

Welcome Back!

- I hope everyone had a good break
- A few comments on the remainder of the course...
 - We have only 3 meetings remaining
 - Question: how to allocate the time

Previously...

- We spent a lot of time discussing the components that make up Aggregate Demand; in a small open (Mundell Fleming) and in a closed (ISLM) economy (*with large open being the average of both extremes*)
 - NB. No economy is perfectly described by either extreme; hence, it's just a question of which one is it closer to
- What we got was: “at a given price level, what is the level of output demanded?” –or- at a given level of output demanded, what is the supportable price level”

The flip side...

- Demand is worthless without a countervailing force...the aggregate supply of output and its relation to the price level
- Our first introduction was a completely vertical or completely horizontal line—dependent on the level of price FLEXIBILITY
- We expand this notion a bit further with:
 - three models of aggregate supply in which output depends positively on the price level in the short run
- In addition, we will see the short-run tradeoff between inflation and unemployment (the Phillips curve)

Three models of aggregate supply

1. The sticky-wage model
2. The imperfect-information model
3. The sticky-price model

All three models imply:

$$Y = \bar{Y} + \alpha (P - P^e)$$

agg. output

natural rate of output

a positive parameter

the actual price level

the expected price level

The sticky-wage model

- Assumes that firms and workers negotiate contracts and fix the nominal wage before they know what the price level will turn out to be.
- The nominal wage they set is the product of a target real wage and the expected price level:

$$W = \omega \times P^e$$

Target
real
wage

$$\Rightarrow \frac{W}{P} = \omega \times \frac{P^e}{P}$$

The sticky-wage model

$$\frac{W}{P} = \omega \times \frac{P^e}{P}$$

If it turns out that

then

$$P = P^e$$

unemployment and output are at their natural rates

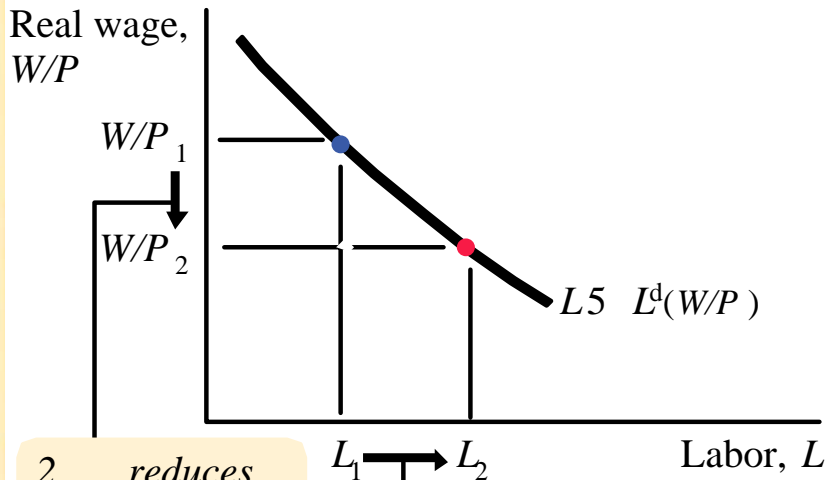
$$P > P^e$$

Real wage is less than its target, so firms hire more workers and output rises above its natural rate

