

MACROECONOMICS

N. GREGORY MANKIW

Aggregate Supply and the Short-Run Tradeoff between Inflation and Unemployment

IN THIS CHAPTER, YOU WILL LEARN:

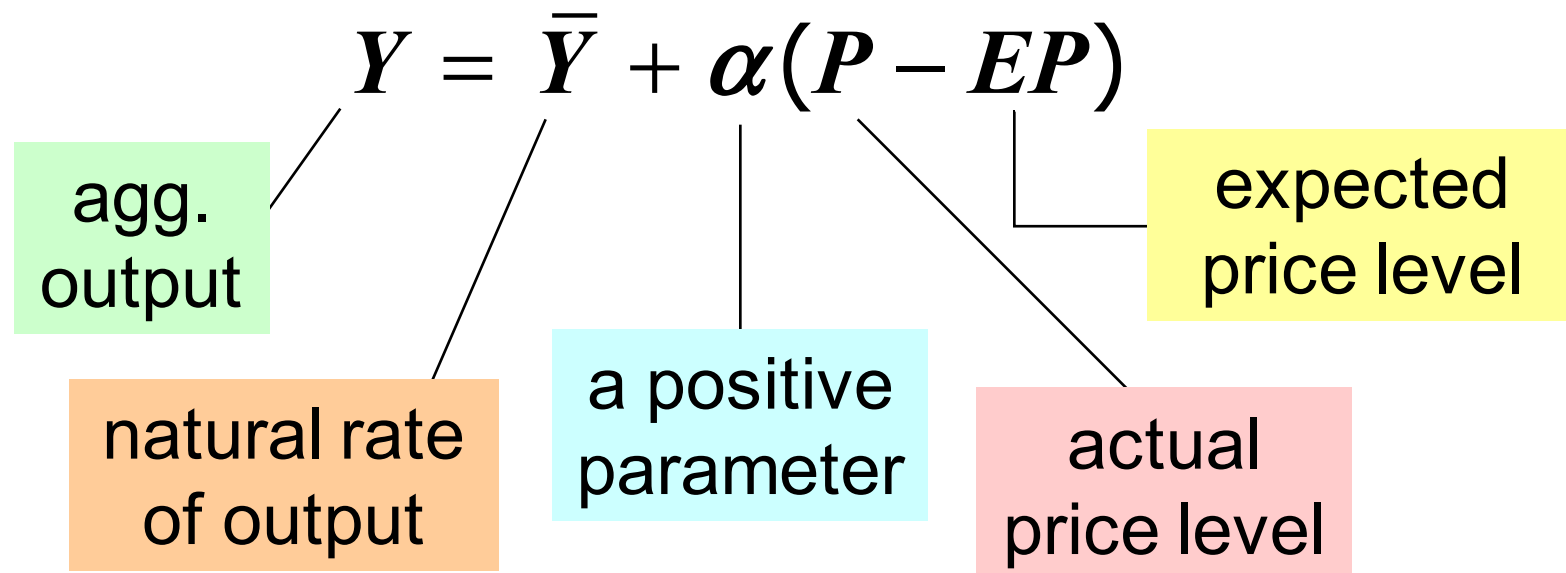
- two models of aggregate supply in which output depends positively on the price level in the short run
- about the short-run tradeoff between inflation and unemployment known as the Phillips curve

Introduction

- In previous chapters, we assumed the price level ***P*** was “stuck” in the short run.
 - This implies a horizontal SRAS curve.
- Now, we consider two prominent models of aggregate supply in the short run:
 - Sticky-price model
 - Imperfect-information model

Introduction

- Both models imply:



- Other things equal, Y and P are positively related, so the SRAS curve is upward sloping.

The sticky-price model

- Reasons for sticky prices:
 - long-term contracts between firms and customers
 - menu costs
 - firms not wishing to annoy customers 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:

$$p = EP + a(EY - E\bar{Y})$$

The sticky-price model

$$p = EP + a(EY - E\bar{Y})$$

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

$$p = EP$$

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

The sticky-price model

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

price set by
sticky-price firms

price set by
flexible-price firms

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

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

- Divide both sides by s :

$$P = EP + \frac{(1-s)a}{s}(Y - \bar{Y})$$

The sticky-price model

$$P = EP + \frac{(1-s)a}{s}(Y - \bar{Y})$$

- High $EP \rightarrow$ High P

If firms expect high prices, then firms that 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 the effect of ΔY on P .

