Aggregate Supply and the Phillips Curve

Chapter 8

In this chapter we further develop the aggregate supply side of the economy. Here, we begin to examine the dynamic adjustment process that carries us from the short run to the long run.

The price-output relation along the aggregate supply curve is built up from the links among wages, prices, employment, and output. The link between unemployment and inflation is called the Phillips curve. We translate between unemployment and output and also translate between inflation and price changes.

Inflation and Unemployment

- Phillips curve (PC) shows the relationship between unemployment and inflation
  - Although GDP is linked to unemployment, it is easier to work with the PC than the AS when discussing unemployment

The Phillips Curve

- In 1958 A.W. Phillips published a study of wage behavior in the U.K. between 1861 and 1957
- The main findings are summarized in Figure 8.2
  - → There is an inverse relationship between the rate of unemployment and the rate of increase in money wages
  - → From a policymaker's perspective, there is a tradeoff between wage inflation and unemployment

The PC shows the rate of growth of wage inflation decreases with increases in unemployment

- If W_t = wage this period
  W_{t+1} = wage next period
  g_w = rate of wage inflation, then

$$g_w = \frac{W_{t+1} - W_t}{W_t} \qquad (1)$$

If μ^* represents the natural rate of unemployment, the simple PC is defined as:

$$g_w = -\varepsilon(\mu - \mu^*) \qquad (2)$$

where ε measures the responsiveness of wages to unemployment

- Wages are falling when $\mu > \mu^*$ and rising when $\mu < \mu^*$
- $(\mu - \mu^*)$ is called the unemployment gap

- Suppose the economy is in equilibrium with prices stable and unemployment at the natural rate
  - If money supply increases by 10%, wages and prices both must increase by 10% for the economy to return to equilibrium
  - PC shows:
    - If wages increase by 10%, unemployment will have to fall
    - If wages increase, price will increase and the economy will return to the full employment level of output and unemployment

- To see why this is so, rewrite equation (1) in terms of current and past wage levels:

$$\frac{W_{t+1} - W_t}{W_t} = -\varepsilon(\mu - \mu^*)$$

$$W_{t+1} - W_t = W_t(-\varepsilon(\mu - \mu^*))$$

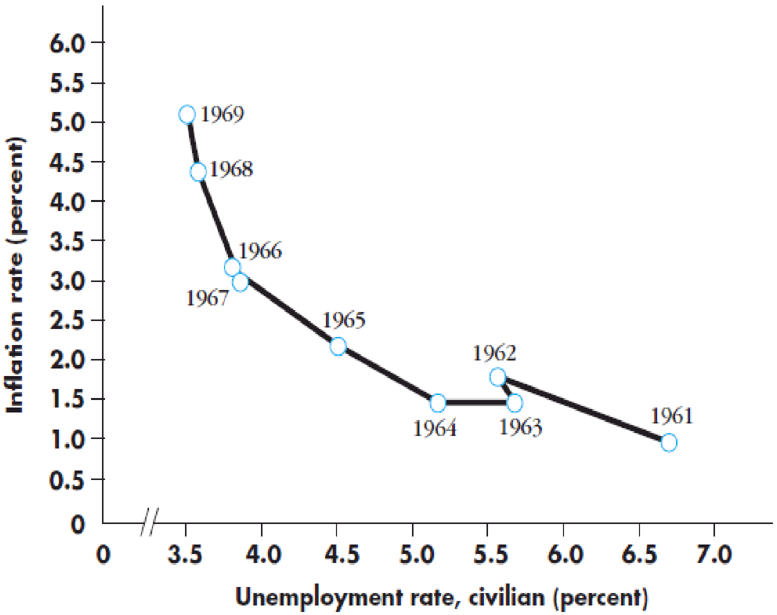
$$W_{t+1} = W_t(-\varepsilon(\mu - \mu^*)) + W_t \quad \text{(2a)}$$

$$W_{t+1} = W_t[1 - \varepsilon(\mu - \mu^*)]$$

$\rightarrow$ *For wages to rise above previous levels, u must fall below the natural rate*

The Policy Tradeoff

- PC quickly became a cornerstone of macroeconomic policy analysis since it suggests that policy makers could choose different combinations of u and Π rates
  - Can choose low u if willing to accept high Π (late 1960's)
  - Can maintain low Π by having high u (early 1960's)
- In reality the tradeoff between u and Π is a short run phenomenon
  - Tradeoff disappears as AS becomes vertical



The Inflation Expectations-Augmented Phillips Curve

The expectations-augmented Phillips curve introduces adaptive expectations into the Phillips curve.

Adaptive expectation models are ways of predicting an agent's behaviour based on their past experiences and past expectations for that same event. They are first used by Irving Fisher in his book "The Purchasing Power of Money", 1911, and further developed in the 1940s and 1950s, especially by Phillip Cagan in his article "The Monetary Dynamics of Hyper-Inflation", 1956 and, most famously, by Milton Friedman in 1957, in his book "A Theory of the Consumption Function".

Models are usually based around the following formula:

$$E_t x_{t+1} = E_{t-1} x_t + \lambda(x_t - E_{t-1} x_t)$$

$$E_t x_{t+1} = E_{t-1} x_t + \lambda(x_t - E_{t-1} x_t)$$

$E_t x_{t+1}$ is our expectation (E) in year t for a variable x in the year $t+1$. It is based on our expectation from the year before ($t-1$) for variable x in our current year, and a weighted proportion of our past expectations. Remember that our expectations from last year were, in turn, based on those of the year before, so all our expectations from the first time we ever dared assume anything are contained within the equation.

