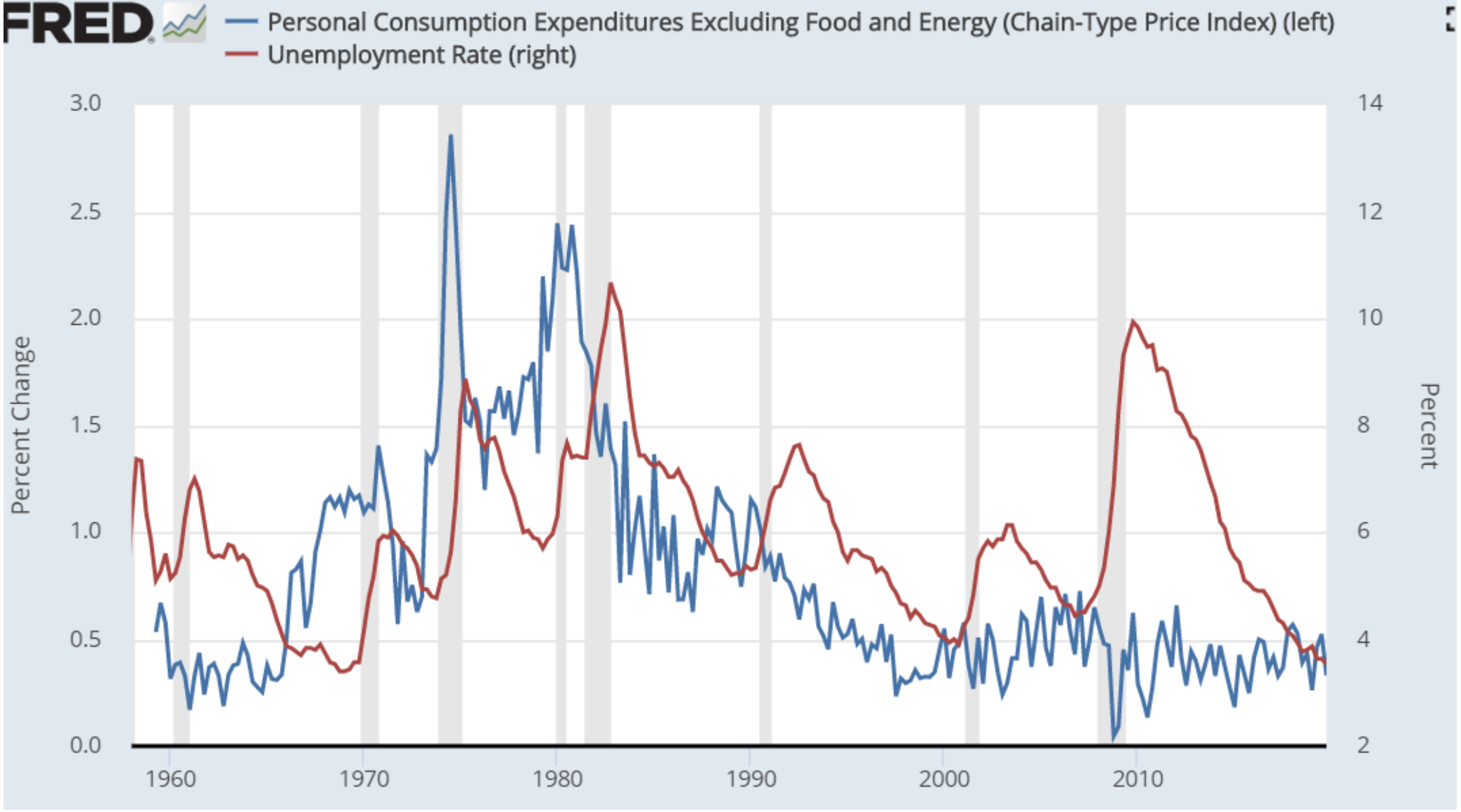

*Source:* Series UNRATE, CPIAUSCL Federal Reserve Economic Data (FRED) http://research.stlouisfed.org/fred2/

- $\pi_t = \beta - \alpha u_t$. In the United States, 1948–1969.
- Good fit to the data.




*Source:* See Figure 8-2.

- $\pi_t = \beta - \alpha u_t$. In the United States, 1970–2010.
- No sign of a negative relationship between $\pi_t$ and $u_t$.