$$P < P^e$$

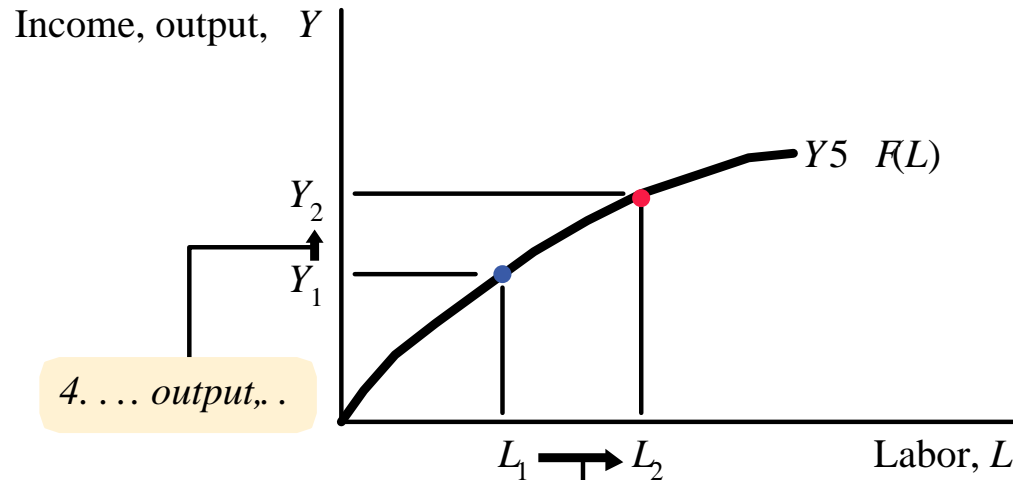
Real wage exceeds its target, so firms hire fewer workers and output falls below its natural rate

(a) Labor Demand



2. ... reduces the real wage for a given nominal wage,.

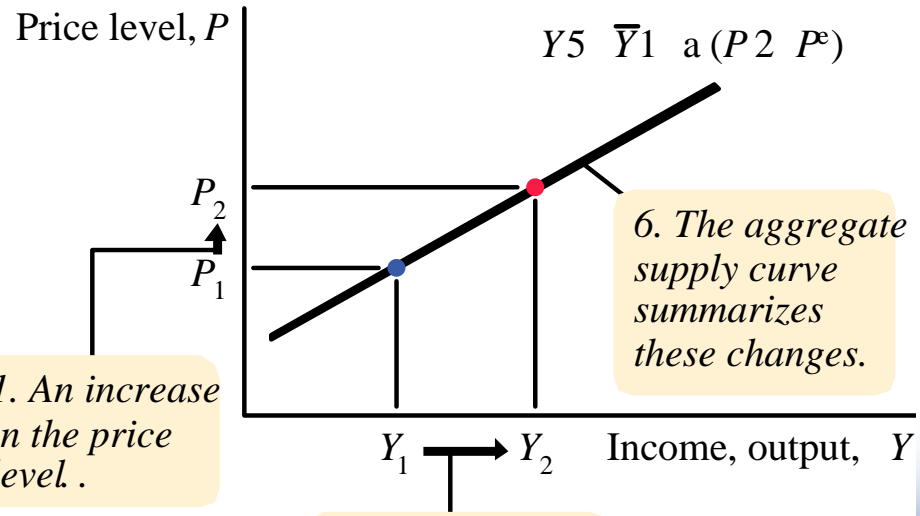
(b) Production Function



4. ... output, ..

3. ... which raises employment, .