- Figure 8-4 shows the behavior of Π and u in the US since 1960 → does not fit the simple PC story
  - Individuals are concerned with standard of living, and compare wage growth to inflation
  - *If wages do not "keep up" with inflation, standard of living falls*
  - Individuals form expectations as to what Π will be over a particular period of time, and use in wage negotiations (Π^e)
- Rewrite (2) to reflect this as:

$$(g_w - \Pi^e) = -\varepsilon(\mu - \mu^*) \quad (3)$$

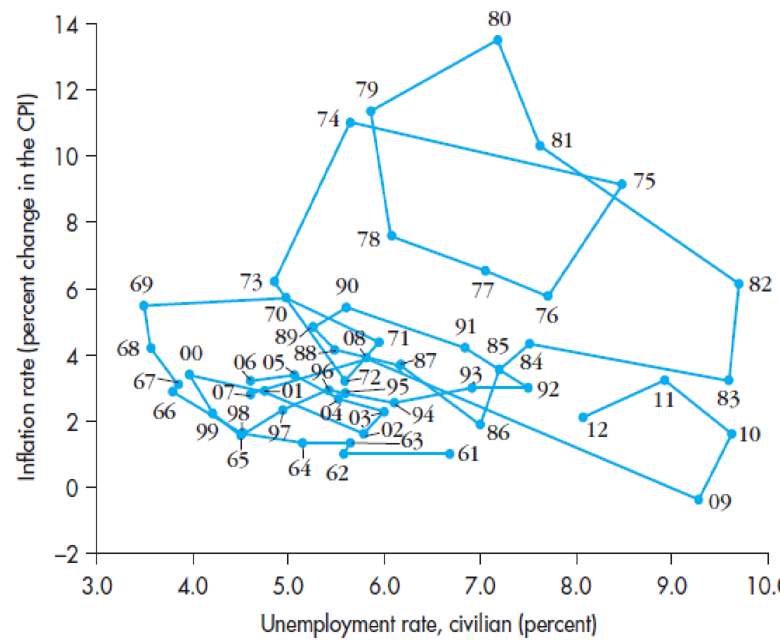


FIGURE 6-4 RELATIONSHIP OF INFLATION AND UNEMPLOYMENT: UNITED STATES, 1961–2012.

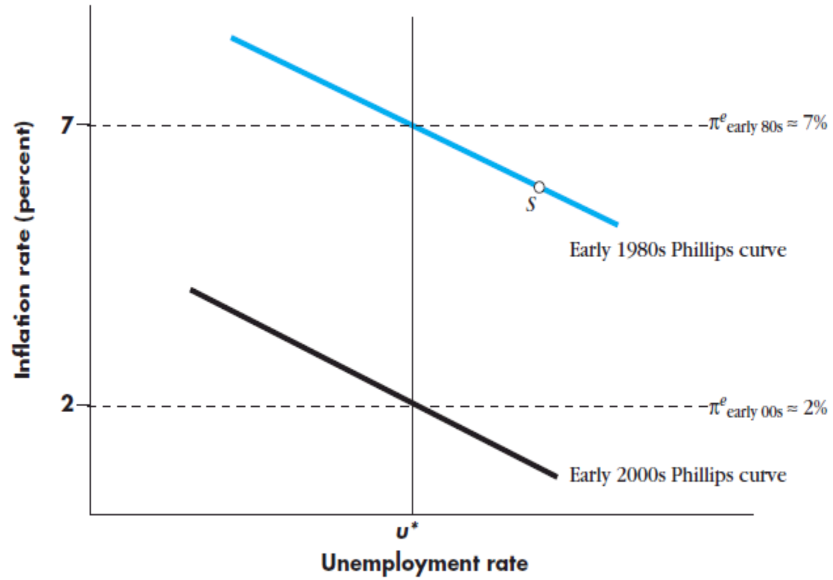
- If maintaining the assumption of a constant real wage, W/P, actual Π will equal wage inflation
- The equation for the modern version of the PC, the expectations augmented PC, is:

$$
\begin{aligned}
&(g_w - \Pi^e) = -\varepsilon(\mu - \mu^*) \Rightarrow \\
&(\Pi - \Pi^e) = -\varepsilon(\mu - \mu^*) \Rightarrow \\
&\Pi = \Pi^e - \varepsilon(\mu - \mu^*)
\end{aligned}
\qquad (4)
$$

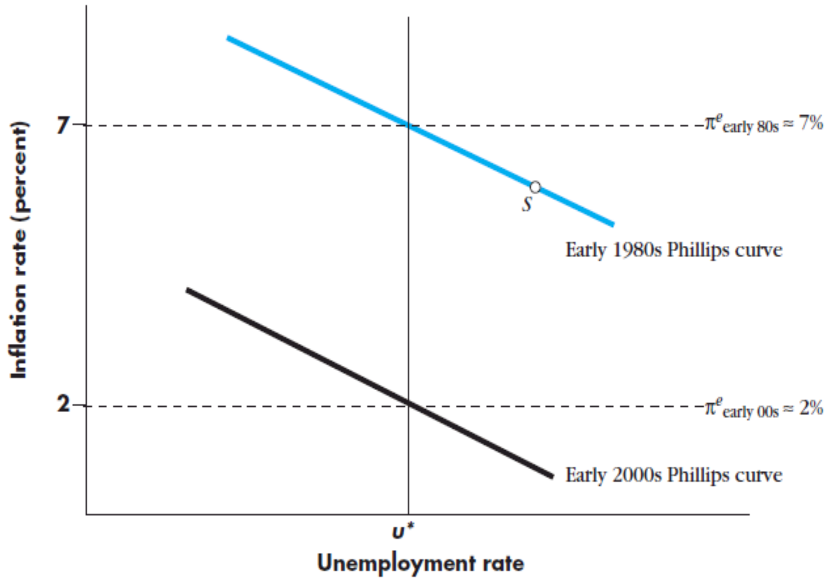
NOTE:

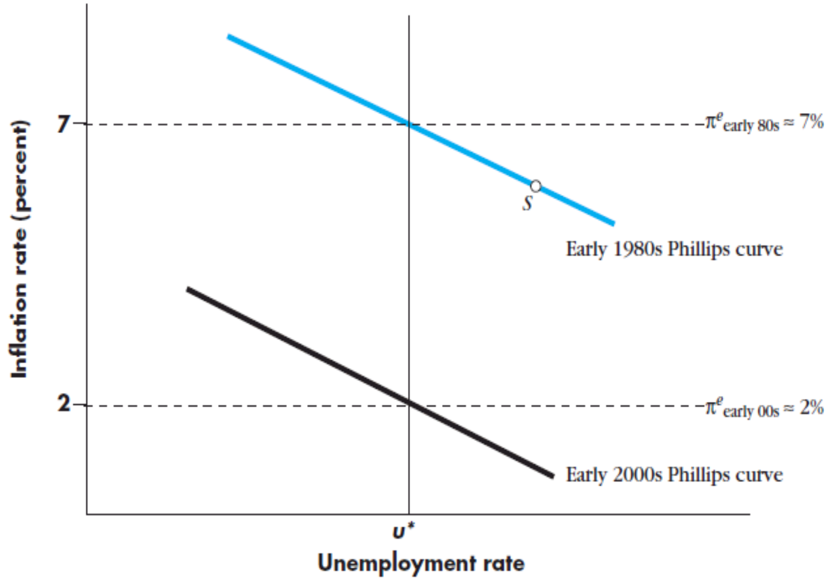
1. Π^e is passed one for one into actual Π
2. u = u* when $\Pi^e = \Pi$(Unemployment is at the natural rate when actual inflation equals expected inflation.)

- The modern PC intersects the natural rate of u at the level of expected inflation
- Figure 8-5 illustrates the inflation expectations-augmented Phillips curve for the 1980s and early 2000
- The height of the SRPC depends upon Π^e



- Changes in expectations <u>shifts</u> the curve up and down
  - The role of Π^e adds another automatic adjustment mechanism to the AS side of the economy
- When high AD moves the economy up and to the left along the SRPC, Π results
  - if persists, people adjust their expectations upwards, and <u>move to higher SRPC</u>





The curves have two properties you should note.

- First, the curves have the same short-run tradeoff between unemployment and inflation; that is to say, the slopes are equal.
- Second, in the early 2000s full employment was compatible with roughly 2 percent annual inflation; in the early 1980s full employment was compatible with roughly 7 percent inflation.

The height of the short-run Phillips curve, the level of expected inflation, moves up and down over time in response to the changing expectations of firms and workers.

The role of expected inflation in moving the Phillips curve adds another automatic adjustment mechanism to the aggregate supply side of the economy. When high aggregate demand moves the economy up and to the left along the short-run Phillips curve, inflation results. If the inflation persists, people come to expect inflation in the future (rises) and the short-run Phillips curve moves up.

- After 1960, the original PC relationship broke down
- *How does the augmented PC hold up?*
- To test the augmented PC, need a measure of Π^e → best estimate is last period's inflation, $\Pi^e = \Pi_{t-1}$
- Figure 8-6 illustrates the augmented PC using the equation:

$$\Pi - \Pi^e \approx \Pi - \Pi_{t-1} = -\varepsilon(u - u^*)$$

→ *Appears to work well in most periods*

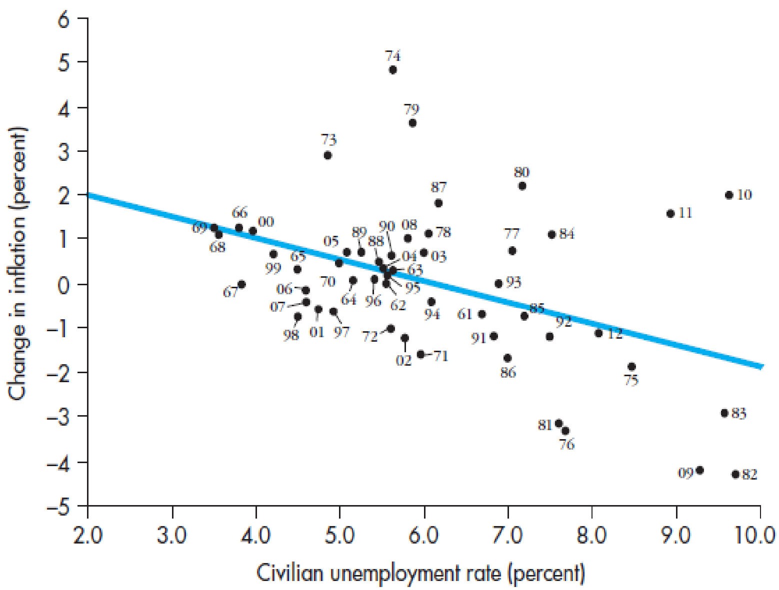
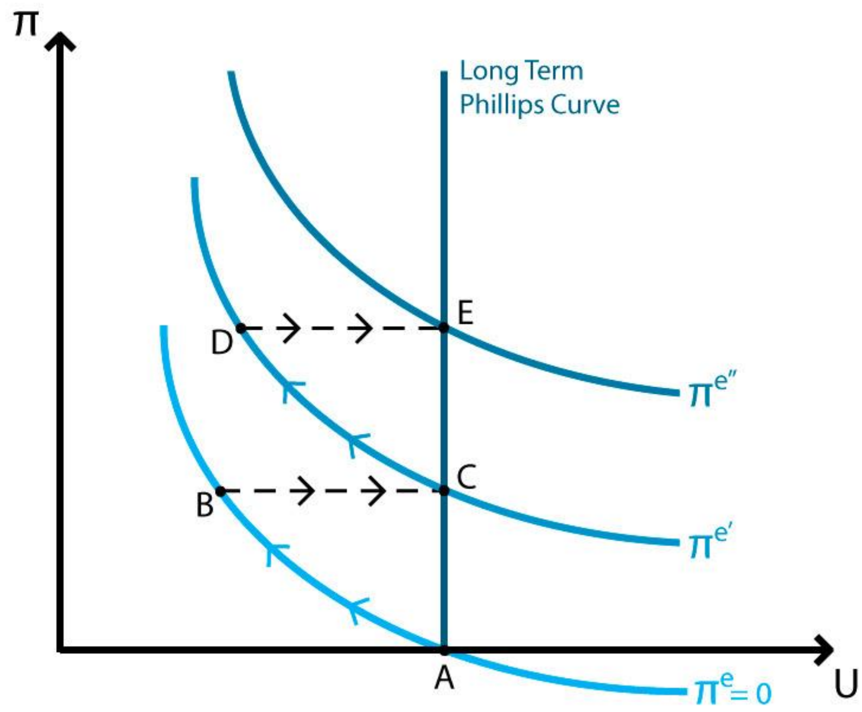
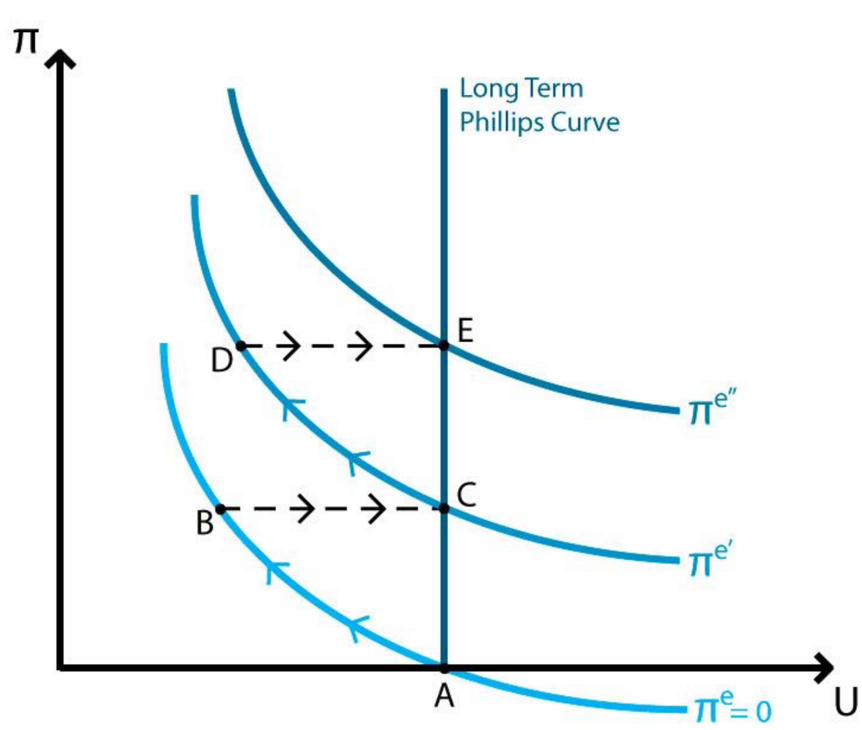


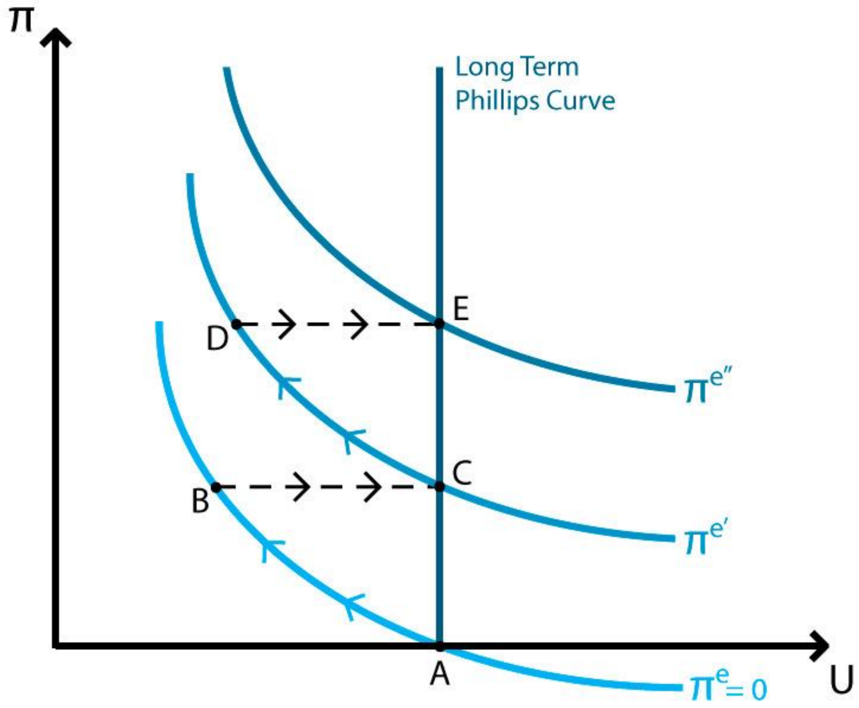
FIGURE 6-6 RELATIONSHIP OF CHANGES IN INFLATION AND UNEMPLOYMENT RATES.