- $\pi_t$ and $u_t$ in the US.
- The relationship between $\pi$ and $u$ seem to be different before and after 1970.

# Outline

- Derivation of the Phillips curve (PC)
  - Version 1: the original Phillips curve
  - Version 2: the accelerationist Phillips curve

- The Natural Rate of Unemployment, $u_n$

- A recent debate: Is the Phillips curve dead or alive?

# Version 2: the accelerationist Phillips curve

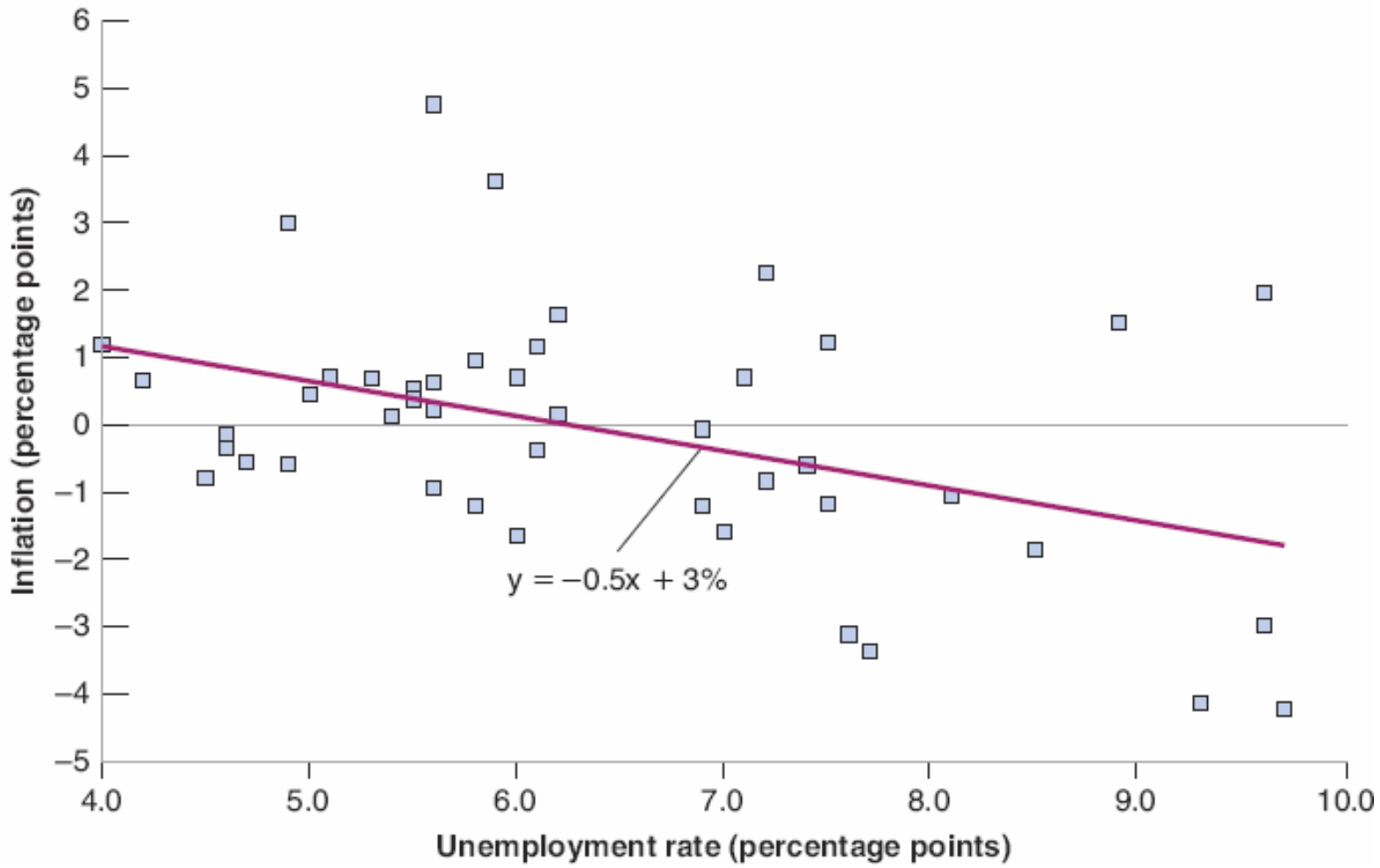
- $\pi_t = \pi_t^e + (m + z) - \alpha u_t \quad (*)$

- When $\pi_t^e = \pi_{t-1}$, Equation (*) becomes to

$$\pi_t =$$

- $u \downarrow \rightarrow \quad \Delta\pi \quad \rightarrow \quad P$ accelerates. ($\Delta\pi$=second difference of $\ln P$)
- $\pi_t^e = \pi_{t-1}$: Inflation is very *persistent*.