(c) Aggregate Supply



1. An increase in the price level. .

6. The aggregate supply curve summarizes these changes.

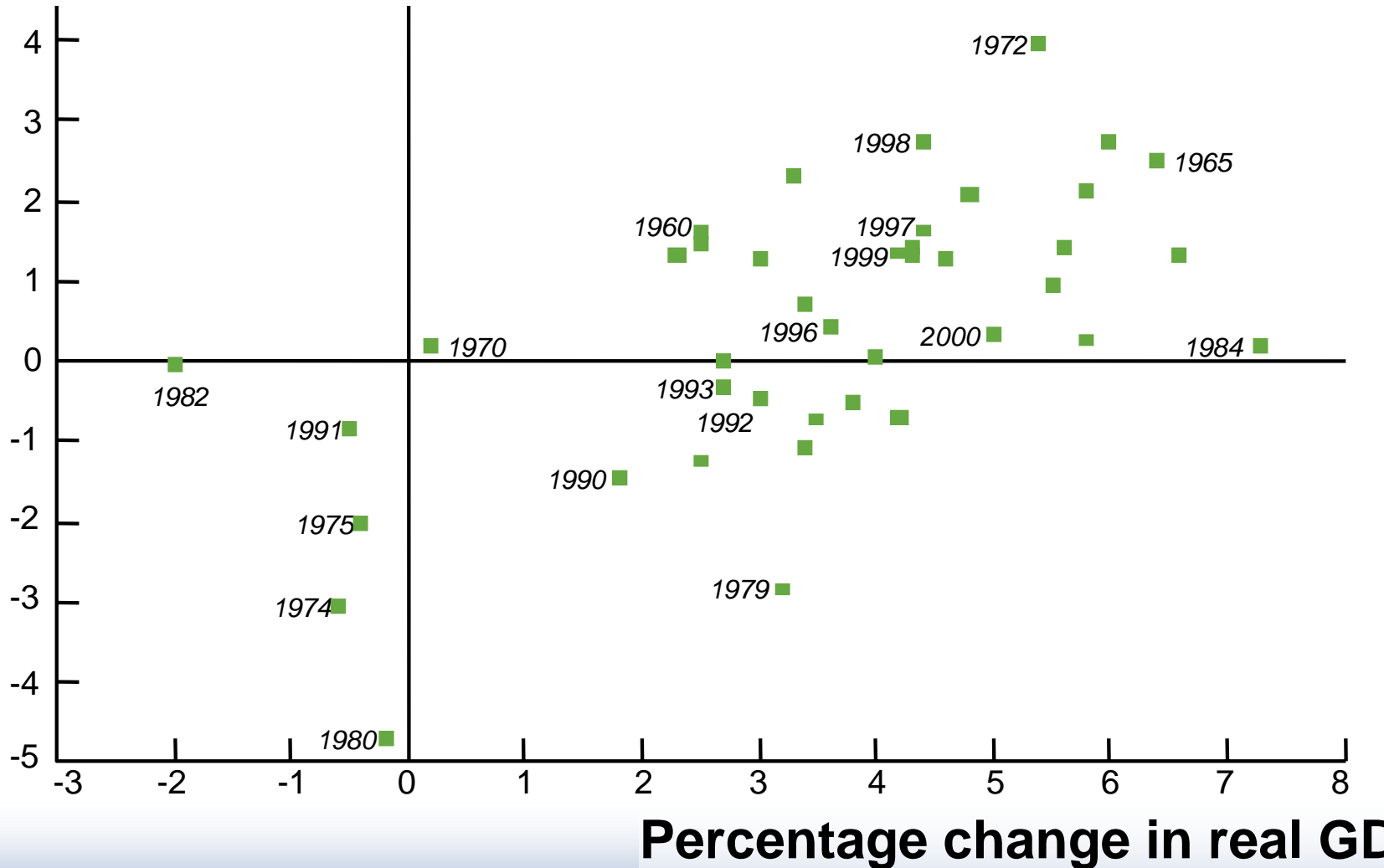
5. ... and income.

The sticky-wage model

- Implies that the real wage should be *counter-cyclical*, it should move in the opposite direction as output over the course of business cycles:
 - In booms, when P typically rises, the real wage should fall.
 - In recessions, when P typically falls, the real wage should rise.

The cyclical behavior of the real wage

Percentage change
in real wage



The imperfect-information model

(just understand the basic intuition)

Assumptions:

- all wages and prices perfectly flexible, all markets clear (a Chicago school idea)

Basic IDEA: Misperceptions

- each supplier produces one good, consumes many goods
- each supplier knows the nominal price of the good she produces, but does not know the overall price level

The imperfect-information model

- Supply of each good depends on its relative price: the nominal price of the good divided by the overall price level.
- Supplier doesn't know price level at the time she makes her production decision, so uses the expected price level, P^e .
- Suppose P rises but P^e does not.
Then supplier thinks her relative price has risen, so she produces more.
With many producers thinking this way,
 Y will rise whenever P rises above P^e .

The sticky-price model

- Reasons for sticky prices:
 - long-term contracts between firms and customers
 - menu costs
 - firms do not wish to annoy customers or business relations with frequent price changes
- Assumption:
 - Firms set their own prices (e.g. as in monopolistic competition)

The sticky-price model

- An individual firm's desired price is

$$p = P + a(Y - \bar{Y})$$

where $a > 0$.

