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

Probably the single most important macroeconomic relationship is the Phillips curve.

—Janet Yellen's partner, George Akerlof

In This Chapter We . . .

- examine the basic theory of the short-run aggregate supply curve.

- describe the tradeoff between inflation and unemployment —the *Phillips Curve*

- explain why policymakers face this tradeoff in the short run, and why they don't in the long run

The Basic Theory of Aggregate Supply

We began our studies using classical, "frictionless" assumptions. We have since dispensed of them.

There are two prominent models of aggregate supply:

- The sticky-price model

- The imperfect-information model

Both models imply that output deviates from its natural level

The models both yield the same short-run aggregate supply equation

$$Y = \overline{Y} + \alpha(P - EP), \quad \alpha > 0$$

The Sticky-Price Model

The **sticky-price** model emphasizes that suppliers do not instantly adjust their prices to changes in demand.

- We'll consider the pricing actions of a single firm

- We'll additionally depart from the notion of a competitive firm and say that firms have some pricing power

Consider the pricing decision faced by a single firm. The firm's desired price depends on two variables:

- The overall level of prices P

- The level of aggregate income Y

We write the firm's desired price p as

$$p = P + a(Y - \overline{Y}) \tag{1}$$

where a measures firm's responsiveness to aggregate output

Assume there are two types of firms:

1. Those with flexible prices. i.e. they set their prices according to (1)

2. Those with sticky prices. i.e. they announce their prices in advance based on their expectation of economic conditions.

Firms with sticky prices set their prices according to

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

For simplicity, we'll assume the second term is zero, so we're left with

$$p = EP$$

We can derive the aggregate supply equation from the pricing rules of the two groups of firms. Suppose s is the fraction of firms with sticky prices and $1 - s$ is the fraction of firms with flexible prices, then the price level is

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

subtract $(1 - s)P$ from both sides

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

and then divide both sides by s to solve for the overall price level

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

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We can interpret the two terms as follows:

- When firms expect a high price level, they expect high costs

- When output is high, the demand for goods is high

We can rearrange the pricing equation and get the aggregate supply equation as well,

$$Y = \overline{Y} + \alpha(P - EP) \tag{2}$$

The Imperfect-Information Model

The **imperfect-information** model allows all prices to adjust. Differences in short-run and long-run aggregate supply arise due to temporary misperceptions about prices.

- Each supplier produces a single good and consumes many goods

- The number of goods is large, so the supplier cannot observe all prices

- They monitor the price of what they produce most closely

- Because of this, they sometimes confuse changes in the overall level of prices with changes in the relative level

Consider an asparagus farmer,
- they earn income through selling asparagus and use that income to buy goods
    - If the relative price is high, the farmer is motivated to work hard and produce more
    - If the relative price is low, the farmer will opt for additional leisure time

- The farmer, however, observes the nominal, not relative, price

- Instead, he estimates the relative price using the nominal price of asparagus and his expectation of the price level for the economy

Consider how the farmer responds if all prices in the economy, including the price of asparagus increase.
- One possibility is that he expected the change in prices
    - He does not work any harder

- Another is he did not expect the price level to increase or at least not as much
    - He is not sure whether all prices have increased or just asparagus
    - The rational farmer likely assumes a little bit of both

The imperfect-information model says that when actual prices exceed expected prices, suppliers raise their output. Thus, the aggregate supply equation takes the form

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

International Differences in the Aggregate Supply Curve

One of the implications of the imperfect-information model is that the slope of the aggregate supply curve should depend on the volatility of aggregate demand.

- In countries where AD fluctuates wildly, so will prices
    - These movements will not reflect changes in relative price
    - The AS will be relatively steep

- In countries where AD is relatively stable, most price changes will be relative
    - Suppliers will be more responsive to price changes
    - the AS curve will be relatively flat

- Does the relationship hold?

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- Does the relationship hold?
    - In general, yes

Implications

Both of our previous models can be summarized by the aggregate supply equation,

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

If the price level is higher than the expected price level, output exceeds its natural level. If the price level is lower than the expected level, output falls short of its natural level.