  If $\pi_{t-1}$ was high, it is expected that $\pi_t$ is also high.




- $\Delta\pi_t = \gamma - \alpha u_t$. In the United States, 1970–2014.
- Reasonable fit to the data.

# Outline

- Derivation of the Phillips curve (PC)
  - Version 1: the original Phillips curve
  - Version 2: the accelerationist Phillips curve

- The Natural Rate of Unemployment, $u_n$

- A recent debate: Is the Phillips curve dead or alive?

# The natural rate of unemployment, $u_n$

- Remember that the natural rate of unemployment, , is the unemployment rate that makes .

$$(WS) \quad \frac{W}{P^e} = \mathcal{A}F(u,z), \qquad (PS) \quad \frac{W}{P} = \frac{\mathcal{A}}{1+m}.$$

$$P = P^e \quad \Rightarrow \quad 1 - \alpha u_n + z = F(u_n, z) = \frac{1}{1+m}$$

$$\Rightarrow \quad -\alpha u_n + z \approx -m \quad \text{(why?)}$$

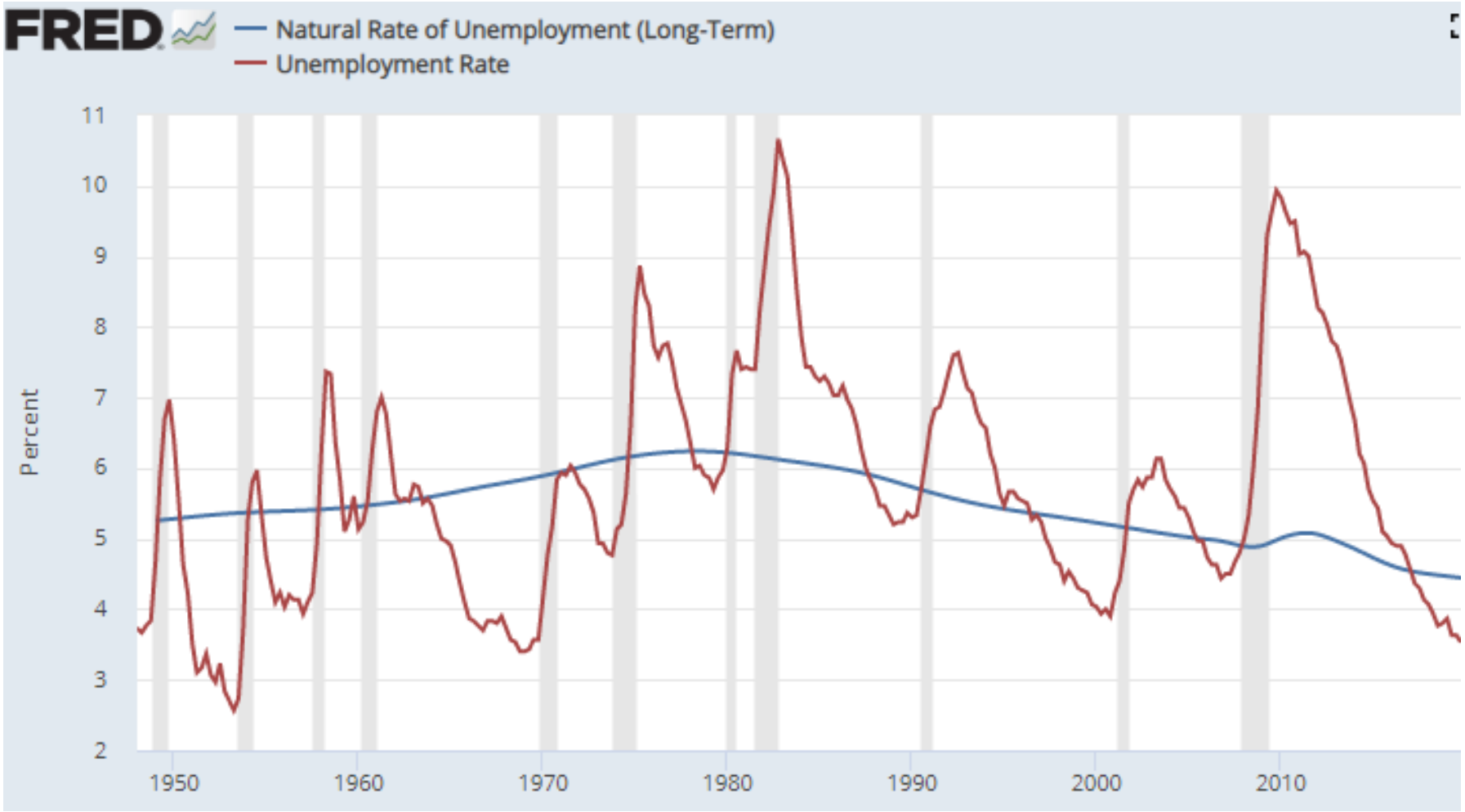
$$\Rightarrow \qquad .$$

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

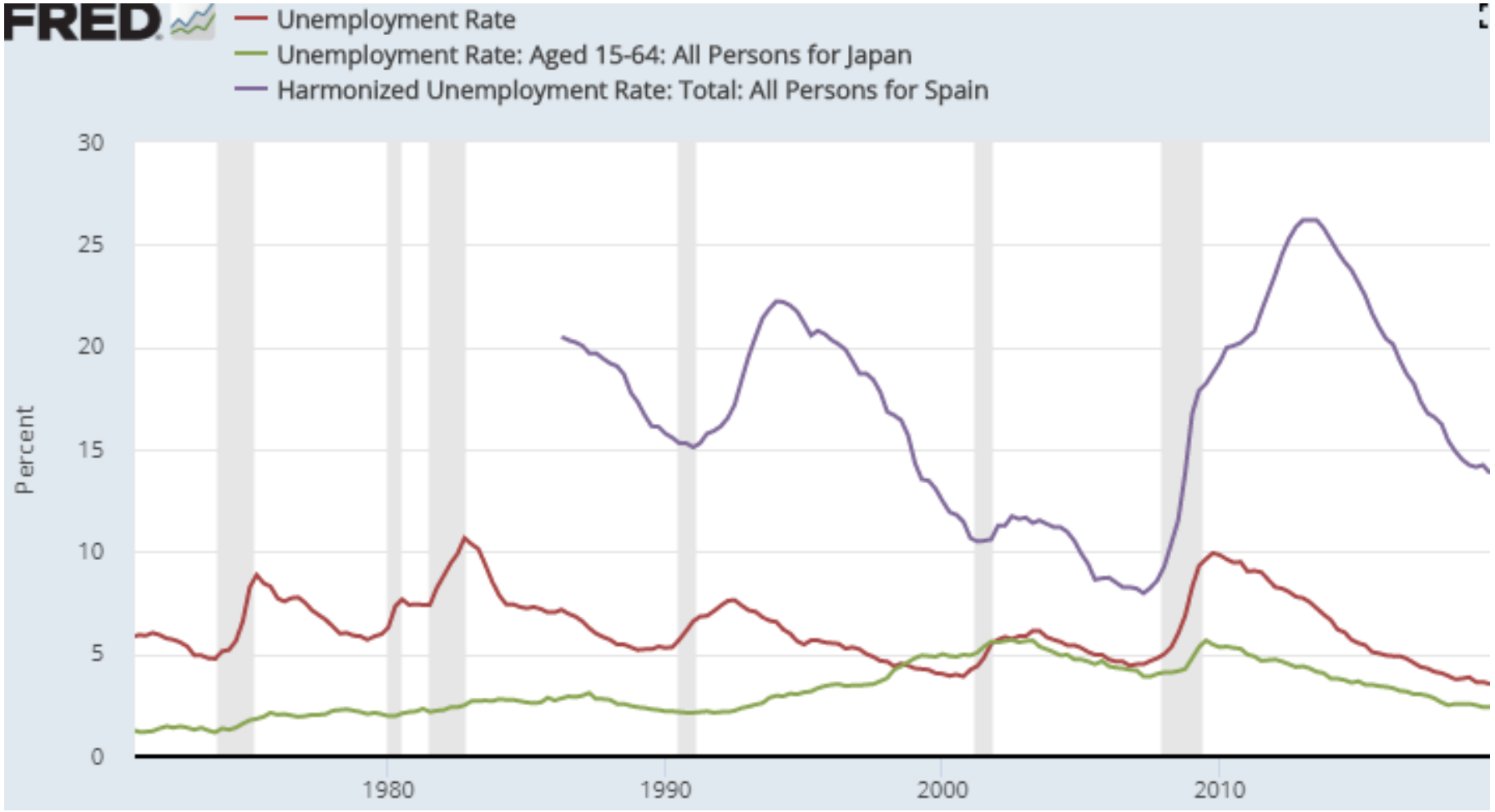
- $\pi_t = \pi_t^e + (m + z) - \alpha u_t \quad (*)$

