Lecture 16:
The Phillips Curve and the Great Inflation

Macroeconomics (Quantitative)

Economics 101B

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Where Do We Stand?

- Money Market (LM Curve):

$$\Delta \log M_t - \pi_t = -\phi i_t + \phi i_{t-1} + \tilde{Y}_t - \tilde{Y}_{t-1} + \Delta \log v_t$$

- Fisher Equation: $R_t = i_t - E_t \pi_{t+1}$
- Price Setting Equation: $\pi_t = \theta \tilde{Y}_{t-1}$
- Goods Market (IS Curve): $\tilde{Y}_t = \bar{a} - \bar{b}\,(R_t - \bar{r})$
- Okun's Law: $u_t - u^n = -\frac{1}{2}\tilde{Y}_t$
- Next: "Modernize" analysis of price setting

The Phillips Curve

- A note on language: “Phillips curve”, “Price setting equation”, “short run aggregate supply curve” are all the same thing
- Phillips curve in medieval economy model:

$$\pi_t = \theta \tilde{Y}_{t-1} \quad \text{or} \quad \pi_t = -2\theta(u_{t-1} - u^n)$$

- Phillips curve of this form was “discovered” by A.W. Phillips in 1958 and popularized in U.S. by Paul Samuelson and Robert Solow in 1960

Inflation and Unemployment in U.K.

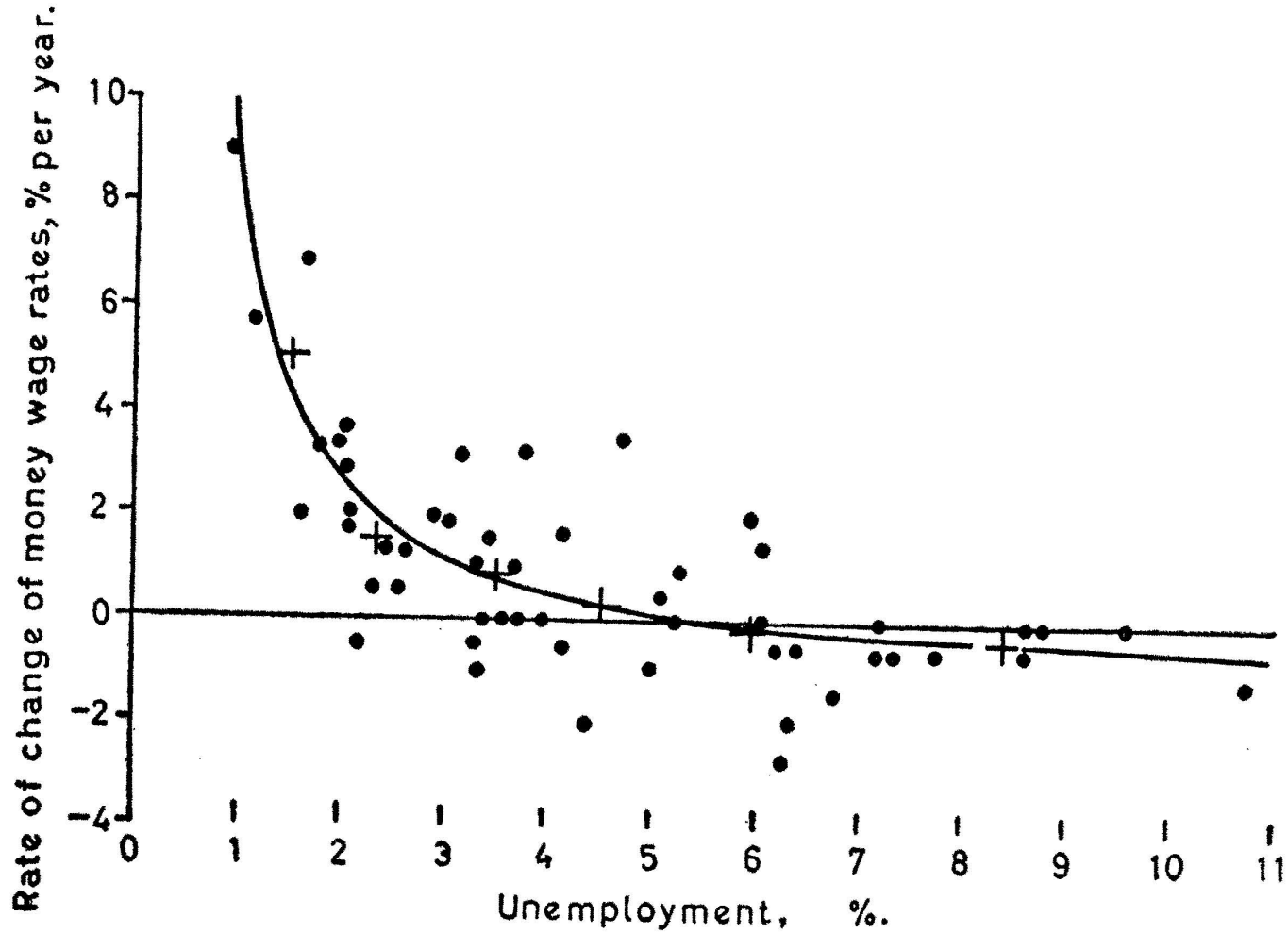


Fig.1. 1861 – 1913

Inflation and Unemployment in U.K.

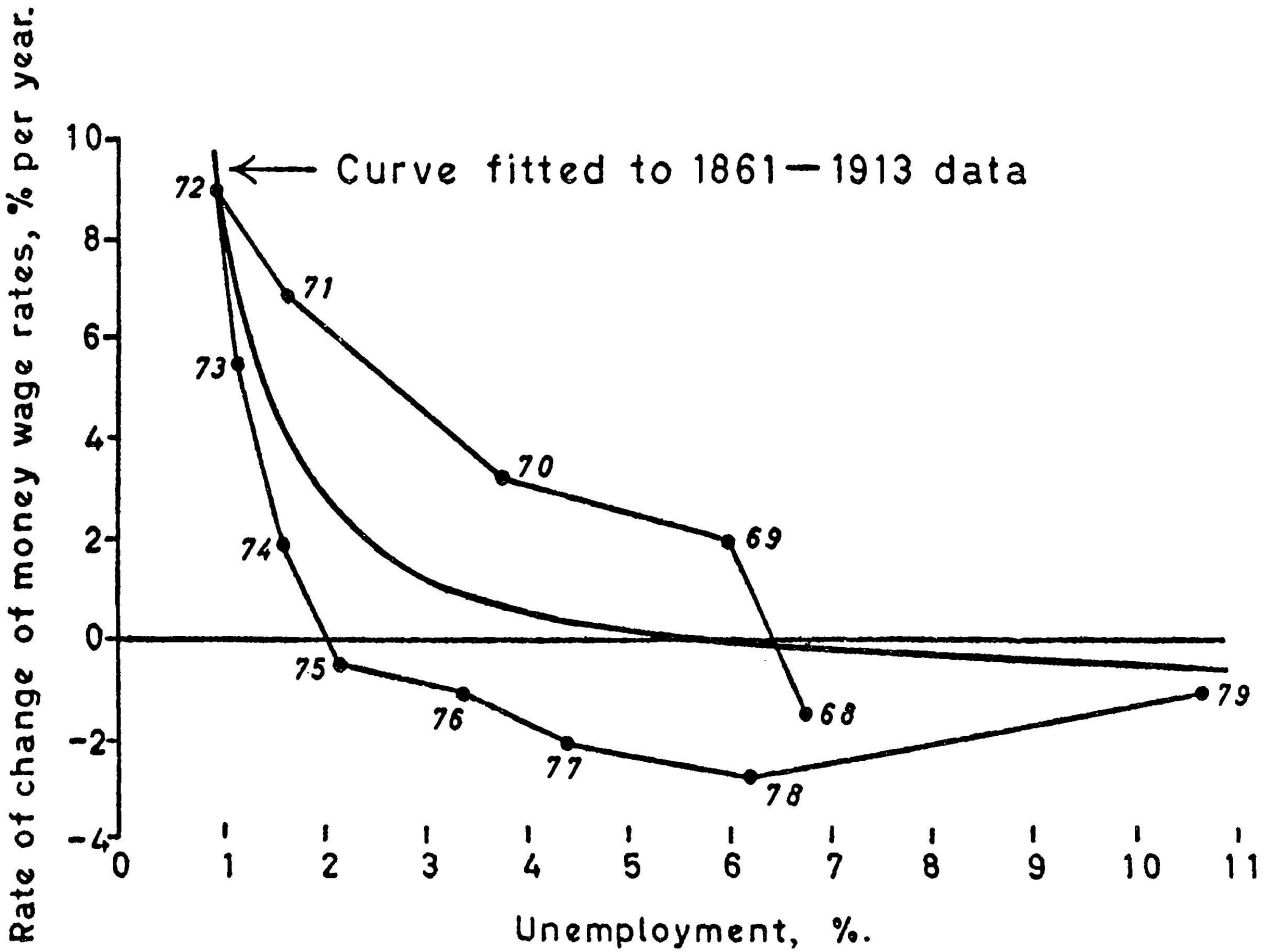


Fig. 3. 1868 —1879

Inflation and Unemployment in U.K.