Initially, unemployment and inflation are at point A. The government decides to embark on an expansionist monetary policy, which floods the markets with inexpensive credit, incentivizing consumption. Expectations shift to point B along the Phillips curve: unemployment is reduced through economic stimulus with a trade off in the form of inflation.



However, after a short period, agents will begin to associate expansionist policies with inflation, which means a drain on their resources, and they will push for higher wages. This will stop the consumption stimulus and also deincentivise hiring. Eventually, agents will shift their expectations curves to point C.

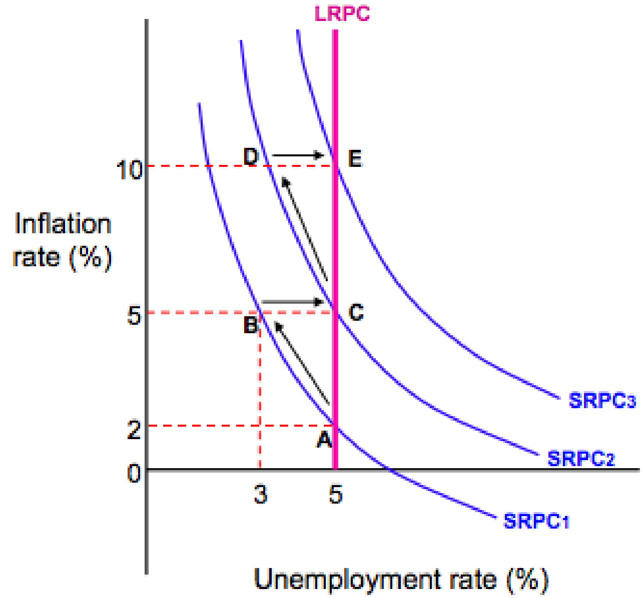


A second time around, D will be achieved, leading more or less rapidly to point E. This is why, in the long term, inflation has little effect on unemployment and vice versa. Expansionist monetary policy will lead directly to inflation, with no permanent effect on unemployment.

Explain the other way: Adaptive Expectations:

The theory of adaptive expectations states that individuals will form future expectations based on past events. For example, if inflation was lower than expected in the past, individuals will change their expectations and anticipate future inflation to be lower than expected.

To connect this to the Phillips curve, consider. Assume the economy starts at point A at the natural rate of unemployment with an initial inflation rate of 2%, which has been constant for the past few years. Accordingly, because of the adaptive expectations theory, workers will expect the 2% inflation rate to continue, so they will incorporate this expected increase into future labor bargaining agreements. This way, their nominal wages will keep up with inflation, and their real wages will stay the same.



Now assume that the government wants to lower the unemployment rate. To do so, it engages in expansionary economic activities and increases aggregate demand. As aggregate demand increases, inflation increases. Because of the higher inflation, the real wages workers receive have decreased. Although the workers' real purchasing power declines, employers are now able to hire labor for a cheaper real cost. Consequently, employers hire more workers to produce more output, lowering the unemployment rate and increasing real GDP. On, the economy moves from point A to point B. However, workers eventually realize that inflation has grown faster than expected, their nominal wages have not kept pace, and their real wages have been diminished. They demand a 4% increase in wages to increase their real purchasing power to previous levels, which raises labor costs for employers. As labor costs increase, profits decrease, and some workers are let go, increasing the unemployment rate. Graphically, the economy moves from point B to point C.

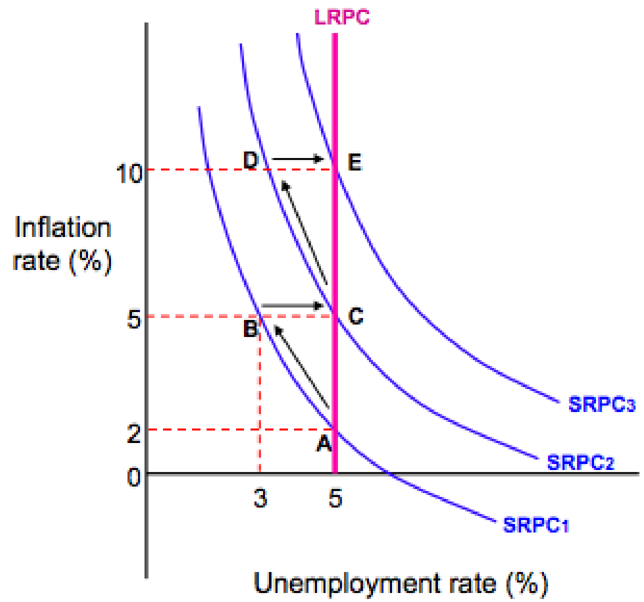
This example highlights how the theory of adaptive expectations predicts that there are no long-run trade-offs between unemployment and inflation. In the short run, it is possible to lower unemployment at the cost of higher inflation, but, eventually, worker expectations will catch up, and the economy will correct itself to the natural rate of unemployment with higher inflation.