- Therefore, the Phillips curve (*) admits the following representation:
- , where $u_t - u_n$ is the *unemployment gap*.

- When $u_t = u_n$, $P_t = P_t^e$. Given $P_{t-1}$, this implies that $\pi_t = \pi_t^e$.
  - If $\pi_t^e = \bar{\pi}$, $u_t = u_n \Rightarrow \pi_t = \bar{\pi}$.
  - If $\pi_t^e = \pi_{t-1}$, $u_t = u_n \Rightarrow \pi_t = \pi_{t-1}$.




- $u_t$ and $u_n$ in the U.S.
- $u_n$ may vary across *time*.



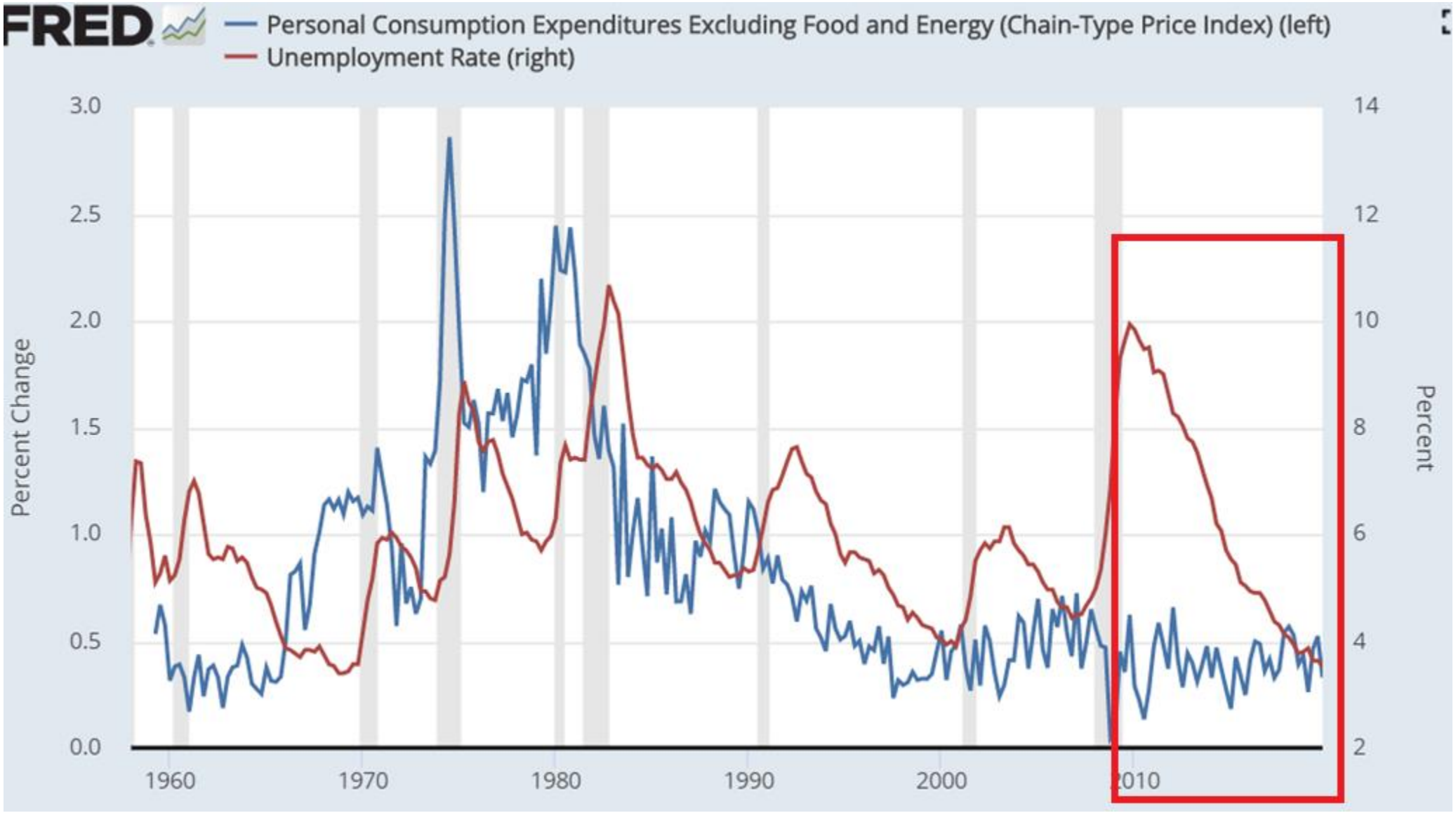

- $u_t$ in the U.S. (red), Japan (green), and Spain (purple).
- $u_n$ may vary across *countries*.

# Outline

- Derivation of the Phillips curve (PC)
  - Version 1: the original Phillips curve
  - Version 2: the accelerationist Phillips curve

- The Natural Rate of Unemployment, $u_n$

- A recent debate: Is the Phillips curve dead or alive?




- $\pi_t$ and $u_t$ in the US.
- (2010-) While $u$ moves from a very high rate to a very low rate, $\pi$ has been stable.

# Is the Phillips curve dead?

- “Prior to the recent deep worldwide recession, macroeconomists of all schools took a negative relation between slack and declining inflation as an axiom. Few seem to have awakened to the recent experience as a contradiction to the axiom.” - Robert Hall (2013)

- Missing disinflation:

  Although $u$ was very high during the Great Recession and the following years, neither $\pi$ nor $\Delta\pi$ decreased.