The Short-Run Aggregate Supply Curve

Price level, P

Income, output, Y

Long-run aggregate supply

$P>EP$

$P=EP$

$P<EP$

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

Short-run aggregate supply
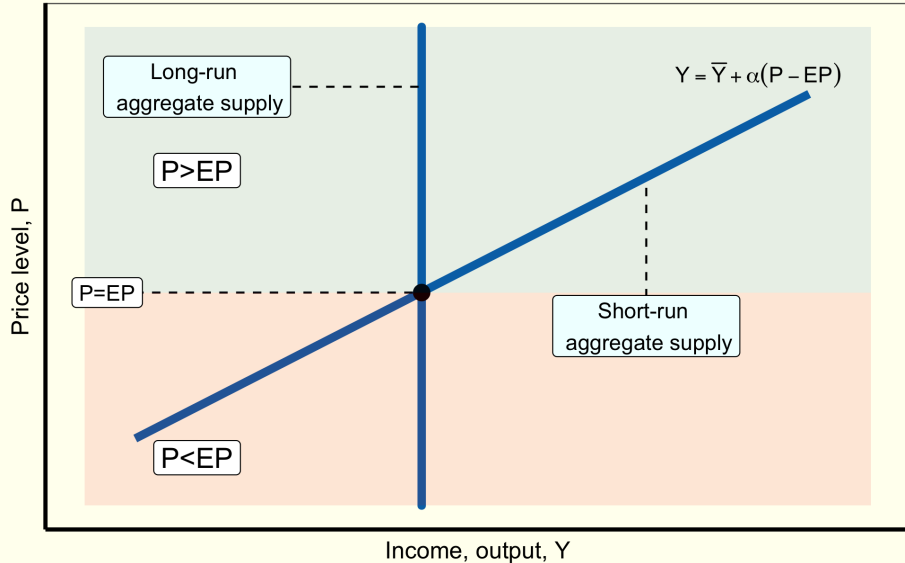
How Shifts in AD Lead to Short-Run Fluctu
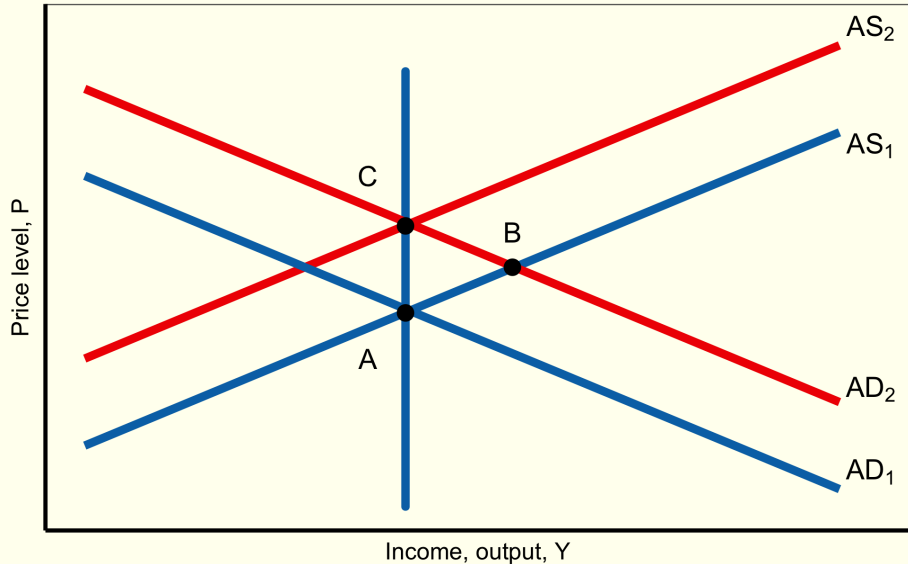
Inflation, Unemployment, and the Phillips Curve

Two goals of economic policymakers are

- Low Unemployment

- Low Inflation

However, thes goals often conflict. The previous graph demonstrates this tradeoff. We'll discuss the *Phillips curve* in terms of how the aggregate supply curve characterizes it.