OVERVIEW

- A version of the Phillips curve, relating wage increases to demand pressure, taking account of expected inflation. If the expected rate of price increases is given, the Phillips curve shows wage increases as a decreasing function of the unemployment rate, or an increasing function of demand pressure.
- Wage increases lead to price increases, so actual inflation is an increasing function of demand pressure.
- If the expected inflation rate did not respond, and the Phillips curve stayed the same from period to period, it would be possible by the use of monetary or fiscal measures to expand demand to get permanently higher employment at the price of accepting a higher rate of inflation.
- The expectations-augmented Phillips curve assumes that if actual inflation rises, expected inflation will also increase, and the Phillips curve will move upwards so as to give the same expected real wage increase at each employment level.
- Under this model there is no long-run trade-off between unemployment and inflation. To achieve an unemployment rate below the non-accelerating inflation rate of unemployment would involve an ever-increasing rate of inflation.
- This is thought to be undesirable, since while moderate rates of inflation may do relatively little harm, hyperinflation seriously interferes with the efficient running of the real economy by impairing the economic functions of money.

Rational Expectations

The theory of rational expectations states that individuals will form future expectations based on all available information, with the result that future predictions will be very close to the market equilibrium. For example, assume that inflation was lower than expected in the past. Individuals will take this past information and current information, such as the current inflation rate and current economic policies, to predict future inflation rates.



As an example of how this applies to the Phillips curve, consider again. Assume the economy starts at point A, with an initial inflation rate of 2% and the natural rate of unemployment. However, under rational expectations theory, workers are intelligent and fully aware of past and present economic variables and change their expectations accordingly. They will be able to anticipate increases in aggregate demand and the accompanying increases in inflation. As such, they will raise their nominal wage demands to match the forecasted inflation, and they will not have an adjustment period when their real wages are lower than their nominal wages. Graphically, they will move seamlessly from point A to point C, without transitioning to point B.

In essence, rational expectations theory predicts that attempts to change the unemployment rate will be automatically undermined by rational workers. They can act rationally to protect their interests, which cancels out the intended economic policy effects. Efforts to lower unemployment only raise inflation.

Rational Expectations

- The augmented PC predicts that actual Π will rise above Π^e when u < u$^* \rightarrow$ So why don't individuals quickly adjust their expectations to match the model's prediction?
  - The PC relationship relies on people being *WRONG* about Π in a very predictable way
  - If people learn to use $\Pi = \Pi^e - \varepsilon(\mu - \mu^*)$ (4) to predict Π, Π^e should always equal Π, and thus u = u*
- Robert Lucas modified the model to allow for *mistakes*
  - He argued that a good economics model should not rely on the public making easily avoidable mistakes
  - So long as we are making predictions based on information available to the public, then the values we use for Π^e should be the same as the values the model predicts for Π
  - <u>Surprise</u> shifts in AD will change u, but <u>predictable</u> shifts will not

Rational Expectations

- The argument over rational expectations is as follows:
  - The usual macroeconomic model takes the height of the PC as being pegged in the SR by Π^e, where Π^e is set by historical experience
  - The rational expectations model has the SRPC floating up and down in response to available information about the near future
    - Individuals use new information to update their expectations
- Both models agree that if money growth were permanently increased, the PC would shift up in the LR, and Π would increase with no LR change in u
  - The RE model states that this change is instantaneous, while the traditional model argues that the shift is gradual

The Wage-Unemployment Relationship and Sticky Wages

- In neoclassical theory of supply, wages adjust instantly to ensure that output always at the full employment level, BUT output is <u>not</u> always at the full employment level, and the PC suggests that wages adjust slowly in response to changes in u
- The key question in the theory of AS is *"Why does the nominal wage adjust slowly to shifts in demand?"* OR *"Why are wages sticky?"*
- Wages are sticky when wages move slowly over time, rather than being flexible, allowing for economy to deviate from the full employment level

The Wage-Unemployment Relationship and Sticky Wages

- To clarify the assumptions about wage stickiness, translate (3) into a relationship between g_w and the level of employment:

$$(g_w - \Pi^e) = -\varepsilon(\mu - \mu^*) \qquad (3)$$

If N^* = full employment level of employment

N = actual level of employment

u = share of N^* that is not employed, then

$$\mu - \mu^* = \frac{N^* - N}{N^*} \qquad (5)$$

- Substitute (5) into (3) we have the PC relationship between E, Π^e, and g_w:

$$g_w - \Pi^e = \frac{W_{t+1} - W_t}{W_t} - \Pi^e = -\varepsilon\left(\frac{N^* - N}{N^*}\right) \qquad (2b)$$

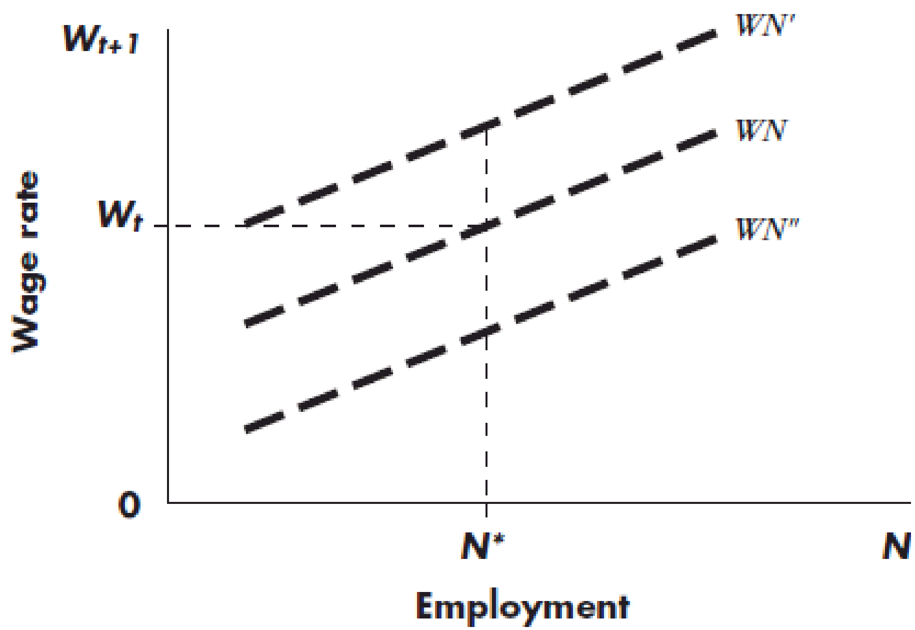
The Wage-Unemployment Relationship and Sticky Wages

$$g_w - \Pi^e = \frac{W_{t+1} - W_t}{W_t} - \Pi^e = -\varepsilon\left(\frac{N^* - N}{N^*}\right) \quad (2b)$$