The sticky-price model

$$P = EP + \frac{(1-s)a}{s}(Y - \bar{Y})$$

- Finally, derive AS equation by solving for Y :

$$Y = \bar{Y} + \alpha(P - EP),$$

$$\text{where } \alpha = \frac{s}{(1-s)a} > 0$$

The imperfect-information model

Assumptions:

- All wages and prices are perfectly flexible, all markets are clear.
- 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.
- Supplier knows history of price movements and can compute variances of prices.

The imperfect-information model

Output from producer, i , should respond positively to the relative price of good i :

$$y_i = \bar{y}_i + \lambda r_i$$

where: $r_i = p_i - P$

But relative price of good i depends on the overall price level, which is not observed. The producer observes only his/her own nominal price, so output depends on expected value of the relative price conditioned on their own nominal price:

$$y_i = \bar{y}_i + \lambda E[r_i \mid p_i]$$

The imperfect-information model

Since the relative price equals nominal price minus overall price level, we can rearrange to express nominal price equal to relative price plus price level:

$$p_i = r_i + P$$

Assuming that the relative price is uncorrelated with the overall price level, we can express the variance of the nominal price as:

$$Var[p_i] = Var[r_i] + Var[P]$$

The imperfect-information model

We need to compute the expected value of the relative price conditioned on the nominal price:

$$E[r_i | p_i] = ?$$

We can do this by running a regression (extracting the "signal" from the nominal price):

$$r_i = \beta[p_i - P]$$

where:

$$\begin{aligned}\beta &= \frac{\text{Cov}[r_i, p_i]}{\text{Var}[p_i]} = \frac{\text{Cov}[r_i, r_i + P]}{\text{Var}[r_i + P]} \\ &= \frac{\text{Var}[r_i]}{\text{Var}[r_i] + \text{Var}[P]}\end{aligned}$$

The imperfect-information model

So this implies:

$$E[r_i | p]_i = \beta[p_i - EP]$$

And implies the following supply function for producer i :

$$y_i = \bar{y}_i + \lambda\beta[p_i - EP]$$

Aggregating over all producers (who are identical) gives the short-run aggregate supply equation:

$$y = \bar{y} + \lambda\beta[P - EP]$$

The imperfect-information model

Using the earlier notation for the short-run aggregate supply curve:

$$y = \bar{y} + \alpha[P - EP]$$

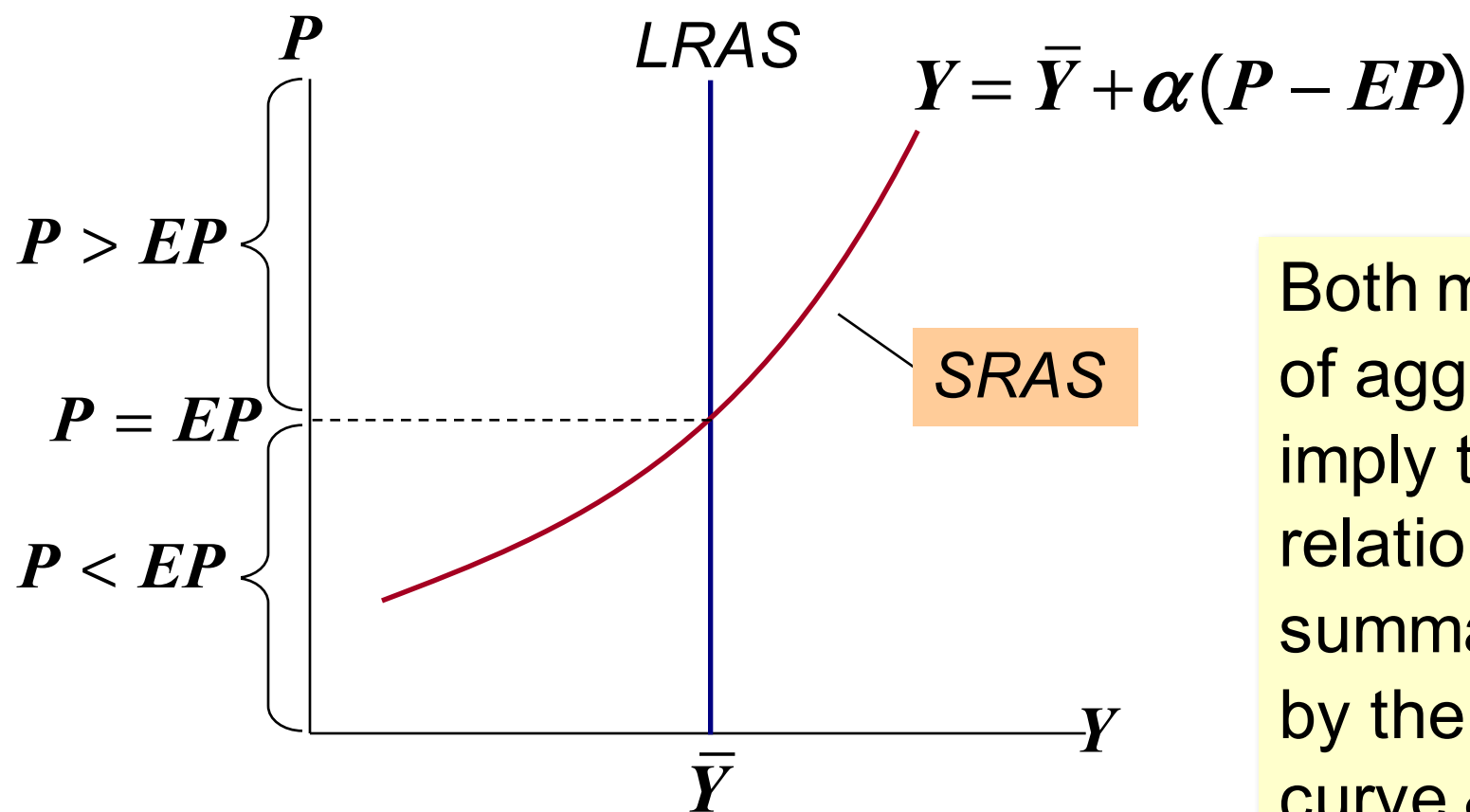
where: $\alpha = \lambda\beta$

Note that β (and therefore α) will be small (and the aggregate supply curve will be steep) when the variance of the relative price is small compared with the variance of the overall price level. And β (and therefore α) will be large (and the aggregate supply curve will be flat) when the variance of the relative price is large compared with the variance of the overall price level.

The imperfect-information model

- Supply of each good depends on its relative price: the nominal price of the good minus the overall price level.
- Supplier does not know price level at the time but does observe her own price. When she makes her production decision, she uses EP .
- Suppose P rises but EP does not.
 - Supplier sees own price increase and thinks her relative price has risen, so she produces more.
 - With many producers thinking this way, Y will rise whenever P rises above EP .