Deriving the Phillips Curve From the Aggregate Supply Curve

The **Phillips curve** states that the inflation rate depends on three forces:
- expected inflation

- *cyclical unemployment*, the deviation of unemployment from the natural rate

- supply shocks

Combined, they are expressed as

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

$$\text{Inflation} = \text{Expected Inflation} - \left(\beta \times \text{Cyclical Unemployment}\right) + \text{Supply Shock}$$

Where Does This Equation Come From?

We can derive it from the aggregate supply equation

$$P = EP + (1/\alpha)(Y - \overline{Y})$$

Add to the right side ν to represent exogenous changes (e.g. an oil shock)

$$P = EP + (1/\alpha)(Y - \overline{Y}) + \nu$$

Now, we move from the price level to inflation rates by subtracting last periods prices from both sides

$$(P - P_{-1}) = (EP - P_{-1}) + (1/\alpha)(Y - \overline{Y}) + \nu$$

We can tidy the former

$$\pi = E\pi + (1/\alpha)(Y - \overline{Y}) + \nu$$

One's version of Okun's law states that the deviation of output from its natural level is inversely related to the deviation of unemployment from its natural rate. We can write this as

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

We'll replace the devation in output with Okun's law

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

All of this is to say that the Phillips curve and AS equation represent the same macroeconomic phenomena.

History of the Modern Phillips Curve

The Phillips curve is named after A.W. Phillips, the man who discovered the relationship. The modern Phillips curve differs from the traditional Phillips curve in three ways:

- Wage inflation is observed instead of price inflation
- Modern curve includes expected inflation
- Includes supply shocks
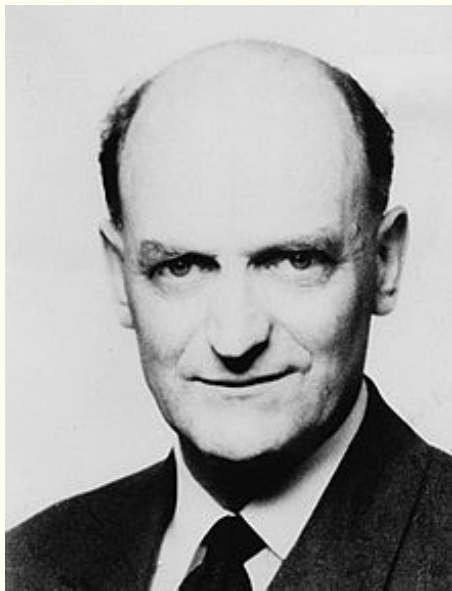
Adaptive Expectations and Inflation Inertia

We need to specify what determines expected inflation. In general **adaptive expectations**, people form expectations based on previous inflation.

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

which, in turn, gives us

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

The natural rate of unemployment, in this form, is called the non-accelerating inflation rate of unemployment.
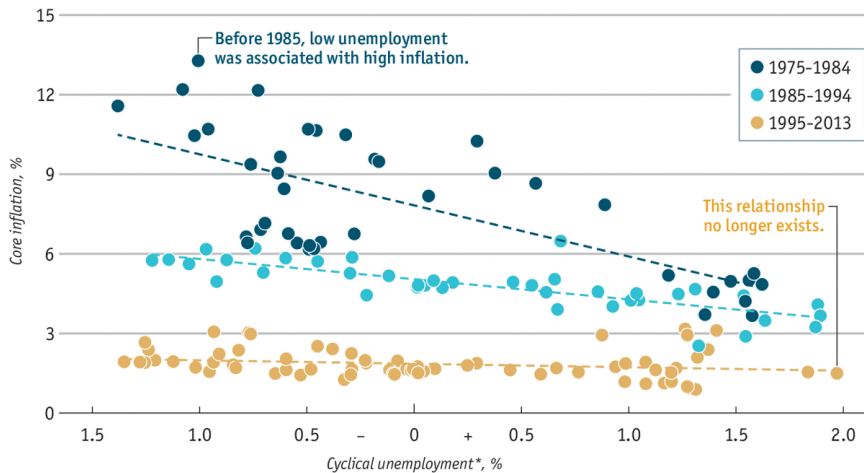
Two Causes of Rising and Falling Inflation

The second and third terms of the Phillips curve equation show the two forces that can change the rate of inflation.