- The wage next period is equal to the wage that prevailed this period, but with an adjustment for the level of employment and π^e
  - At full employment, $N^* = N$, this period's wage equals last period's, plus an adjustment for π^e
  - If $N > N^*$, the wage next period increases above this period's by more than π^e since $g_w - \pi^e > 0$

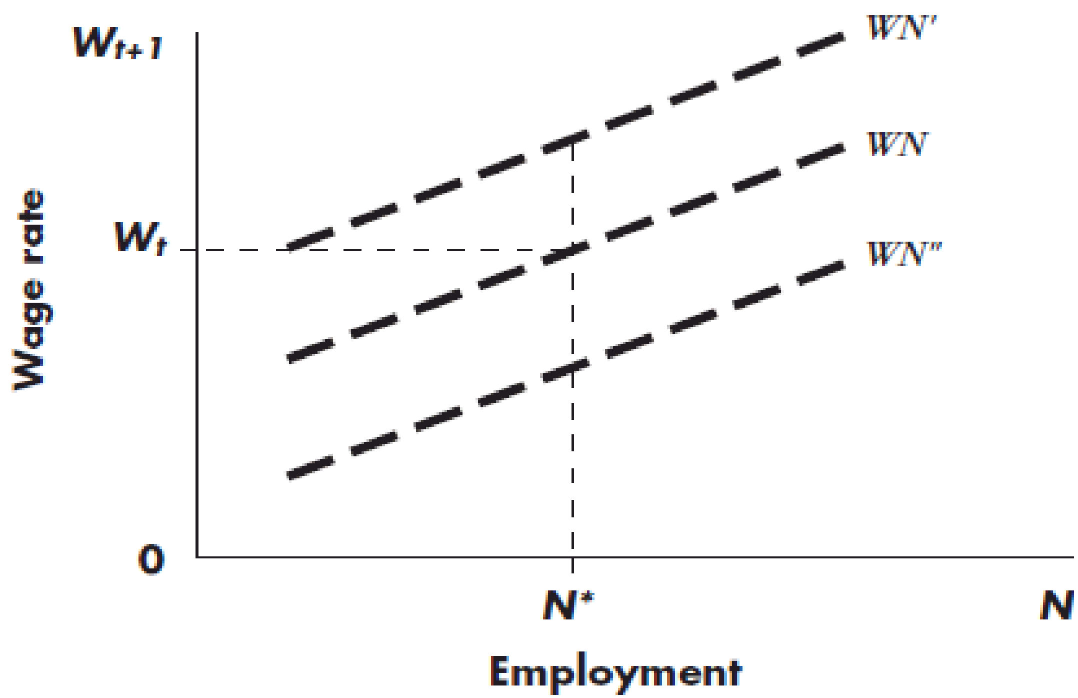
The Wage-Unemployment Relationship and Sticky Wages

- Figure 8-7 illustrates the wage-employment relationship, WN
- The extent to which the wage responds to E depends on the parameter ε
- If ε is large, u has large effects on wages and the WN line is steep



- The PC relationship also implies WN relationship shifts over time
- If there is over-employment this period, WN shifts up to WN’
- If there is less than full employment this period, WN curve shifts down to WN’’

→ <u>*Result*</u>*: Changes in AD that alter the u this period will have effects on wages in subsequent periods*



- Each school of thought has to explain why there is a PC, or the reasons for wage and price stickiness

  Examples of such explanations for wage and price stickiness include:

  1. Imperfect information
     - Friedman and Phelps
     - In the context of clearing markets
  2. Coordination problems
     - Focus on the process by which firms adjust their prices when demand changes
  3. Efficiency wages and costs of price changes
     - Focus on wage as a means of motivating labor

- Explanation of wage stickiness builds upon mentioned theories and one central element $\rightarrow$ the labor market involves long-term relationships between firms and workers
  - Working conditions, including the wage, are renegotiated periodically, but not frequently, due to the costs of doing so
- At any time, firms and workers agree on a wage schedule to be paid to currently employed workers
  - If demand for labor increases and firms increase hours of work, in the SR wages rise along the WN curve
  - With demand up, workers press for increased wages, but takes time to renegotiate all wages (staggered wage-setting dates)
  - During the adjustment process, firms also resetting P to cover increased cost of production
    - Process of W and P adjustment continues until economy back at full employment level of output

From the Phillips Curve to the AS Curve

The transition from the PC to the AS curve requires four steps:

1. Translate output to employment
2. Link prices firms charge to costs
3. Use Phillips curve relationship between W and E
4. Combine 1-3 to derive upward sloping AS curve

<u>Translate output to employment</u>

- Close relationship between unemployment/employment and output in SR

- Okun's Law defines this relationship:

$$\frac{Y - Y^*}{Y^*} = -\omega(u - u^*) \tag{6}$$

- Estimate ω to be close to 2 → each point of u costs 2% points of GDP

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<u>Link prices to costs</u>

- Firms supply output at a price that at least covers costs of production
- Assuming N is the only cost of production, if each unit of N produces a units of output, the labor costs of production per unit is W/a
- Firms set price as a markup, *z*, on labor costs:

$$P = \frac{(1+z)W}{a} \qquad (7)$$

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<u>The Aggregate Supply curve</u>