Suppose two types of firms:

- firms with flexible prices, set prices as above
- firms with sticky prices, must set their price before they know how P and Y will turn out:

$$p = P^e + a(Y^e - \bar{Y}^e)$$

The sticky-price model

$$p = P^e + a(Y^e - \bar{Y}^e)$$

- Assume sticky price firms expect that output will equal its natural rate. Then,

$$p = P^e$$

- To derive the aggregate supply curve, we first find an expression for the overall price level.
- Let s denote the fraction of firms with sticky prices. Then, we can write the overall price level as

The sticky-price model

$$P = s P^e + (1 - s) [P + a(Y - \bar{Y})]$$

price set by sticky
price firms

price set by flexible
price firms

- Subtract $(1-s)P$ from both sides:

$$sP = sP^e + (1 - s)[a(Y - \bar{Y})]$$

- Divide both sides by s :

$$P = P^e + \left[\frac{(1 - s)a}{s} \right] (Y - \bar{Y})$$

The sticky-price model

$$P = P^e + \left[\frac{(1-s)a}{s} \right] (Y - \bar{Y})$$

- High $P^e \Rightarrow$ High P

If firms expect high prices, then firms who must set prices in advance will set them high.

Other firms respond by setting high prices.

- High $Y \Rightarrow$ High P

When income is high, the demand for goods is high.

Firms with flexible prices set high prices.

The greater the fraction of flexible price firms, the smaller is s and the bigger is the effect of ΔY on P .

The sticky-price model

$$\mathbf{P} = \mathbf{P}^e + \left[\frac{(1 - \mathbf{s})a}{\mathbf{s}} \right] (\mathbf{Y} - \bar{\mathbf{Y}})$$

- Finally, derive *AS* equation by solving for \mathbf{Y} :