Summary & implications



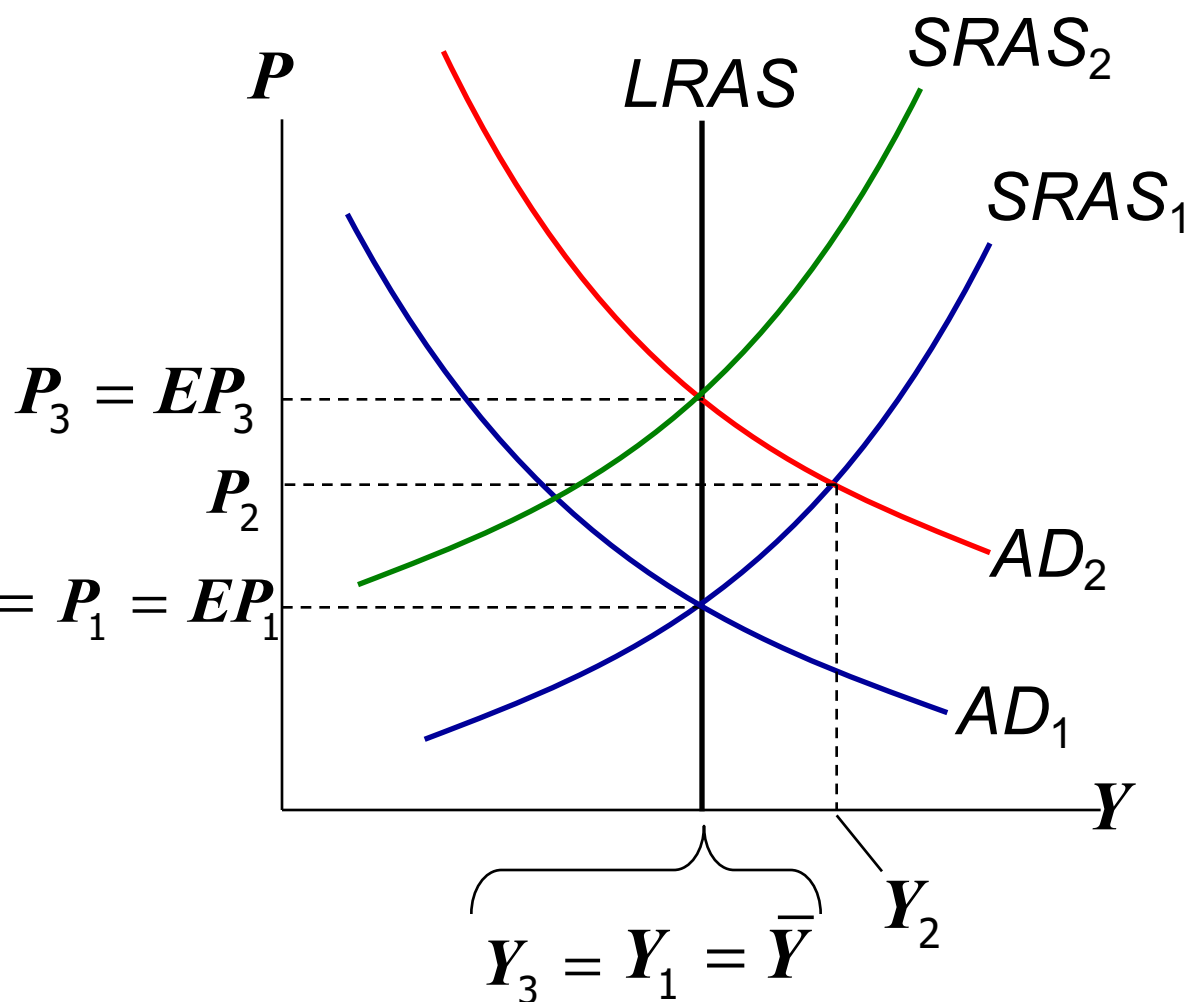
Both models of agg. supply imply the relationship summarized by the *SRAS* curve & equation.

Summary & implications

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

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

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



Inflation, unemployment, and the Phillips curve

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

- expected inflation, $E\pi$
- **cyclical unemployment**: the deviation of the actual rate of unemployment from the natural rate
- supply shocks, v (Greek letter “nu”).

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

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

Deriving the Phillips curve from *SRAS*

$$(1) \quad Y = \bar{Y} + \alpha(P - EP)$$

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

$$(3) \quad P = EP + (1/\alpha)(Y - \bar{Y}) + v$$

$$(4) \quad (P - P_{-1}) = (EP - P_{-1}) + (1/\alpha)(Y - \bar{Y}) + v$$

$$(5) \quad \pi = E\pi + (1/\alpha)(Y - \bar{Y}) + v$$

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

$$(7) \quad \pi = E\pi - \beta(u - u^n) + v$$

Comparing *SRAS* and the Phillips curve

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

$$\text{Phillips curve: } \pi = E\pi - \beta(u - u^n) + v$$

- *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 version:
Expected inflation = last year's actual inflation

$$E\pi = \pi_{-1}$$

- Then, Phillips curve eq'n becomes

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

Inflation inertia

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

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

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

- **cost-push inflation:**

inflation resulting from supply shocks

Adverse supply shocks typically raise production costs and induce firms to raise prices, *pushing* inflation up.