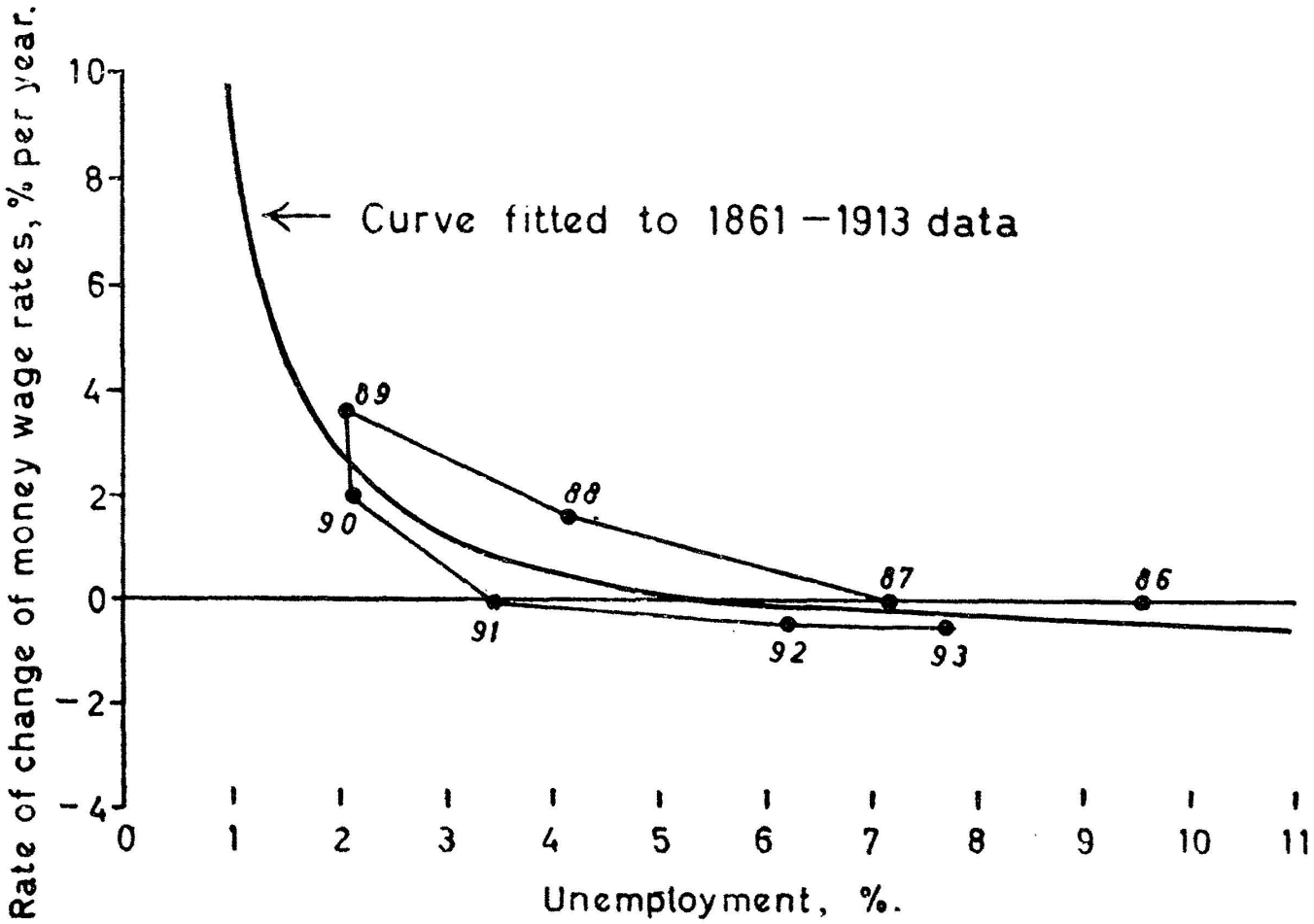


Fig.5. 1886 – 1893

Inflation and Unemployment in U.K.