- Low (high) unemployment pulls the inflation rate up (down). i.e it accelerates inflation
  - This is called **demand-pull inflation**

- Supply shocks increase or decrease the rate of inflation
  - Inflation caused by an adverse shock is called **cost-push inflation**

Flatlining

Inflation and cyclical unemployment, average across advanced economies, quarterly

Core inflation, %

Before 1985, low unemployment was associated with high inflation.

This relationship no longer exists.

- 1975-1984
- 1985-1994
- 1995-2013

Cyclical unemployment*, %

Sources: OECD; IMF

*Actual unemployment minus the "natural" rate of unemployment

The Short Run Tradeoff Between Inflation and Unemployment

Consider the options the Phillips curve gives to a policymaker who can influence aggregate demand with monetary or fiscal policy.
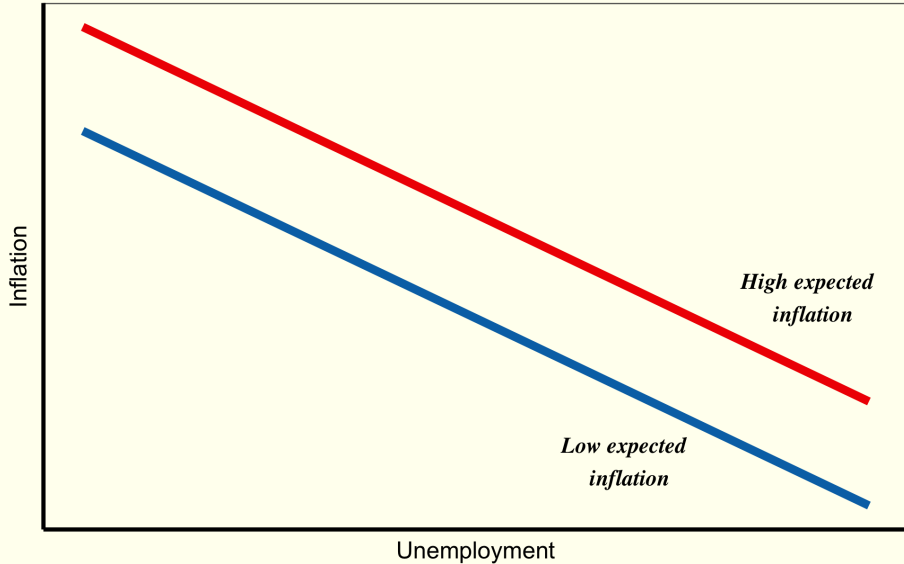- They have no control over inflation nor over supply shocks
- Expanding AD will reduce unemployment raising inflation
- Depressing AD will reduce inflation raising unemployment

β determines inflation's responsiveness to unemployment

The Short-Run Tradeoff Between Inflation
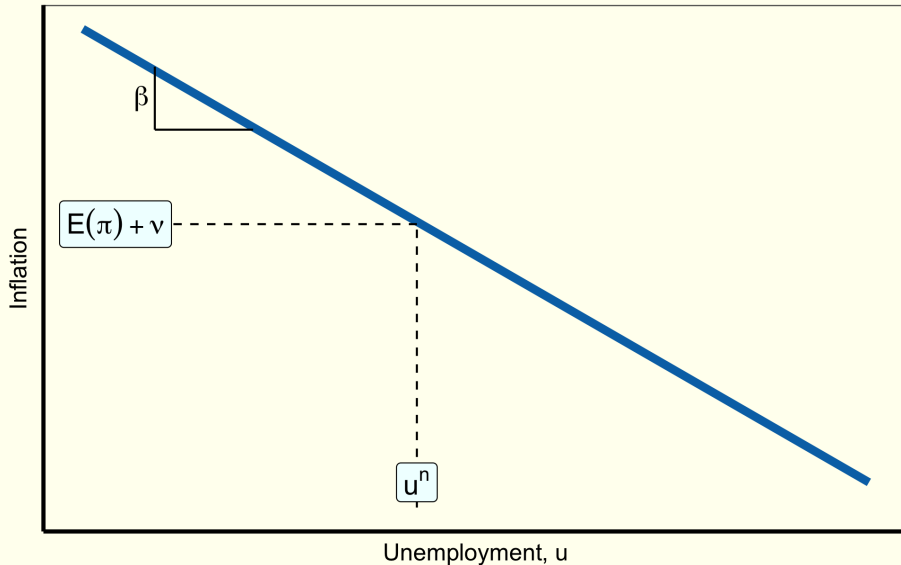
Shifts in the Short-Run Tradeoff