$$\mathbf{Y} = \bar{\mathbf{Y}} + \alpha (\mathbf{P} - \mathbf{P}^e),$$

$$\text{where } \alpha = \frac{\mathbf{s}}{(1 - \mathbf{s})a}$$

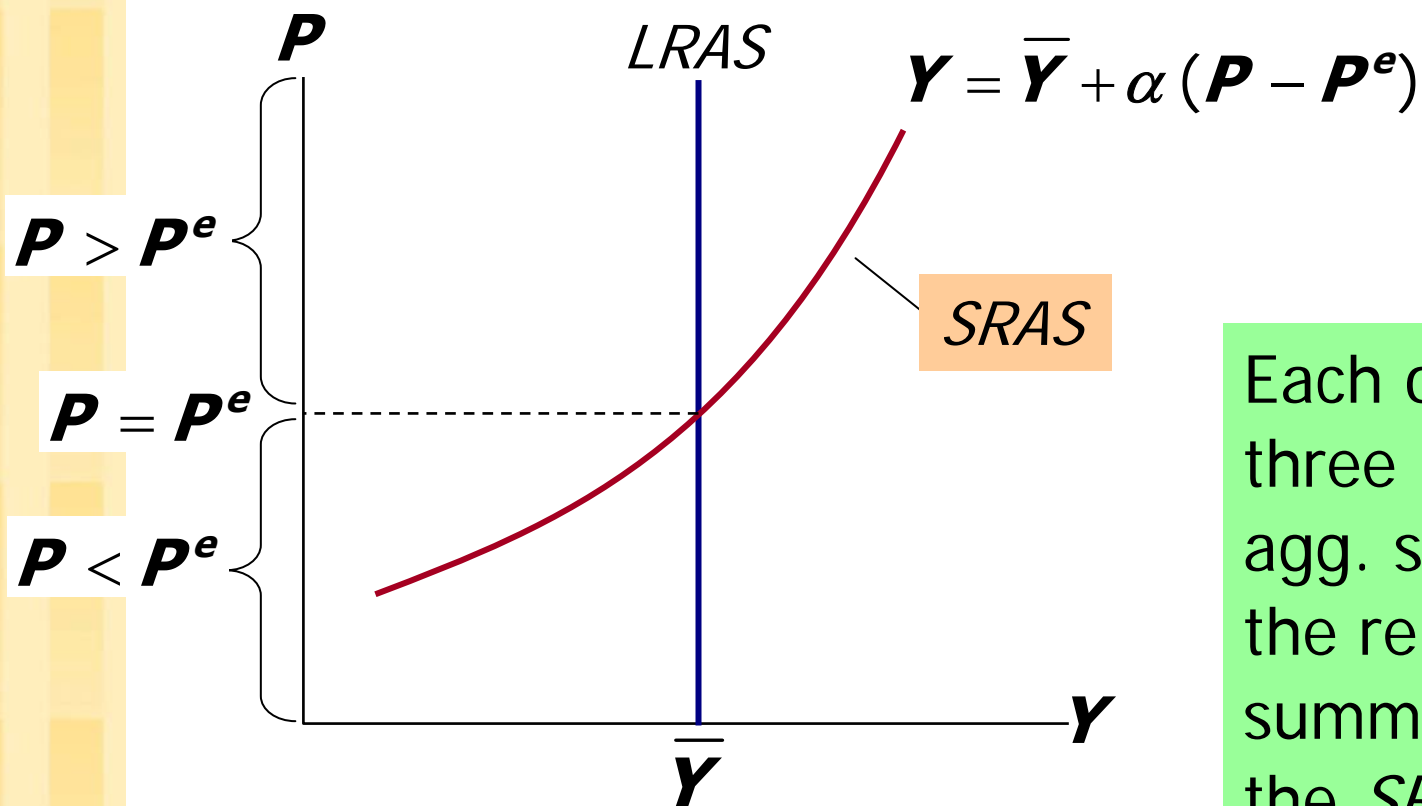
The sticky-price model

In contrast to the sticky-wage model, the sticky-price model implies a pro-cyclical real wage:

Suppose aggregate output/income falls. Then,

- Firms see a fall in demand for their products.
- Firms with sticky prices reduce production, and hence reduce their demand for labor.
- The leftward shift in labor demand causes the real wage to fall.

Summary & implications



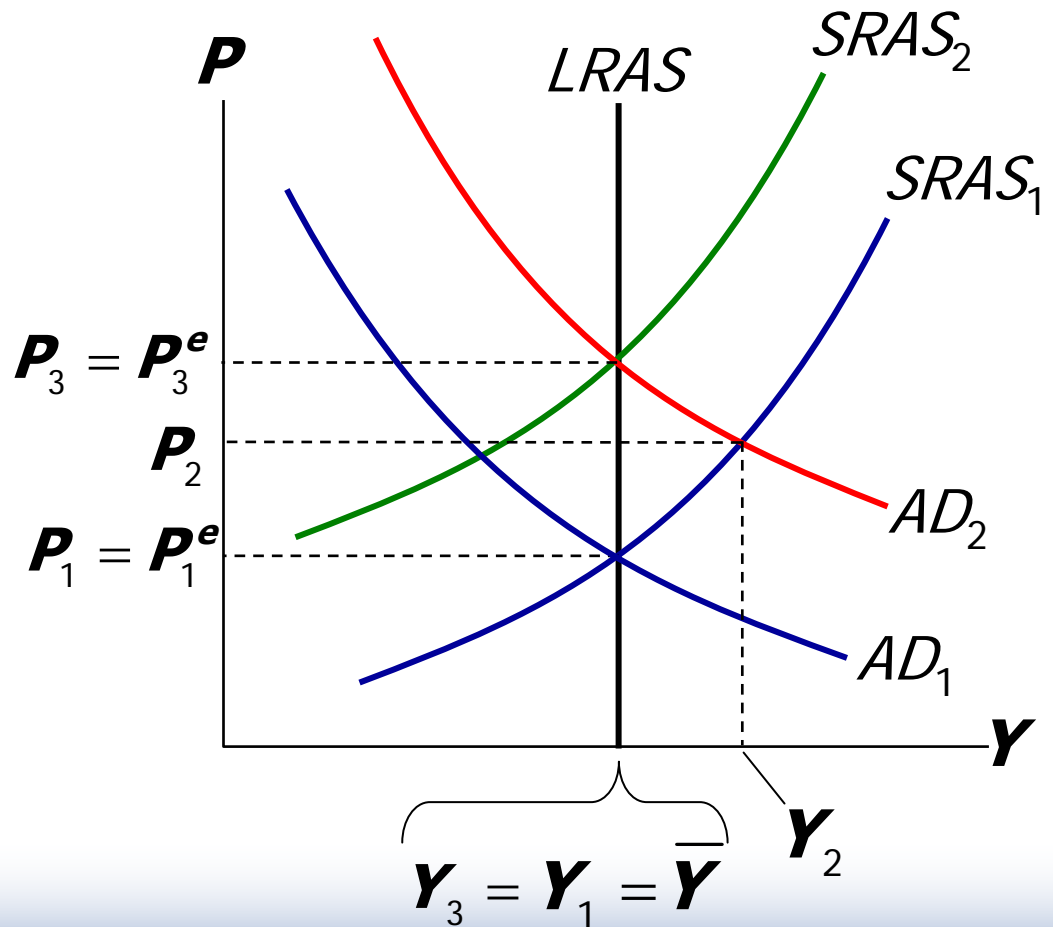
Each of the three models of agg. supply imply the relationship summarized by the *SRAS* curve & equation