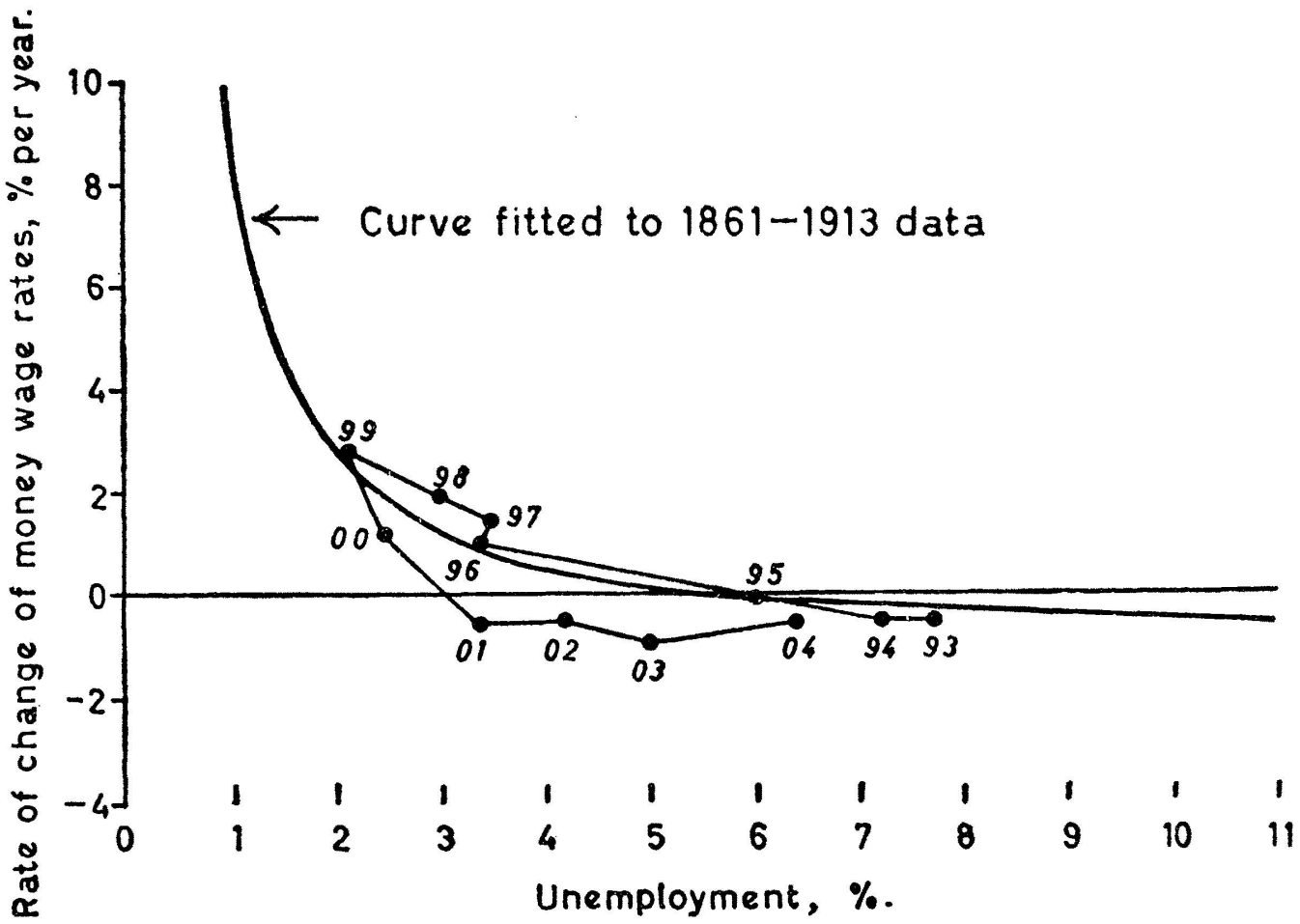


Fig.6. 1893 – 1904

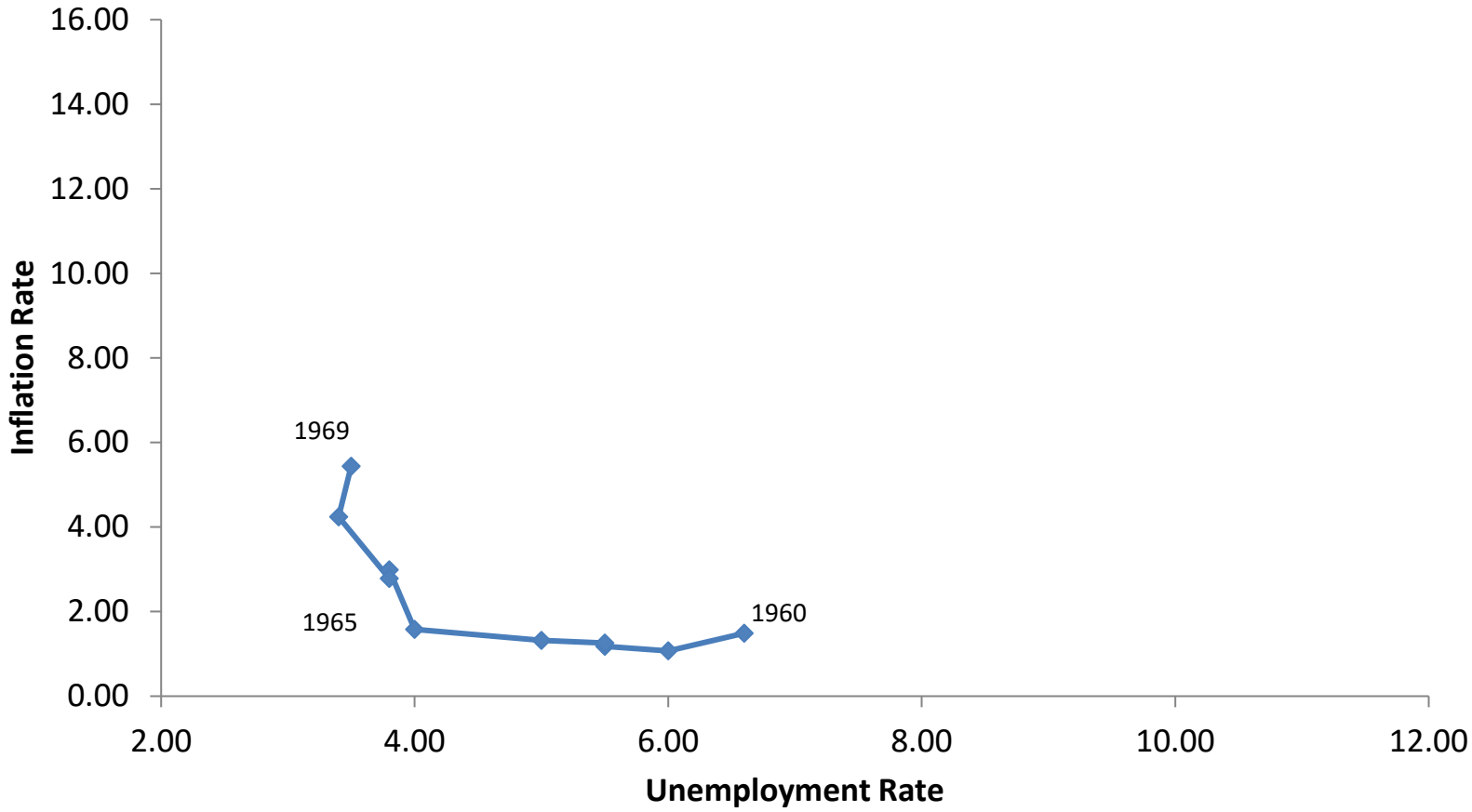
Phillips Curve and Monetary Policy

- Phillips Curve: Negative relationship between inflation and unemployment
- Suggests that:
  - We can engineer a lower unemployment rate if we are willing to tolerate higher inflation
- What is optimal policy?
- Depends on:
  - Relative cost of unemployment and inflation
  - Slope of Phillips curve (how much π for given u)

U.S. in the 1960's

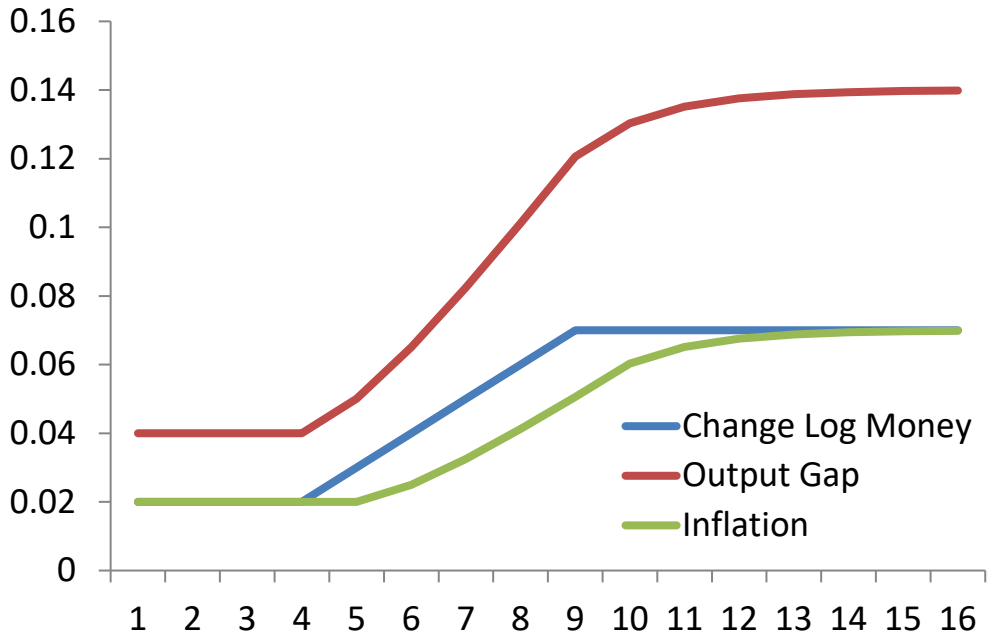
- "Guns and butter":
  - Vietnam war and Great Society
- Inflation rose
- Many argued:
  - Low price to pay for lower unemployment
- Phillips curve thinking had major influence on policy

U.S. in the 1960's



U.S. 1960's through the Lens of Medieval Economy

- Start with steady state with low $\Delta \log M$
- Raise money growth: $\Delta \log M' > \Delta \log M$
- Response of economy:



Dynamics:

$$\Delta \log M_t = \pi_t + \tilde{Y}_t - \tilde{Y}_{t-1}$$

$$\pi_t = \theta \tilde{Y}_{t-1}$$

Steady State:

$$\bar{\pi} = \Delta \log M$$

$$\bar{\pi} = \theta \bar{\tilde{Y}}$$

Phillips Curve in Medieval Model

- Short run:

$$\pi_t = \theta \tilde{Y}_{t-1}$$

- Long run (steady state):

$$\bar{\pi} = \theta \bar{\tilde{Y}}$$

- And combined with Okun's law:

$$\bar{\pi} = -2\theta(\bar{u} - u^n)$$

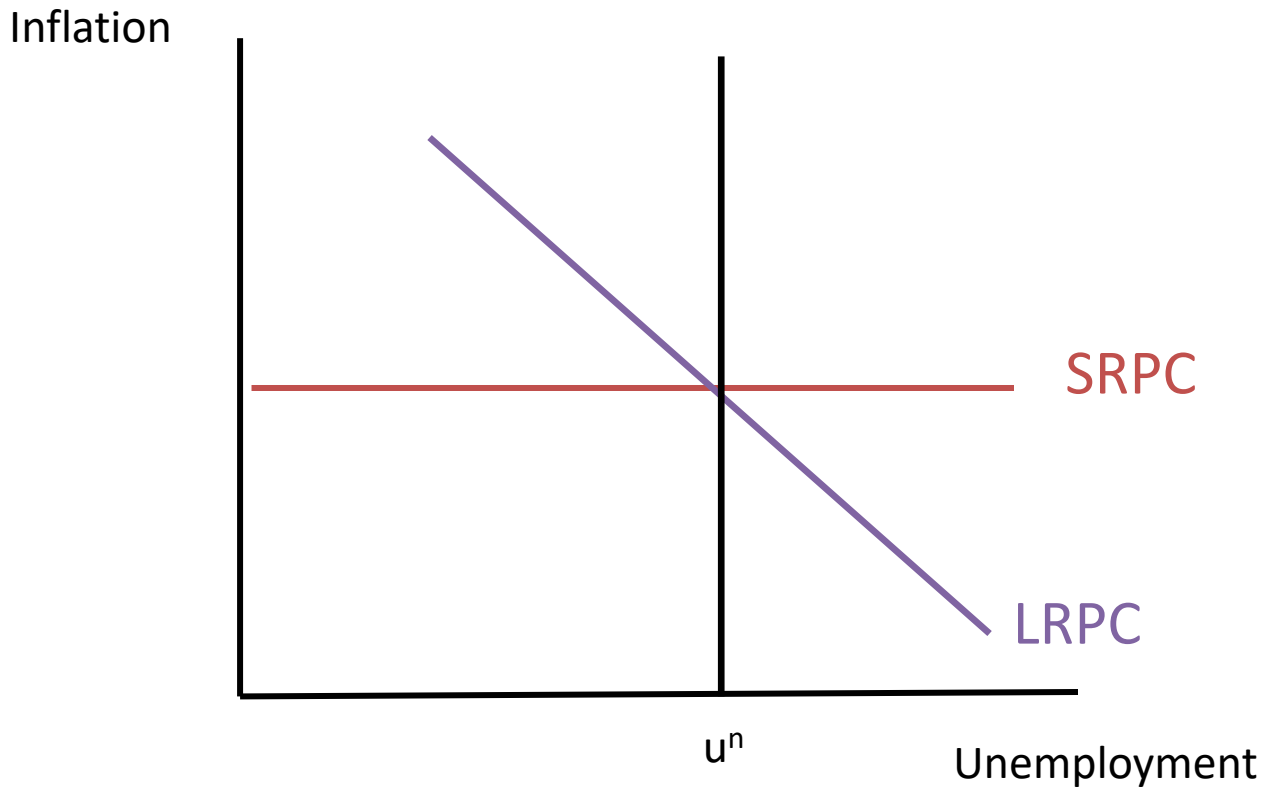
Long-Run Phillips Curve in Medieval Model

- Short-run Phillips curve:

$$\pi_t = -2\theta(u_{t-1} - u^n)$$

- Long-run Phillips curve:

$$\bar{\pi} = -2\theta(\bar{u} - u^n)$$



Price Setting

- Does the long run Phillips curve in the Medieval model make sense?
- Idea behind price setting equation:
  - Shop keeper wants to work a certain amount (natural rate of output/unemployment)
  - If demand is too high on a particular day, she raises her price for the next day
  - Worked well in middle ages model with stable price level
  - But now we are in a world with steady inflation

Price Setting

- With steady positive inflation we can end up having a steady state positive output gap:

$$\bar{\pi} = \theta \bar{\tilde{Y}}$$

- Shop keeper always works more than she wants
- She is making systematic mistakes:
  - Always wrong in the same direction
  - Each period she raises her price to compensate for rise in money supply since last period
  - But she doesn't learn that there will be even more money in the economy next period since money supply is rising at a steady rate
  - Behaves as though each period's increase in money supply is a "surprise"

Price Setting

- Abraham Lincoln:

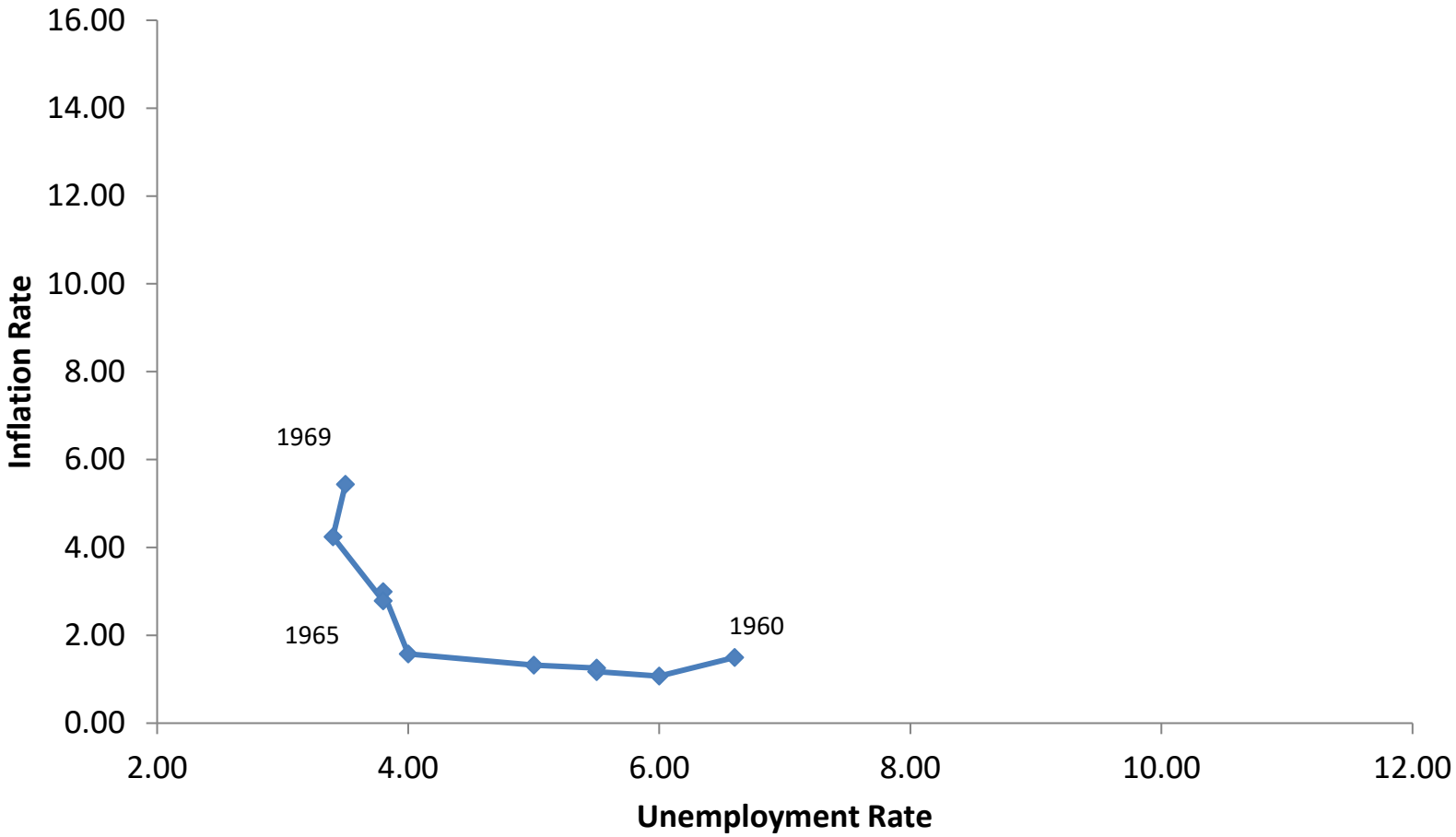
  “You can fool some of the people all of the time, and all of the people some of the time, but you can not fool all of the people all of the time.”

- Medieval price setting equation violates this
- Not a very satisfying theory of price setting in an economy with steady non-zero inflation

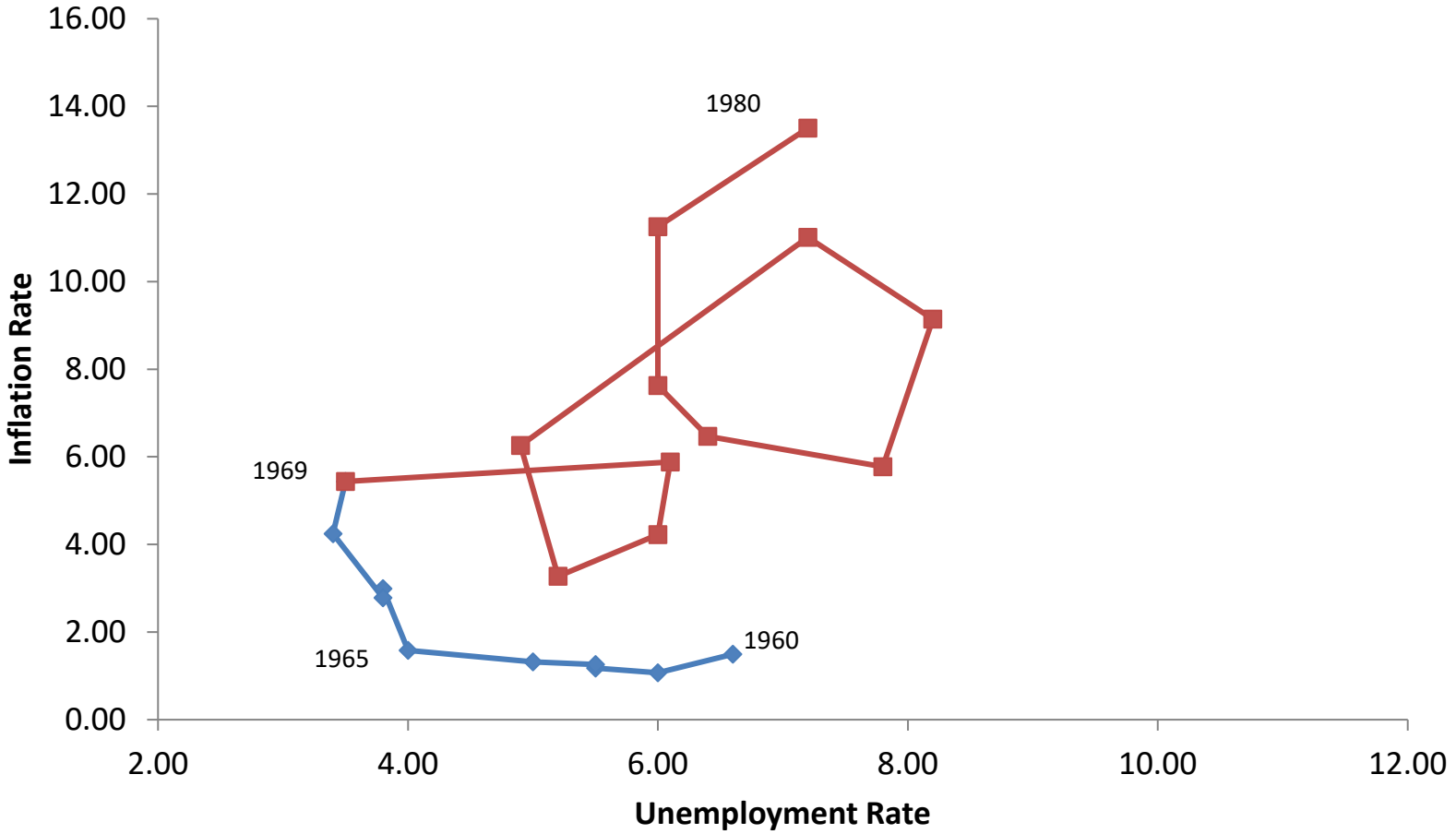
Expectation's Augmented Phillips Curve

- In 1968, Milton Friedman and Edmund Phelps independently argued:
  - Phillips curve trade off will break down
  - People will come to expect higher inflation and will take this into account when setting prices
  - This will shift Phillips curve up if policy makers try to exploit it

U.S. in 1960's

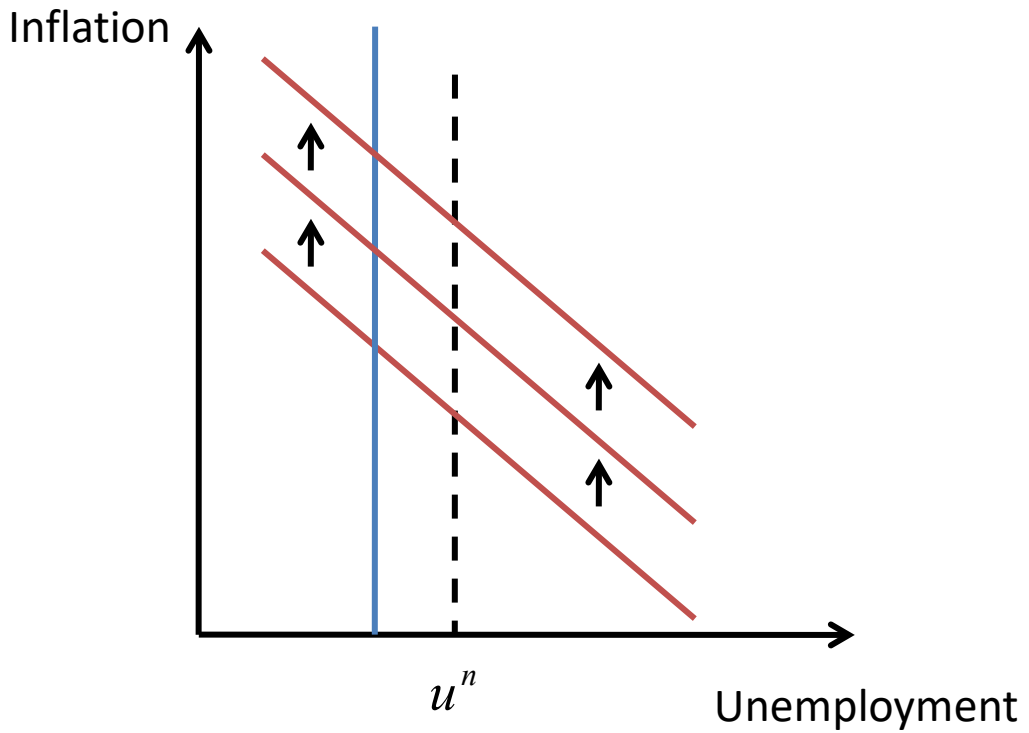

16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Inflation Rate
1969
1965
1960
2.00
4.00
6.00
8.00
10.00
12.00
Unemployment Rate

Friedman and Phelps Were Right!!