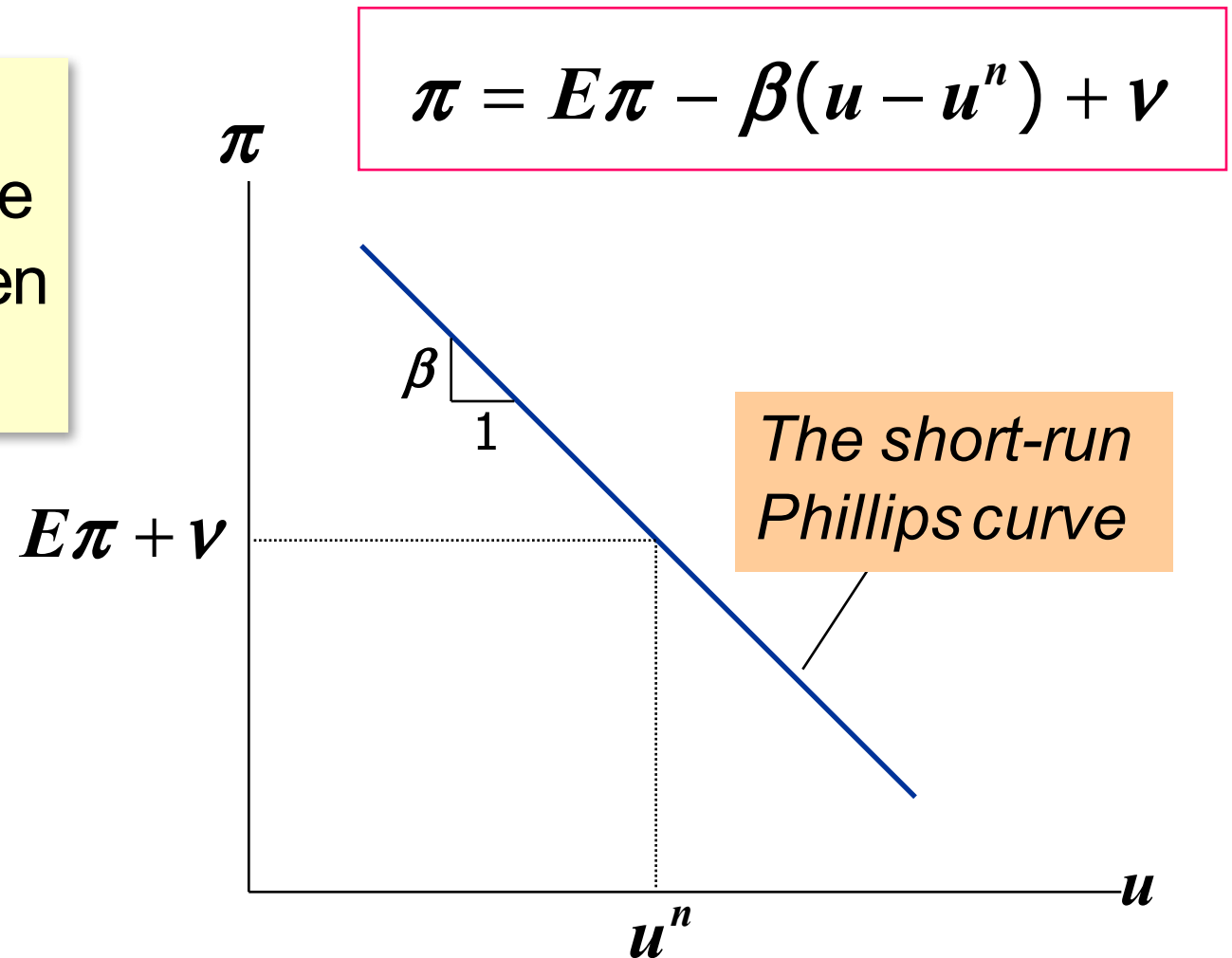
- **demand-pull inflation:**

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