Summary & implications

$$SRAS \text{ equation: } Y = \bar{Y} + \alpha (P - P^e)$$

Suppose a positive AD shock moves output above its natural rate and P above the level people had expected.

Over time, P^e rises, $SRAS$ shifts up, and output returns to its natural rate.



Inflation, Unemployment, and the Phillips Curve

The **Phillips curve** states that π depends on

- expected inflation, π^e
- **cyclical unemployment**: the deviation of the actual rate of unemployment from the natural rate
- supply shocks, v

$$\pi = \pi^e - \beta(u - u^n) + v$$

where $\beta > 0$ is an exogenous constant.

Deriving the Phillips Curve from SRAS

$$(1) \quad \mathbf{Y} = \bar{\mathbf{Y}} + \alpha (\mathbf{P} - \mathbf{P}^e)$$

$$(2) \quad \mathbf{P} = \mathbf{P}^e + (1/\alpha) (\mathbf{Y} - \bar{\mathbf{Y}})$$

$$(3) \quad \mathbf{P} = \mathbf{P}^e + (1/\alpha) (\mathbf{Y} - \bar{\mathbf{Y}}) + \nu$$

$$(4) \quad (\mathbf{P} - \mathbf{P}_{-1}) = (\mathbf{P}^e - \mathbf{P}_{-1}) + (1/\alpha) (\mathbf{Y} - \bar{\mathbf{Y}}) + \nu$$

$$(5) \quad \pi = \pi^e + (1/\alpha) (\mathbf{Y} - \bar{\mathbf{Y}}) + \nu$$

$$(6) \quad (1/\alpha) (\mathbf{Y} - \bar{\mathbf{Y}}) = -\beta (\mathbf{u} - \mathbf{u}^n)$$

$$(7) \quad \pi = \pi^e - \beta (\mathbf{u} - \mathbf{u}^n) + \nu$$

The Phillips Curve and *SRAS*

$$\text{SRAS: } \mathbf{Y} = \bar{\mathbf{Y}} + \alpha (\mathbf{P} - \mathbf{P}^e)$$

$$\text{Phillips curve: } \pi = \pi^e - \beta (\mathbf{u} - \mathbf{u}^n) + \nu$$

- *SRAS* curve:
output is related to unexpected movements in the price level
- Phillips curve:
unemployment is related to unexpected movements in the inflation rate