U.S. in 1970's

- Policy-makers tried to maintain unemployment below "natural" rate
- Phillips curve started to shift up



Big Mistake

- Many economists in the 60's and 70's looked at the plots in Phillips' paper and believed in a permanent trade-off between inflation and output
- It turns out that they got things terribly wrong
  - U.S. economy spiraled out of control
- They argued: Here is a correlation, let's exploit it!
  - But they didn't understand the causation behind the correlation properly
  - In this case, the correlation would break down when policymakers tried to exploit it because expectations changed

Expectations Augmented Phillips Curve

- Friedman and Phelps' argument suggests the following modification to the price setting equation:

$$\pi_t = E_{t-1}\pi_t + \bar{v}\tilde{Y}_t + \bar{o}_t$$

- $E_{t-1}\pi_t$ denotes the expectation at time t-1 of inflation between time t-1 and time t
- New features:
  - Expectations term
  - Timing of output gap term (time t rather than t-1)
  - Random "cost-push" (supply) shock

Timing of Output Gap Term

- New expectations augmented Phillips curve involves output gap at time t rather than t-1

$$\pi_t = E_{t-1}\pi_t + \bar{v}\tilde{Y}_t + \bar{o}_t$$

- This results from a model where
  - Some prices are set one period in advance
  - Some prices are perfectly flexible
  - Price setters have rational expectations
- We skip this derivation (see Woodford, 2003, section 3.1.3)

Jones' Notation Versus Our Notation

- We use slightly different notation than Jones
- Jones defines: $\pi_t = (P_{t+1} - P_t)/P_t$
- We define: $\pi_t = (P_t - P_{t-1})/P_{t-1}$
- Jones is imprecise about the timing of expected inflation
  - He denotes expected inflation by π_t^e
  - Not clear what time the expectation is taken and what inflation rate
- We use $E_{t-1}\pi_t$ instead.
  (Alternative would be $E_t\pi_{t+1}$. This alternative is also common.)

Expectations Formation

- How do people form expectations?
- **Assumption (Adaptive expectations):**
  Assume that people look at the past to form expectation:

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

- Alternative: Rational Expectations
  - People form “model consistent” expectations
  - Use all information available correctly
  - Make no systematic mistakes

Expectations Augmented Phillips Curve

- Expectations augmented Phillips curve:

$$\pi_t = E_{t-1}\pi_t + \bar{v}\tilde{Y}_t + \bar{o}_t$$

- Adaptive expectations: $E_{t-1}\pi_t = \pi_{t-1}$
- Combining these yields:

$$\pi_t = \pi_{t-1} + \bar{v}\tilde{Y}_t + \bar{o}_t$$

Expectations Augmented Phillips Curve

- With adaptive expectations:

$$\pi_t = \pi_{t-1} + \bar{v}\tilde{Y}_t + \bar{o}_t$$

- When output is above potential …

$$\tilde{Y}_t > 0 \qquad \pi_t > \pi_{t-1}$$

… inflation is rising.

- When output is below potential …

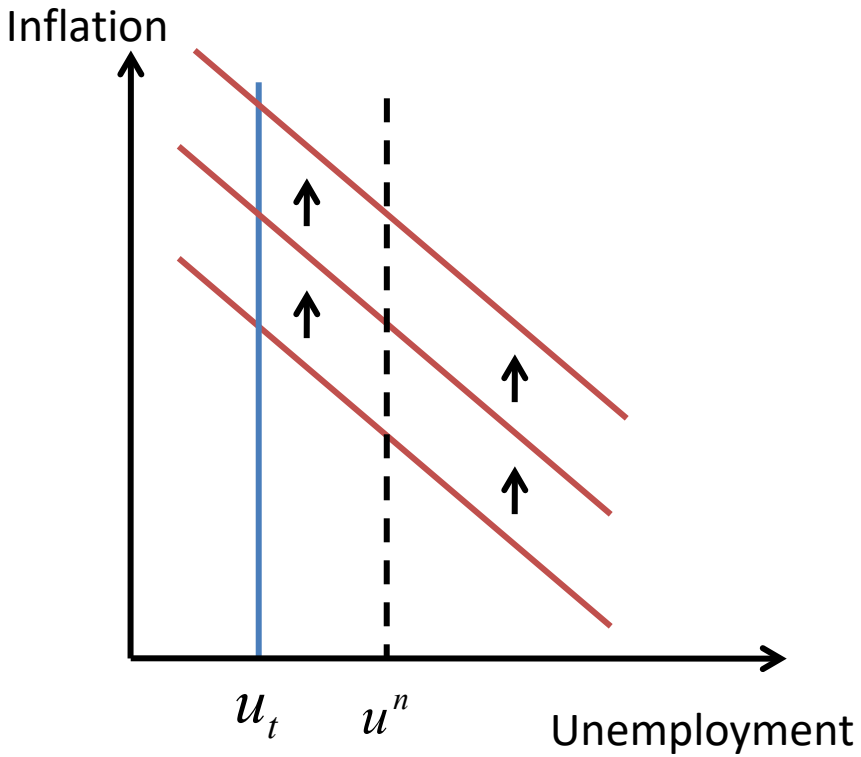
$$\tilde{Y}_t < 0 \qquad \pi_t < \pi_{t-1}$$