- Missing inflation:

  Although $u$ was very low in the recent years, neither $\pi$ nor $\Delta\pi$ increased.

- There are several explanations.
- Here, we focus on the two of them.
- If you are interested, you may read the following article and references therein.
- Belz, Wessel, and Yellen (2020), What’s (Not) Up With Inflation?

# Explanation 1: the Phillips curve is flattening.

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

- Blanchard (2016), The Phillips Curve: Back to the '60s?

1) Recently, $\pi_t^e$ has become more *anchored.* $\rightarrow$
  - The CB has a target rate of inflation, usually around 2% in the advanced countries.
  - $\pi^e$ of economic agents gets closer to the target rate (anchoring), because the CB communicates well, and people believe in the CB.

2) The slope of the PC has been decreasing. $\rightarrow$

For example, 1) $\pi_t^e = \bar{\pi}$ and 2) $\alpha = 0$

$\rightarrow \pi_t = \bar{\pi} + m + z = \beta$ (constant)

**Figure 1. The Phillips Curve has flattened since the 1980s**


*Sources:* Federal Reserve Bank of St. Louis, Congressional Budget Office (CBO).

*Note*: Y-axis is the 4-quarter change in the PCE inflation rate; X-axis is the difference between the unemployment rate and CBO's estimate of the natural rate of unemployment (NAIRU).