Disinflation and the Sacrifice Ratio

Suppose unemployment is at its natural rate and inflation is at 6 percent. What would happen to output and unemployment if the central bank pursued a policy to lower inflation to 2 percent?

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- In the absence of a beneficial supply shock, the economy experiences a period of high unemployment and reduced output.

Disinflation and theSacrifice Ratio

But by how much and for how long would unemployment need to rise above the natural rate?

We can alternatively translate the sacrifice ratio in terms of unemployment.
- Okun´s law says that a one percentage point change in unemployment changes GDP by 2 percentage points

- Then reducing inflation by 1 percentage point requires about 2.5 percentage points of cyclical unemployment

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- There are several estimates of the sacrifice ratio but the typical estimate is 5.

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Rational Expectations and the Possibility of Painless Disinflation

An alternative to rational expectations is **rational expectations**, people optimally use all of the available information in order to forecast the future. Thomas Sargent relays this as

- Inflation doesn't have inherent *inertia*

- Workers strike inflationary bargains because of their beliefs about monetary and fiscal policies

- Thus inflation is caused by long-term government policy

- Stopping inflation involves credible commitments from policymakers

An Extreme Case of Rational Expectations

One case of ending inflation comes near costlessly. A painless disinflation has two requirements:

- The plan to reduce inflation must be announced before workers and firms set their wage and price expectation

- Workers and firms must believe the announcement

The Sacrifice Ratio in Practice: Unemployment During the Volcker Disinflation

From 1981–1985 inflation fell 6.1 percentage points because of tight monetary policies by the Fed during the Volcker administration.

Year	u	u^n	$u - u^n$
1982	9.7%	6.0 %	3.7 %
1983	9.6	6.0	3.6
1984	7.5	6.0	1.5
1985	7.2	6.0	1.2
			Total 10.0%

Using the cumulative cyclical unemployment and Okun law, we find that 20.0 percentage points of GDP were lost during the disninflation

20.0/6.1 implies that the Volcker disinflation had a sacrifice ratio of 3.3

Hysteresis and the Challenge to the Natural Rate Hypothesis

The **natural rate hypothesis** states

Fluctuations 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.

Some economists challenge that aggregate demand affects output even in the long run.

Hysteresis is the term used to decribe the long-lasting influence of history on the natural rate.

Hysteresis

Why might a recession have enduring impacts?

- Workers might lose valuable job skills when unemployed

- Long periods of unemployment might affect a worker's attachment to the labor force

- The unemployed lose influence in the wage setting process
    - *Insiders* becoming *outsiders*

Hysteresis may be an alternative explanation to explain the decline in the employment-to-population ratio after the Great Recession.

Conclusion

- According to both the sticky-price model and the imperfect information model, output rises to above its natural level because prices exceed expectations

- The Phillips curve expresses the short-run tradeoff between inflation and unemployment

- Inflation has inertia if it depends on previously observed inflation. It is not inert if people have rational expectations

- The natural-rate hypothesis is generally accepted amongst economists. Hysteresis has gained some traction and may partially explain the current slow recovery.

IS-LM Review

Monetary policy and fiscal policy often change at the same time.

- Suppose that the government wants to raise investment but keep output constant. In the IS-LM model what mix of monetary and fiscal policy will achieve this goal?

IS-LM Review

Monetary policy and fiscal policy often change at the same time.

- In the early 1980s, the U.S. government cut taxes and ran a budget deficit while the Fed pursued a tight monetary policy. What effect should this policy mix have?