… inflation is falling

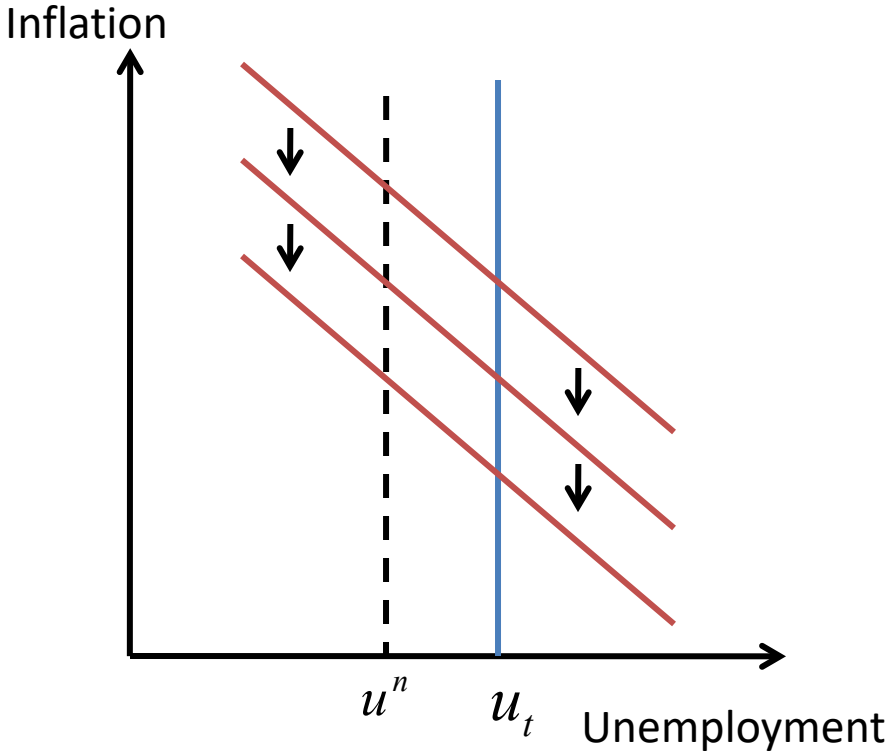
Expectations Augmented Phillips Curve

$$\pi_t = \pi_{t-1} - 2\bar{v}(u_t - u^n) + \bar{o}_t$$

- When $u_t < u^n$



- When $u_t > u^n$

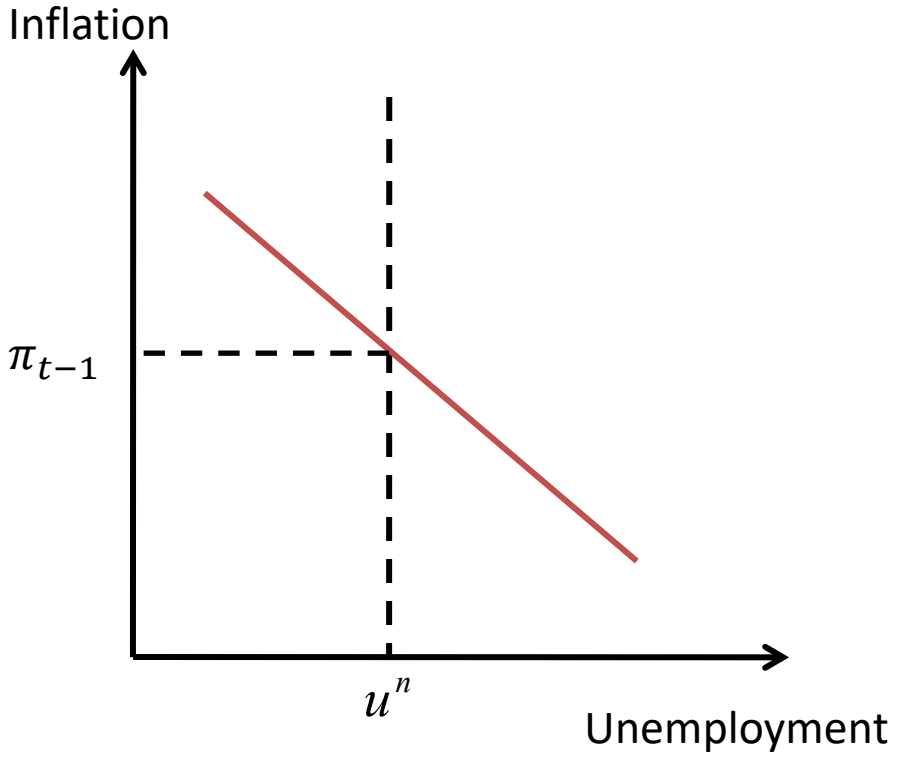


Expectations Augmented Phillips Curve

- Ignore supply shocks:

$$\pi_t = \pi_{t-1} + \bar{v}\tilde{Y}_t$$

- In this case, the Phillips curve crosses $\tilde{Y}_t = 0$ at π_{t-1} (or equivalently $u_t = u_t^n$)
- That tells you how far it will shift if $u_t \neq u_t^n$
- Why? Next period's Phillips curve will cross $u_t = u_t^n$ at this period's inflation rate



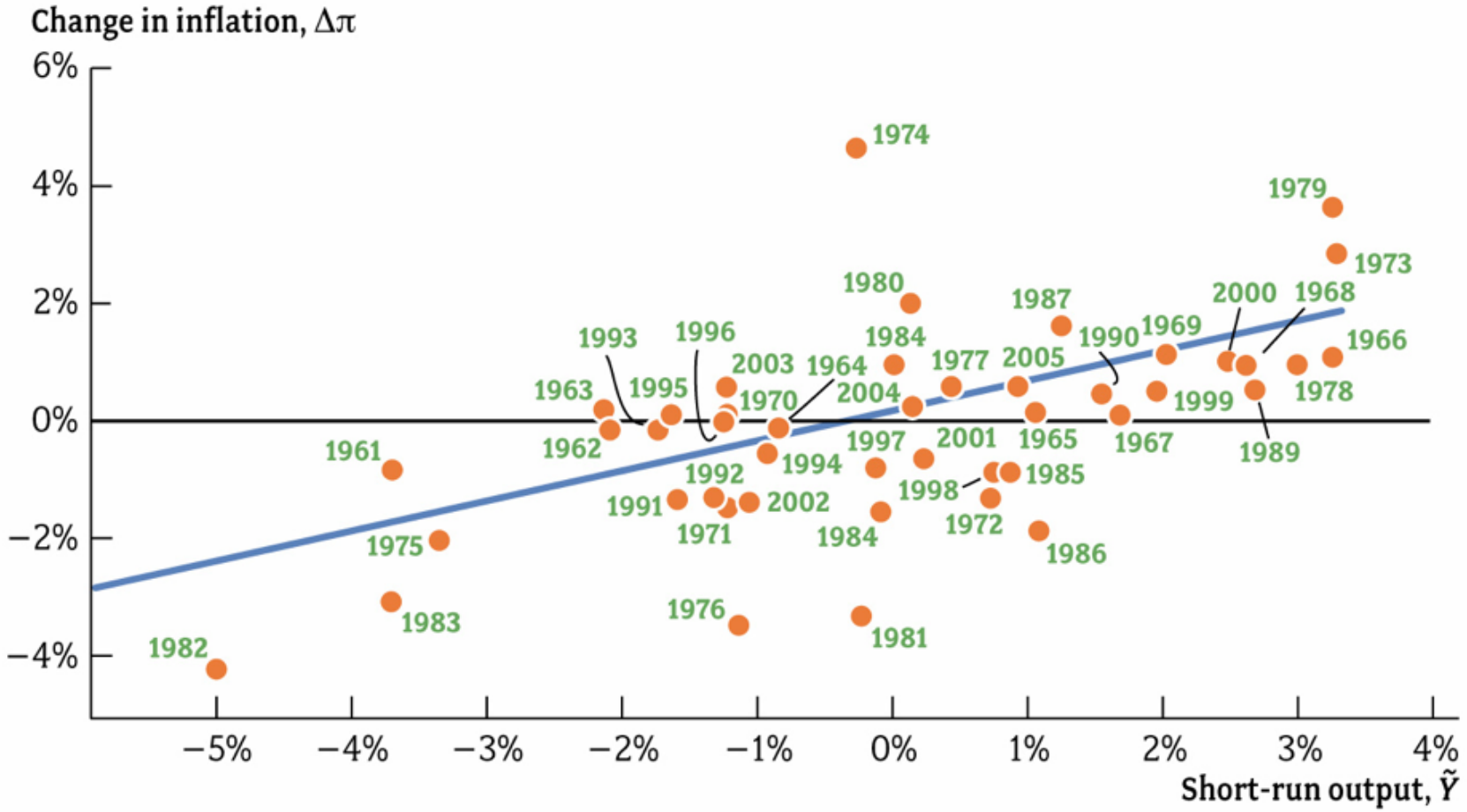


FIGURE 9.6 Measuring the Phillips Curve, 1960–2005

The NAIRU

- An alternative term for the “natural rate” of unemployment is the “NAIRU”
  - “Non-accelerating inflation rate of unemployment”
  - Rate of unemployment that is consistent with stable inflation
- This concept captures the fact that:
  - Inflation rises when unemployment is below the NAIRU or natural rate
  - Inflation falls when unemployment is above the NAIRU or natural rate
- Strictly speaking it should be NIIRU or “nonincreasing inflation rate of unemployment”

Long Run Phillips Curve

$$\pi_t = \pi_{t-1} + \bar{v}\tilde{Y}_t + \bar{o}_t$$

- What type of long run Phillips curve does the expectations augmented Phillips curve imply?

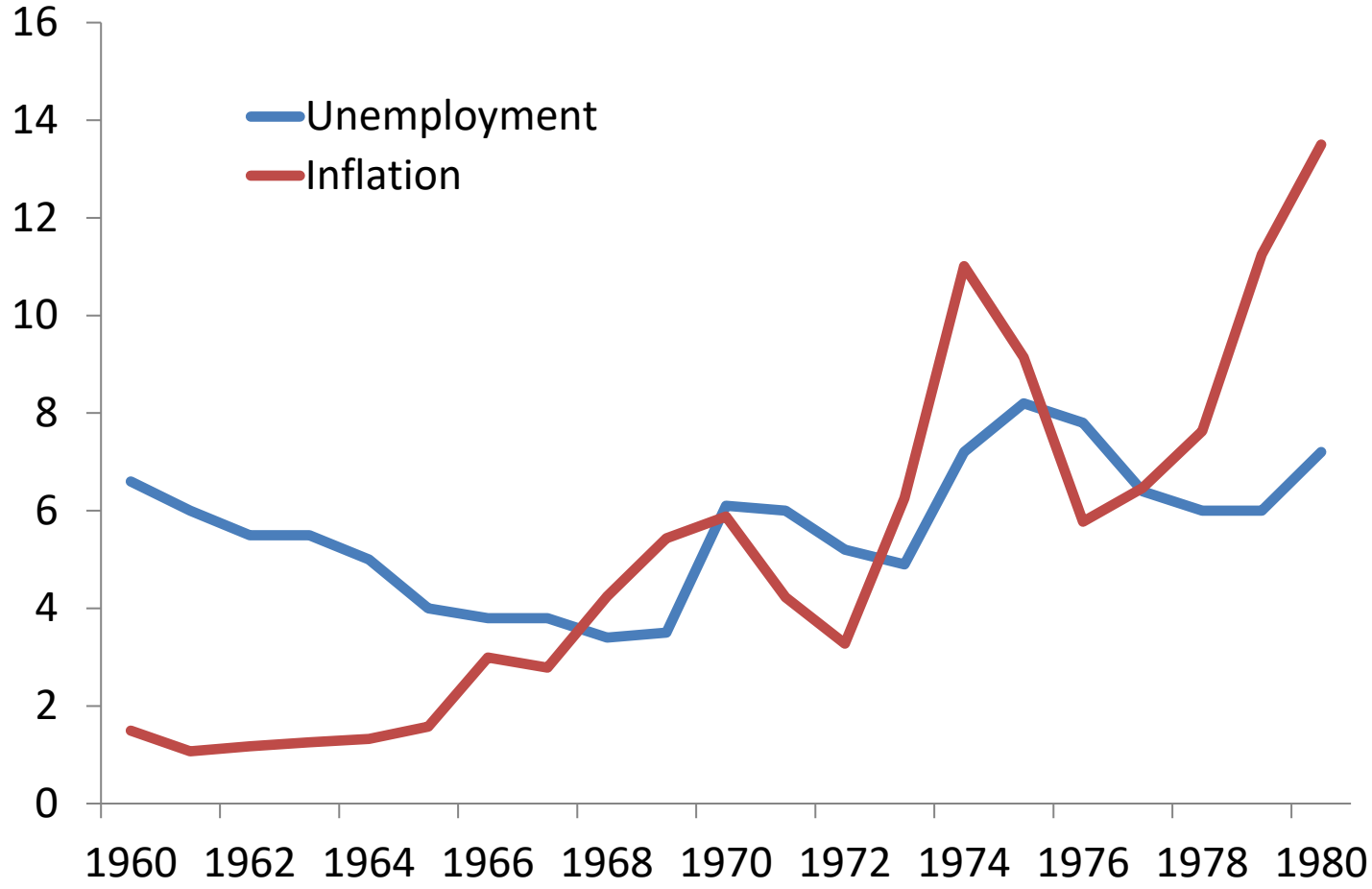
$$\bar{\pi} = \bar{\pi} + \bar{v}\bar{\tilde{Y}}$$

$$\bar{\tilde{Y}} = 0$$

- With stable inflation:
  - Vertical long run Phillips curve
  - Money is neutral in the long run