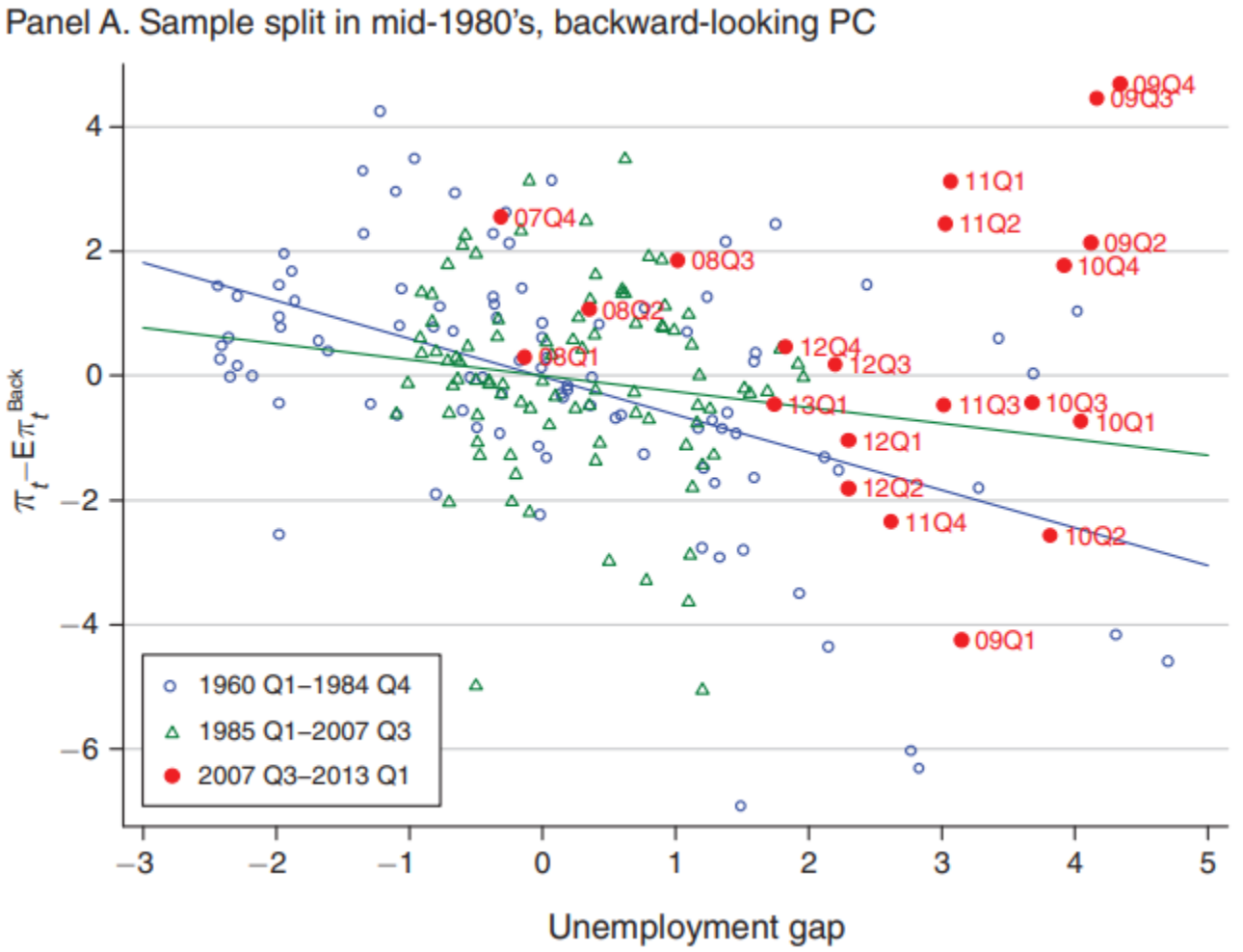
- When we use $\Delta\pi_t = -\alpha(u_t - u_n)$, it seems that $\alpha \downarrow$ to 0 recently.
- Source: Belz, Wessel, and Yellen (2020), What's (Not) Up With Inflation?