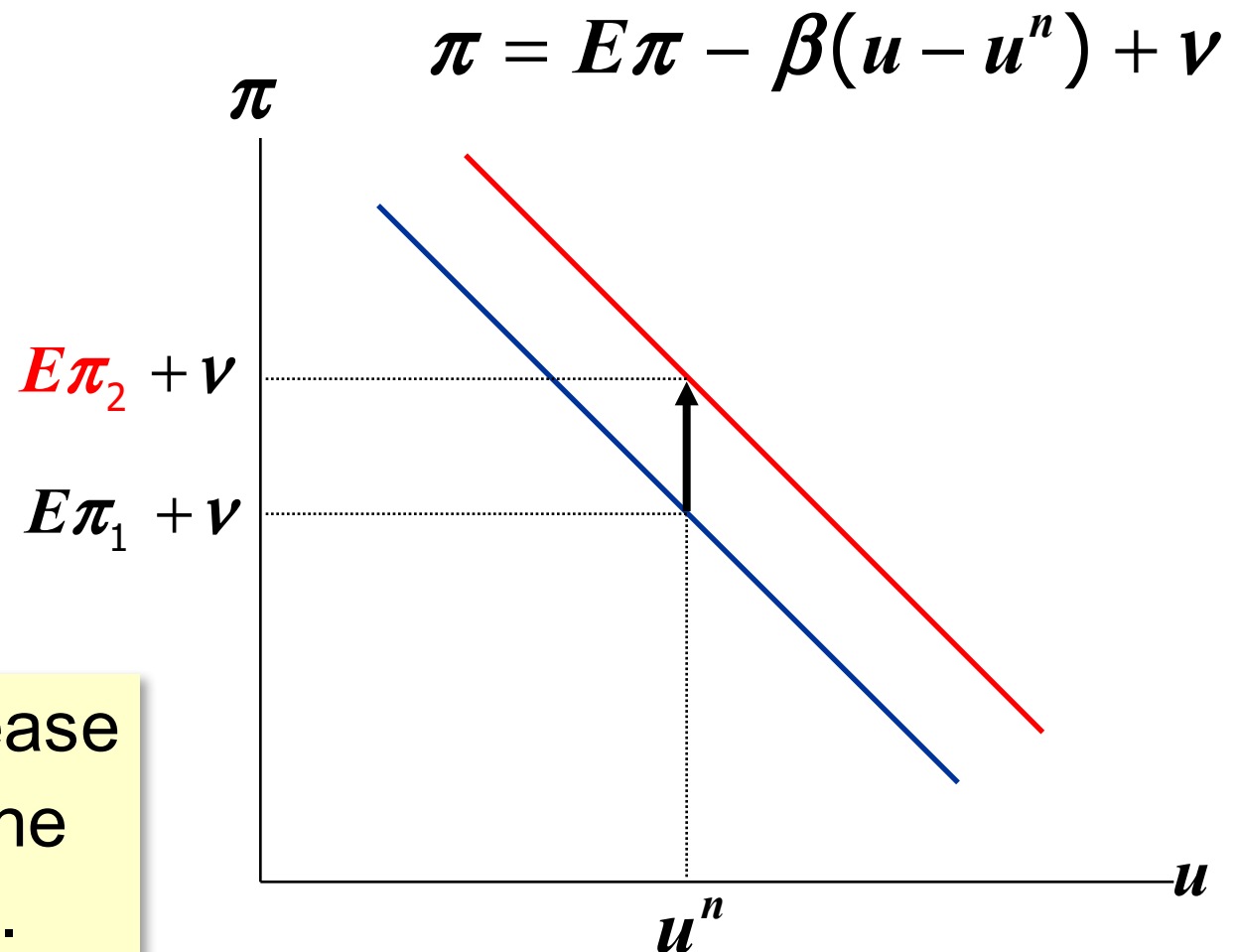
In the short run, policymakers face a tradeoff between π and u .