Stagflation in 1970s

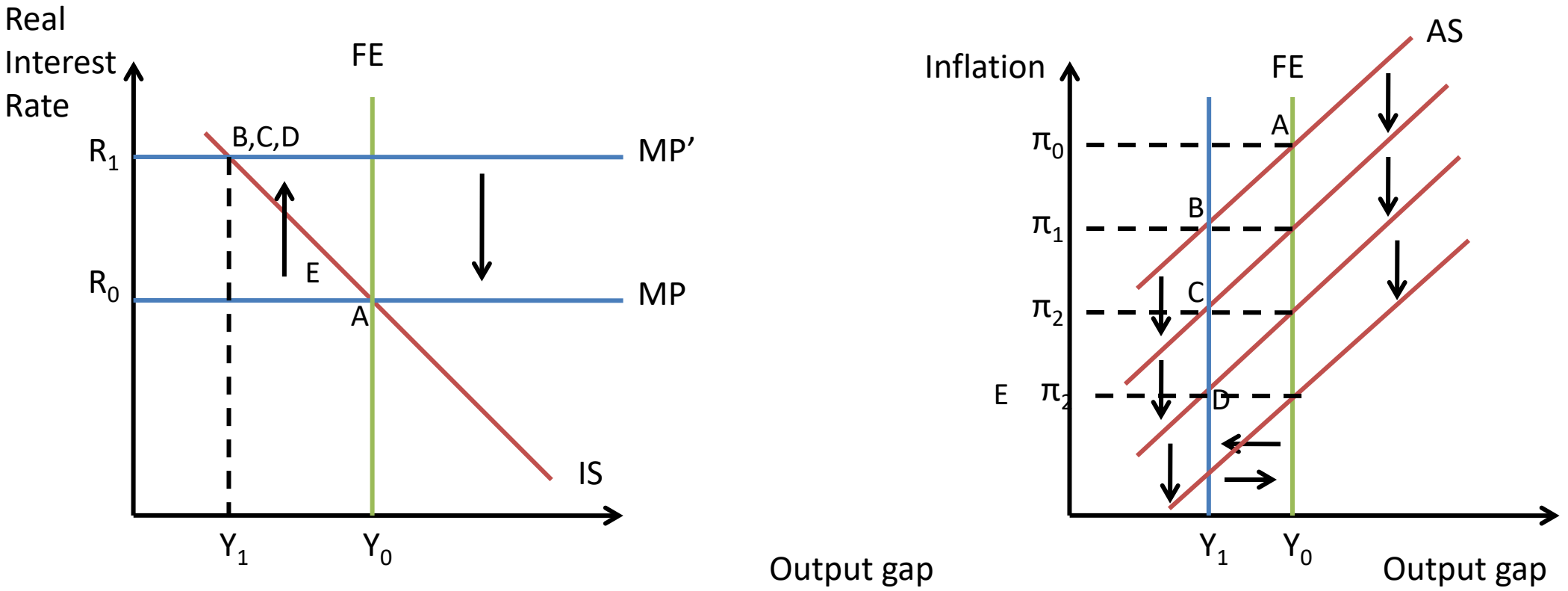
- Rising inflation in late-60s and 1970s
- Stagflation: Rising inflation and rising unemployment
- Causes:
  - Oil shocks (1973 and 1979)
  - Unanchored inflation expectations



High Inflation of the 1970s

- Nixon 1971: Wage and price controls
  - Failure
- Ford 1974:
  - Inflation “public enemy number one”
  - WIN: Whip inflation now
- Carter:
  - “Persistent high inflation threatens the economic security of our country“
  - Oct 1979: Appoints Paul Volcker Chairman of Fed

The Volcker Disinflation



Volcker raised interest rates massively. This led to a deep recession. Inflation came down relatively quickly. Output was then allowed to rise back to potential.

The Sacrifice Ratio

- Sacrifice ratio: Percentage of a year's real GDP foregone to permanently reduce inflation by one percentage point
- In the late 1970's economists believed that sacrifice ratio was high
  - Okun (1978) predicted a sacrifice ratio of 10!
  - I.e., to bring inflation down from 12% to 2% would entail a loss of an entire year's worth of output!
- Led many economists to be skeptical that it was worth the cost to bring down inflation

Rational Expectations Revolution

- Thomas Sargent challenged this idea
  - In a famous article titled "The End of Four Big Inflations"
- Pointed out that:
  - In hyperinflations, inflation is 1,000s% per year (e.g., roughly 25,000% in Germany in late 1923)
  - Hyperinflations always end abruptly! (in late November 1923 in German case)

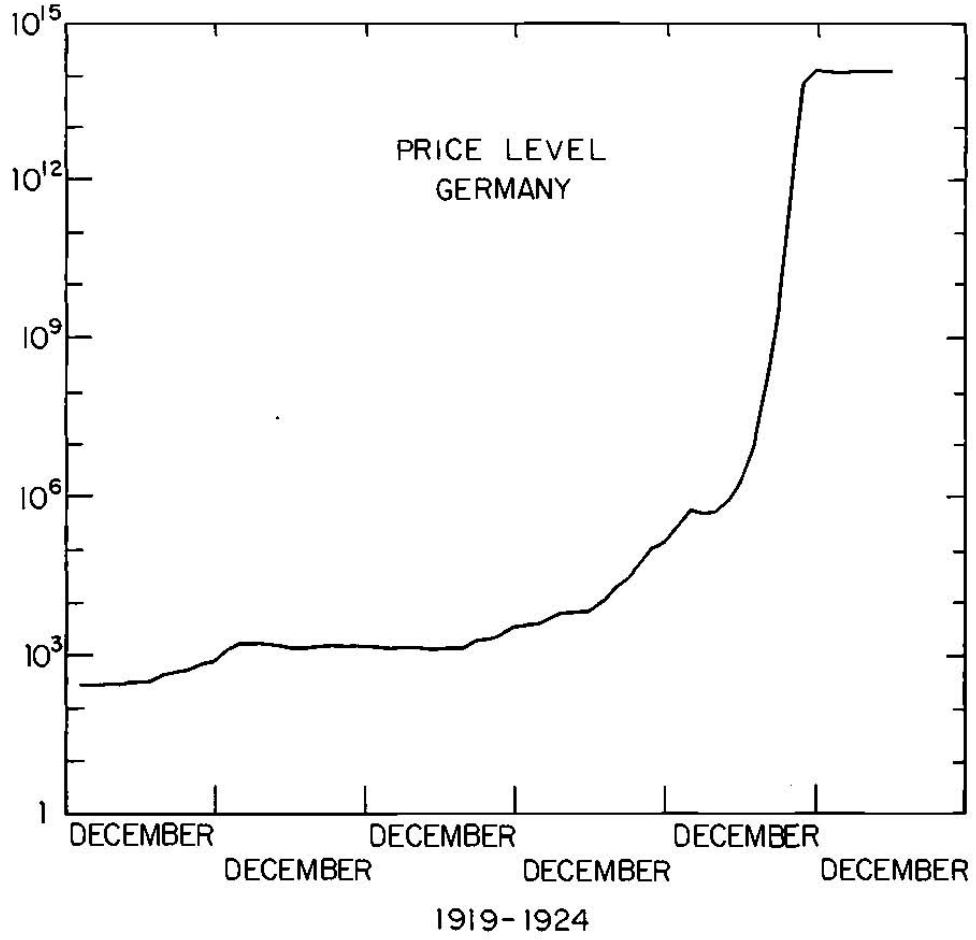


Fig. 2.4 Wholesale prices in Germany.

Source: Sargent (1982)

Sacrifice Ratio

- Hyperinflations always end abruptly
- Inflation goes from 1,000s% to 0% overnight
- If sacrifice ratio is 10, cost should be 10,000s% of output
- In fact, costs are close to zero (perhaps even negative, i.e., net benefits)
- How can this be?