# Explanation 2: $\pi_t^e$ needs not be $\bar{\pi}$ or $\pi_{t-1}$.

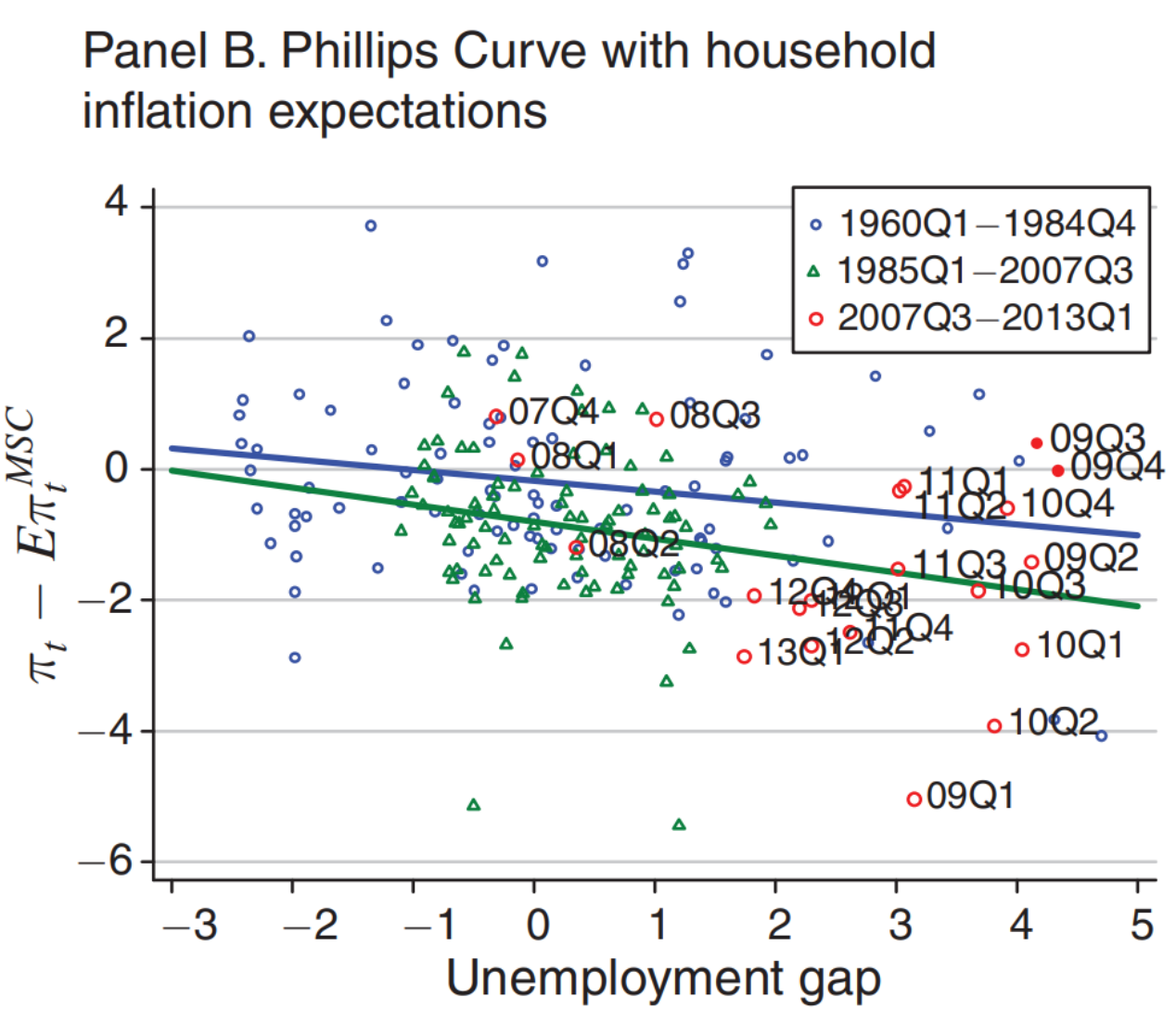
- $\pi_t = \pi_t^e + (m + z) - \alpha u_t \quad (*)$

- Coibion and Gorodnichenko (2015), Is the Phillips Curve Alive and Well After All? Inflation Expectations and the Missing Disinflation.
- IDEA) $\pi_t^e$ needs not be $\bar{\pi}$ or $\pi_{t-1}$. Let's ask people about their inflation expectation.
- They use the inflation expectation data from the Survey of Consumers conducted by U of Michigan.

- Based on the directly observed $\pi_t^e$, Equation (*) can match the recent US data well without relying on a declining $\alpha$.




- $\Delta\pi_t$ vs. $u_t - u_n$
- It appears that $\alpha \downarrow$.
- Also, the PC does not fit the data during the Great Recession.




- $\pi_t - \pi_t^e$ vs. $u_t - u_n$
- It appears that $\alpha$ did not change much.
- Also, the PC fits the data during the Great Recession well.

# A summary:
# Various versions of the Phillips Curve

| | Unemployment: $u_t$ | Unemployment Gap: $u_t - u_n$ |
|---|---|---|
| Benchmark | $\pi_t - \pi_t^e = (m + z) - \alpha u_t$ | $\pi_t - \pi_t^e = -\alpha(u_t - u_n)$ |
| | | |
| $\pi_t^e = \bar{\pi}$ | $\pi_t = (\bar{\pi} + m + z) - \alpha u_t$ | $\pi_t = \bar{\pi} - \alpha(u_t - u_n)$ |
| $\pi_t^e = \pi_{t-1}$ | $\Delta\pi_t = (m + z) - \alpha u_t$ | $\Delta\pi_t = -\alpha(u_t - u_n)$ |

# In the next class…

- We will combine the Phillips curve relation with the IS-LM model.
- The PC relation represents the supply (production) block of the economy, where the IS-LM takes the demand side of the economy into account.
- The IS-LM-PC model will help us to think about all three markets (goods, money(financial), and labor) together along business cycles.