In this chapter, you will learn...

- three 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

Three models of aggregate supply

- The sticky-wage model
- The imperfect-information model
- The sticky-price model

All three models imply:

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

- \( Y \) is aggregate output.
- \( \bar{Y} \) is the natural rate of output.
- \( \alpha \) is a positive parameter.
- \( P \) is the actual price level.
- \( P^e \) is 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:

\[ W = \hat{u} \times P^e \]

\[ \Rightarrow \frac{W}{P} = \frac{\hat{u} \times P^e}{P} \]

Target real wage

If it turns out that:

- \( P = P^e \)
  - Unemployment and output are at their natural rates.
  - Real wage is less than its target, so firms hire more workers and output rises above its natural rate.
  - Real wage exceeds its target, so firms hire fewer workers and output falls below its natural rate.

- \( P > P^e \)
- \( P < P^e \)
The sticky-wage model

- Implies that the real wage should be **counter-cyclical**, should move in the opposite direction as output during business cycles:
  - In booms, when $P$ typically rises, real wage should fall.
  - In recessions, when $P$ typically falls, real wage should rise.
- This prediction does not come true in the real world.

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 he or she produces, but does not know the overall price level.

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

\[ p = p^* + a(Y - y^*) \]

- Assume sticky price firms expect that output will equal its natural rate. Then,
  \[ p = p^* \]
- 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…

\[ eP = sP^* + (1 - s)[a(Y - y)] \]

- Divide both sides by \( s \):
  \[ eP = sP^* + \left( \frac{1 - s}{s} \right)a(Y - y) \]

Finally, derive AS equation by solving for \( Y \):

\[ Y = \bar{Y} + \alpha(P - p^*) \]

where \( \alpha = \frac{s}{(1 - s)\hat{a}} \)

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

Suppose aggregate output/income falls. Then, the leftward shift in labor demand causes the real wage to fall.

Each of the three models of aggregate 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, \( P \) rises, SRAS shifts up, and output returns to its natural rate.

**Inflation, Unemployment, and the Phillips Curve**

The Phillips curve states that \( \pi \) depends on:
- expected inflation, \( \pi^e \)
- cyclical unemployment: the deviation of the actual rate of unemployment from the natural rate
- supply shocks, \( \nu \) (Greek letter “nu”).

\[
\pi = \pi^e - \beta(u - u^*) + \nu
\]

where \( \beta > 0 \) is an exogenous constant.

**Deriving the Phillips Curve from SRAS**

1. \( Y = \bar{Y} + \alpha(P - P^*) \)
2. \( P = P^* + (1/\alpha)(Y - \bar{Y}) \)
3. \( P = P^* + (1/\alpha)(Y - \bar{Y}) + \nu \)
4. \( (P - P^*) = (P^* - P_u^*) + (1/\alpha)(Y - \bar{Y}) + \nu \)
5. \( \pi = \pi^e + (1/\alpha)(Y - \bar{Y}) + \nu \)
6. \( (1/\alpha)(Y - \bar{Y}) = -\beta(u - u^*) \)
7. \( \pi = \pi^e - \beta(u - u^*) + \nu \)

**The Phillips Curve and SRAS**

SRAS: \( Y = \bar{Y} + \alpha(P - P^*) \)

Phillips curve: \( \pi = \pi^e - \beta(u - u^*) + \nu \)

- 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 \( \pi = \pi_{-1} - \beta(u - u^*) + \nu \)

**Inflation inertia**

\[
\pi = \pi_{-1} - \beta(u - u^*) + \nu
\]

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

\[ \pi = \pi_* - \beta(u - u^*) + \nu \]

- **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 \( \pi \) 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 \( \pi_* \) shifts the short-run P.C. upward.

The sacrifice ratio

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

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 \( \pi = \pi^e = 6\% \), 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 \( \pi^e \) will fall, perhaps by the full 4 points.
  - Then, \( \pi \) can fall without an increase in \( u \).

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.
- So, 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. 3-8).

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.
1. Three models of aggregate supply in the short run:
   - sticky-wage model
   - imperfect-information model
   - sticky-price model

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

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

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

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