Credible Announcements

- Sacrifice ratio is not some fundamental unchangeable feature of reality
- Its size depends on how the government goes about reducing inflation
- If the government is able to make a credible commitment to dramatically lower inflation:
  - Inflationary expectations will fall rapidly
  - Phillips curve will shift down rapidly
  - Sacrifice ratio will be small

The Role of Expectations

- General model of inflation:

$$\pi_t = E_{t-1}\pi_t + \bar{v}\tilde{Y}_t + \bar{o}_t$$

- Two ways to lower inflation:
  - Negative output gap
  - Reduce expected inflation
- Expectations:
  - In normal time we assume $E_{t-1}\pi_t = \pi_{t-1}$
  - But credible announcements may lead to deviations from this (i.e., may lead expectations to fall much faster)

Sargent's Argument

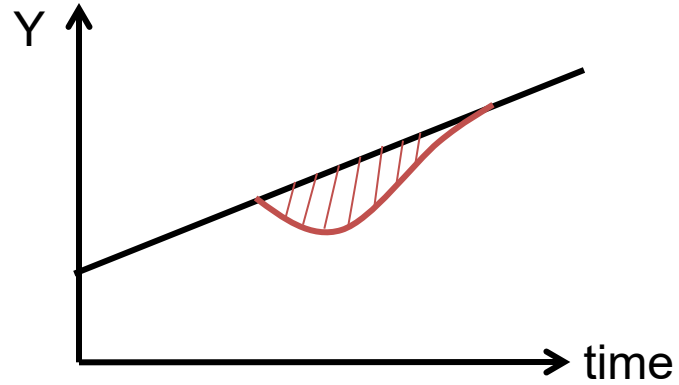
- To bring down inflation at low cost, the Fed should:
  - Make a clear commitment to low inflation
  - Act decisively to convince the public that they were serious about bringing down inflation
- Easier said than done given low credibility of Fed after many failed attempts to lower inflation in the 1970s
- But this is what Volcker did

My Research on the Phillips Curve

- Hazell, Herreno, Nakamura, Steinsson (2020):
  - 1/3 of fall in inflation during Volcker disinflation due to negative output gap
  - 2/3 of fall in inflation during Volcker disinflation due to shifts in inflationary expectations

Volcker Disinflation (1980-84)

- Historical estimate of sacrifice ratio for U.S. ≈ 2.4
  - 1 percentage point drop in inflation costs 2.4% of one year's GDP (could be spread out over time)
- Reduced inflation from ≈ 12.1 % to 3.3% (8.8 pct points)
- Caused severe recession (unemployment up to 9.5%)
- Total output loss estimated ≈ 16% of a year's GDP
- Sacrifice ratio for that episode = 16/8.8 = 1.8



Hyperinflation

- Common definition: >500% per year
- Examples:
  - France during Revolution
  - Germany, Austria, Hungary, Poland after WWI
  - China in 1948-49
  - Argentina, Brazil, Bolivia in 1980's
  - Zimbabwe in 2007-09
  - Venezuela in 2016-22

Monetary Policy and Fiscal Policy

- “Inflation is always and everywhere a monetary phenomenon” (M. Friedman)

$$M_t \bar{V} = P_t Y_t$$

- High inflation is always and everywhere a fiscal phenomenon (attributed to T. Sargent)

$$G_t = T_t + \Delta M_t$$

Cause of Inflation

- Money creation is proximate cause of inflation

$$\Delta \log M_t = \Delta \log P_t + \Delta \log Y_t - \Delta \log V_t$$

- But what is it that causes money creation?
- When money creation is extreme, it is often (always?) caused by fiscal pressures

$$G_t = T_t + \Delta M_t$$

- In that sense high inflation is a fiscal phenomenon

Do Bonds Help?

- Two period world
- Government can issue bonds in first period

$$G_1 = T_1 + B_1 + \Delta M_1$$

- Has to pay them in the second period

$$G_2 + (1 + r)B_1 = T_2 + \Delta M_2$$

- Government's intertemporal budget constraint:

$$G_1 + \frac{G_2}{1 + r} = T_1 + \frac{T_2}{1 + r} + \Delta M_1 + \frac{\Delta M_2}{1 + r}$$

Do Bonds Help?

- Even if governments can issue bonds in the short run, there are ultimately only two ways to pay for its spending:
  - Levy taxes
  - Print money
- But in the real world, there is always another period. Why can't the government keep rolling over (ever increasing amounts of) debt?
  - Who is going to want to hold all this debt?
  - Eventually government can't find buyers for all of it
  - At that point, game is up (problem set 6)

How Do Hyperinflations End?

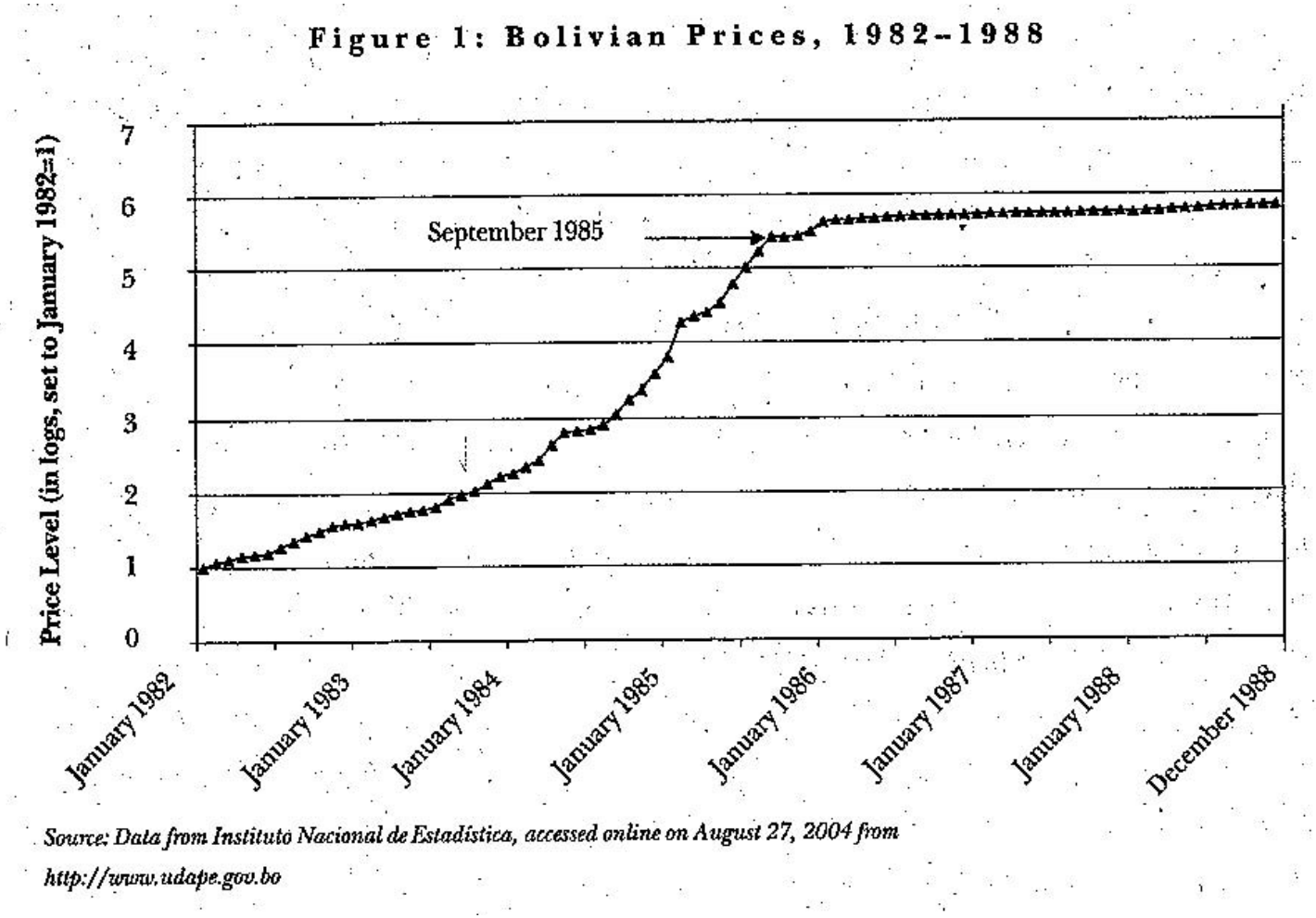
- What kind of policy is best in a hyperinflation:
  - Gradual reduction of the inflation?
  - Shock therapy (attempt at abrupt end)?
- Why does shock therapy make sense?
  - Rapidly change people's expectations
  - Avoid prolonged recession
  - In theory, if policy is perfectly credible and highly salient to everyone, everyone will stop raising prices immediately
  - In fact, this seems to be what happens

Shock Therapy

- What does the shock therapy consist of?
  - Crucial element: Fiscal reform
  - Root cause more spending than tax collection
- How is it done?
  - Different in different cases
  - Sometimes involves institutional change that insulates central bank from political pressure (bars govnm from “borrowing” from central bank)
  - This forces government to cut spending or raise revenue

Bolivian Hyperinflation

- Inflation was really high:
  - Aug-84 to Aug-85: 20,000 %
  - Peaked at 60,000% per year towards end
- Ended abruptly:
  - Comprehensive stabilization plan on Aug 29th 1985
  - Within 10 days inflation was gone



Sachs: End of Poverty

Bolivia: Why did it happen?

- 1978-1985: Great deal of political instability
  - Coups, electoral stalemates, etc.
- 1980 onward: Adverse external shocks
  - High world interest rates (Bolivia had borrowed a lot in the 1970's)
  - Falling prices for Bolivia's exports
- 1982-1985: Weak government
  - Unable to balance the budget due to social and political pressures

Jeffrey Sachs to the Rescue

- August 1985: New government
- They hire Jeffrey Sachs to advise them
- Sachs recommendation:
  - "Shock therapy": End the hyperinflation all at once
  - "No hyperinflation had ever been stopped [gradually]"
- Key: Raise the price of oil!!
  - Hmmm … stop a hyperinflation by raising a price?!?
  - Does this make sense?

Jeffrey Sachs to the Rescue

- Government revenues depended heavily on oil taxes from state oil company
- State oil company set oil prices in pesos and changed them only every few months
- In between price changes, foreign currency price of oil plummeted destroying the budget
  - Gas price in Bolivia in Aug-85: $0.03 per liter
  - World gas price in Aug-85: $0.28 per liter