Shifting the Phillips curve

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

E.g., an increase in $E\pi$ shifts the short-run P.C. upward.



The sacrifice ratio

- To reduce inflation, policymakers can contract agg. demand, causing unemployment to rise above the natural rate.
- The **sacrifice ratio** measures the percentage of a year's real GDP that must be forgone to reduce inflation by 1 percentage point.
- A typical estimate of the ratio is 5.

The sacrifice ratio

- Example: To reduce inflation from 6 to 2 percent, must sacrifice 20 percent of one year's GDP:

$$\begin{array}{rcccl} \text{GDP loss} & = & (\text{inflation reduction}) & \times & (\text{sacrifice ratio}) \\ & & 4 & & 5 \end{array}$$

- This loss could be incurred in one year or spread over several, e.g., 5% loss for each of four years.
- The cost of disinflation is lost GDP.
One could use Okun's law to translate this cost into unemployment.

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.

Painless disinflation?

- Proponents of rational expectations believe that the sacrifice ratio may be very small:
- Suppose $u = u^n$ and $\pi = E\pi = 6\%$, and suppose the Fed announces that it will do whatever is necessary to reduce inflation from 6 to 2 percent as soon as possible.
- If the announcement is credible, then $E\pi$ will fall, perhaps by the full 4 points.
- Then, π can fall without an increase in u .

Calculating the sacrifice ratio for the Volcker disinflation

- 1981: $\pi = 9.7\%$
 - 1985: $\pi = 3.0\%$
- Total disinflation = 6.7%

year	u	u^n	$u - u^n$
1982	9.5%	6.0%	3.5%
1983	9.5	6.0	3.5
1984	7.4	6.0	1.4
1985	7.1	6.0	1.1

Total 9.5%

Calculating the sacrifice ratio for the Volcker disinflation

- From previous slide: Inflation fell by 6.7%, total cyclical unemployment was 9.5%.
- Okun's law:
1% of unemployment = 2% of lost output.
- Thus, 9.5% cyclical unemployment = 19.0% of a year's real GDP.
- **Sacrifice ratio** = (lost GDP)/(total disinflation)
= $19/6.7 = 2.8$ percentage points of GDP were lost for each 1 percentage point reduction in inflation.

The natural-rate hypothesis

Our analysis of the costs of disinflation, and of economic fluctuations in the preceding chapters, is based on the **natural-rate hypothesis**:

Changes in aggregate demand affect output and employment only in the short run.

In the long run, the economy returns to the levels of output, employment, and unemployment described by the classical model (Chaps. 3–9).

An alternative hypothesis: Hysteresis

- **Hysteresis**: the long-lasting influence of history on variables such as the natural rate of unemployment.
- Negative shocks may increase u^n , so economy may not fully recover.

Hysteresis: Why negative shocks may increase the natural rate

- The skills of cyclically unemployed workers may deteriorate while unemployed, and they may not find a job when the recession ends.
- Cyclically unemployed workers may lose their influence on wage setting; then, insiders (employed workers) may bargain for higher wages for themselves.
Result: The cyclically unemployed “outsiders” may become structurally unemployed when the recession ends.

CHAPTER SUMMARY

1. Two models of aggregate supply in the short run:

- sticky-price model
- imperfect-information model

Both models imply that output rises above its natural rate when the price level rises above the expected price level.

CHAPTER SUMMARY

2. Phillips curve

- derived from the *SRAS* curve
- states that inflation depends on
 - expected inflation
 - cyclical unemployment
 - supply shocks
- presents policymakers with a short-run tradeoff between inflation and unemployment

CHAPTER SUMMARY

3. How people form expectations of inflation

- adaptive expectations
 - based on recently observed inflation
 - implies “inertia”
- rational expectations
 - based on all available information
 - implies that disinflation may be painless

CHAPTER SUMMARY

4. The natural rate hypothesis and hysteresis

- the natural rate hypotheses
 - states that changes in aggregate demand can affect output and employment only in the short run
- hysteresis
 - states that aggregate demand can have permanent effects on output and employment