Adaptive expectations

- **Adaptive expectations:** an approach that assumes people form their expectations of future inflation based on recently observed inflation.
- A simple example:
Expected inflation = last year's actual inflation

$$\pi^e = \pi_{-1}$$

- Then, the P.C. becomes

$$\pi = \pi_{-1} - \beta(\mathbf{u} - \mathbf{u}^n) + \nu$$

Inflation inertia

$$\pi = \pi_{-1} - \beta(\mathbf{u} - \mathbf{u}^n) + \nu$$

- In this form, the Phillips curve implies that inflation has inertia:
 - In the absence of supply shocks or cyclical unemployment, inflation will continue indefinitely at its current rate.
 - Past inflation influences expectations of current inflation, which in turn influences the wages & prices that people set.

Two causes of rising & falling inflation

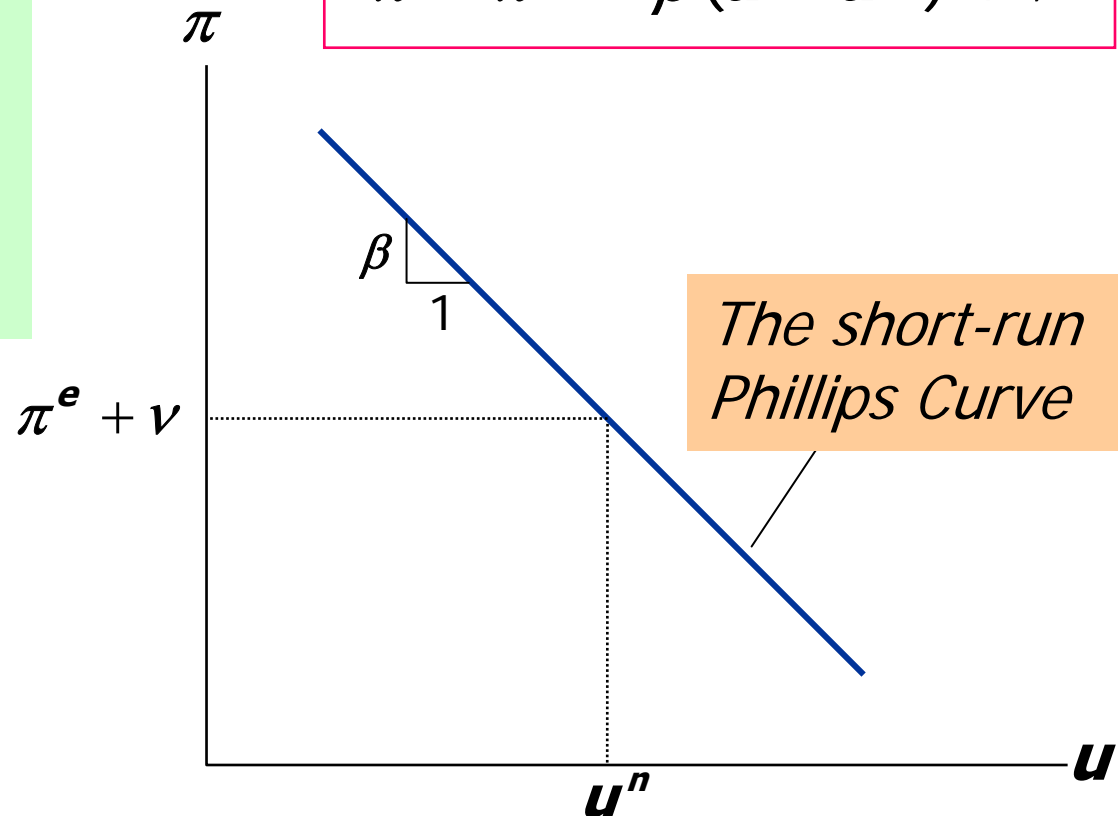
$$\pi = \pi_{-1} - \beta(\mathbf{u} - \mathbf{u}^n) + v$$

- **cost-push inflation**: inflation resulting from supply shocks.
Adverse supply shocks typically raise production costs and induce firms to raise prices, “pushing” inflation up.
- **demand-pull inflation**: inflation resulting from demand shocks.
Positive shocks to aggregate demand cause unemployment to fall below its natural rate, which “pulls” the inflation rate up.

Graphing the Phillips curve

In the short run, policymakers face a trade-off between π and u .

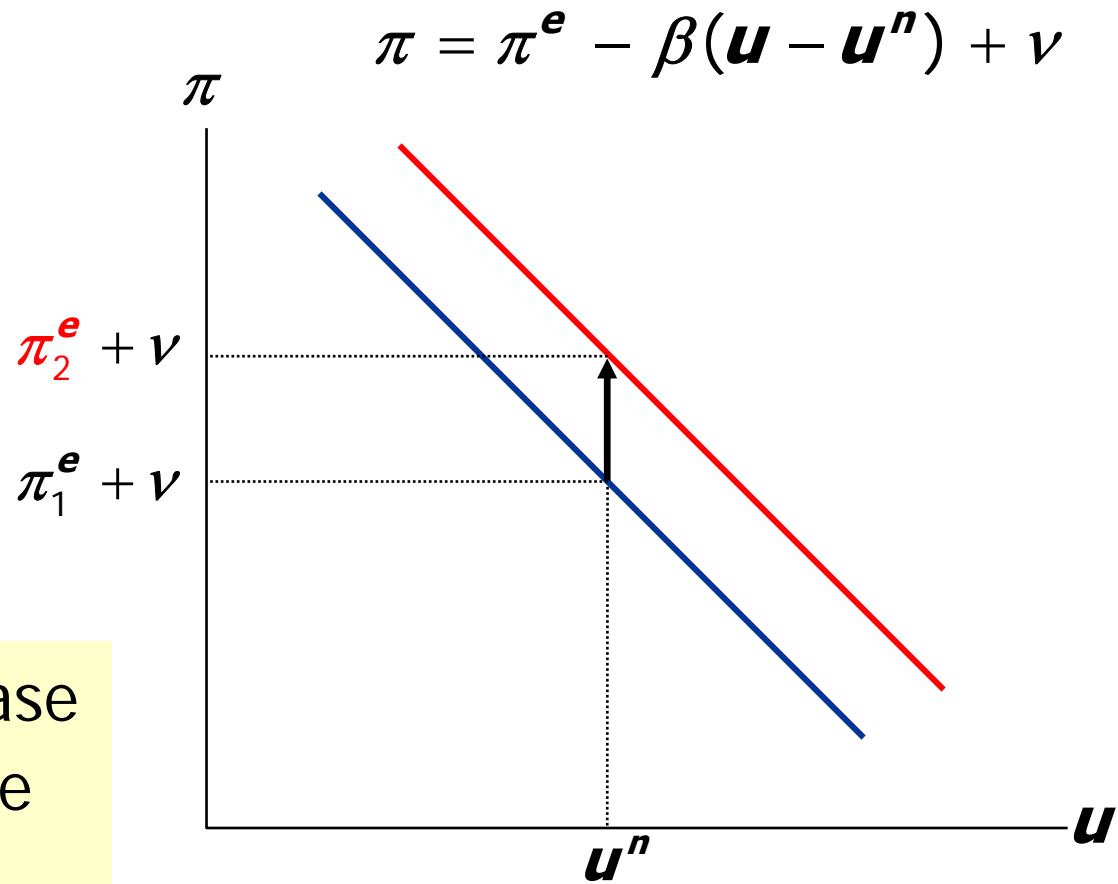
$$\pi = \pi^e - \beta(u - u^n) + v$$



Shifting the Phillips curve

People adjust their expectations over time, so the tradeoff only holds in the short run.

E.g., an increase in π^e shifts the short-run P.C. upward.



Rational expectations

Ways of modeling the formation of expectations:

- **adaptive expectations:**
People base their expectations of future inflation on recently observed inflation.
- **rational expectations:**
People base their expectations on all available information, including information about current and prospective future policies.