- Combining (2b), (6), and (7) yields:

$$P_{t+1} = P_{t+1}^{e} + P_t \frac{\varepsilon}{\omega}\left(\frac{Y - Y^*}{Y^*}\right) \qquad (8)$$

- Often replace (8) with an approximate version:

$$P_{t+1} = P_{t+1}^{e}\left[1 + \lambda(Y - Y^*)\right] \qquad (9)$$

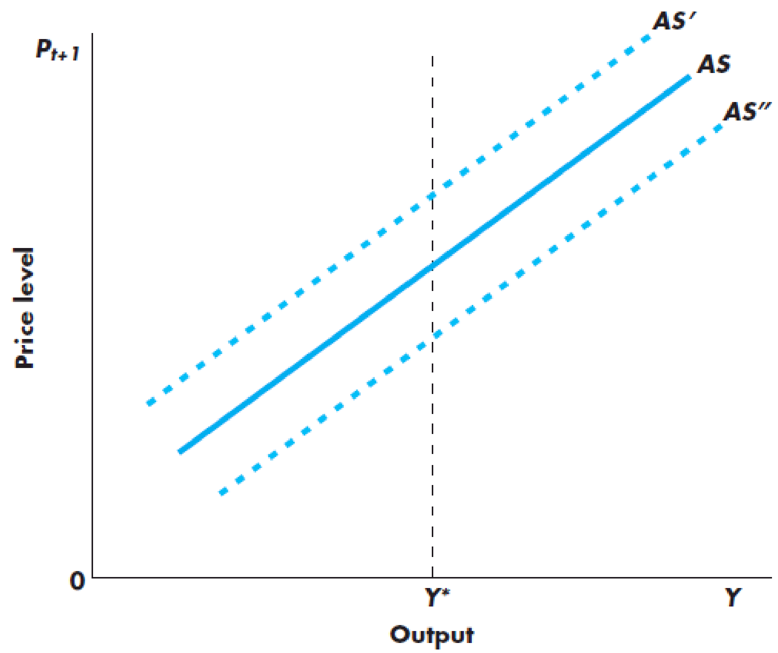
which is the equation for the aggregate supply curve

From the Phillips Curve to the AS Curve

$$P_{t+1} = P^e_{t+1}\left[1 + \lambda(Y - Y^*)\right]$$

- Figure 6-8 shows AS curve implied by equation (9)
  - If $Y > Y^*$, next period the AS curve will shift up to AS′
  - If $Y < Y^*$, next period AS will shift down to AS′′

<u>NOTE</u>: These are the same properties as the WN curve



Disinflation

Disinflation is a decline in the rate of inflation, and can be caused by declines in the money supply or recessions in the business cycle.

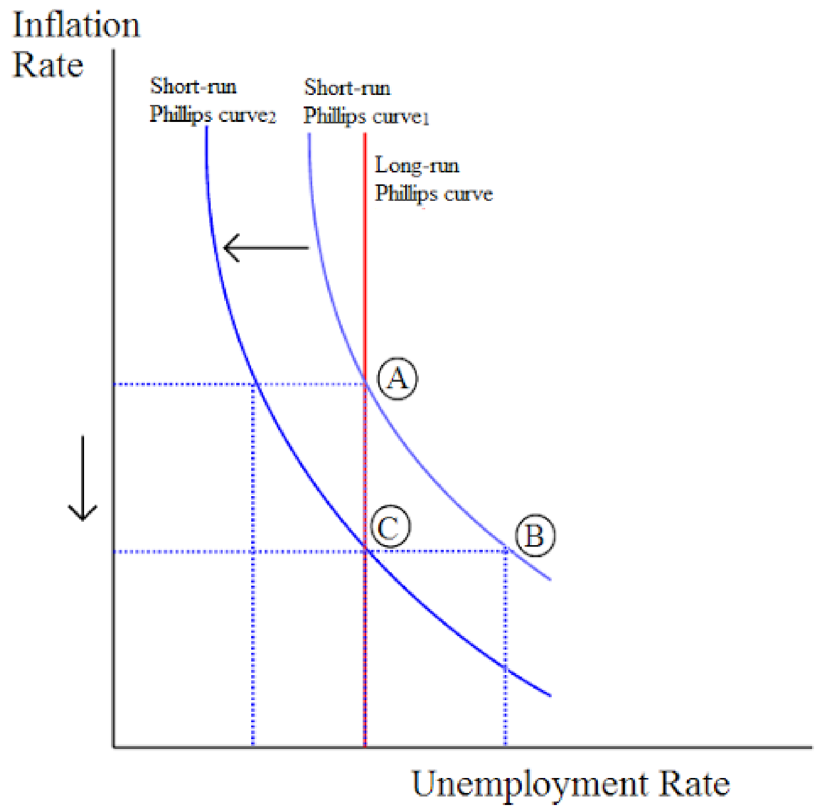
Inflation is the persistent rise in the general price level of goods and services. Disinflation is a decline in the rate of inflation; it is a slowdown in the rise in price level.

As an example, assume inflation in an economy grows from 2% to 6% in Year 1, for a growth rate of four percentage points. In Year 2, inflation grows from 6% to 8%, which is a growth rate of only two percentage points. The economy is experiencing disinflation because inflation did not increase as quickly in Year 2 as it did in Year 1, but the general price level is still rising. Disinflation is not to be confused with deflation, which is a decrease in the general price level.

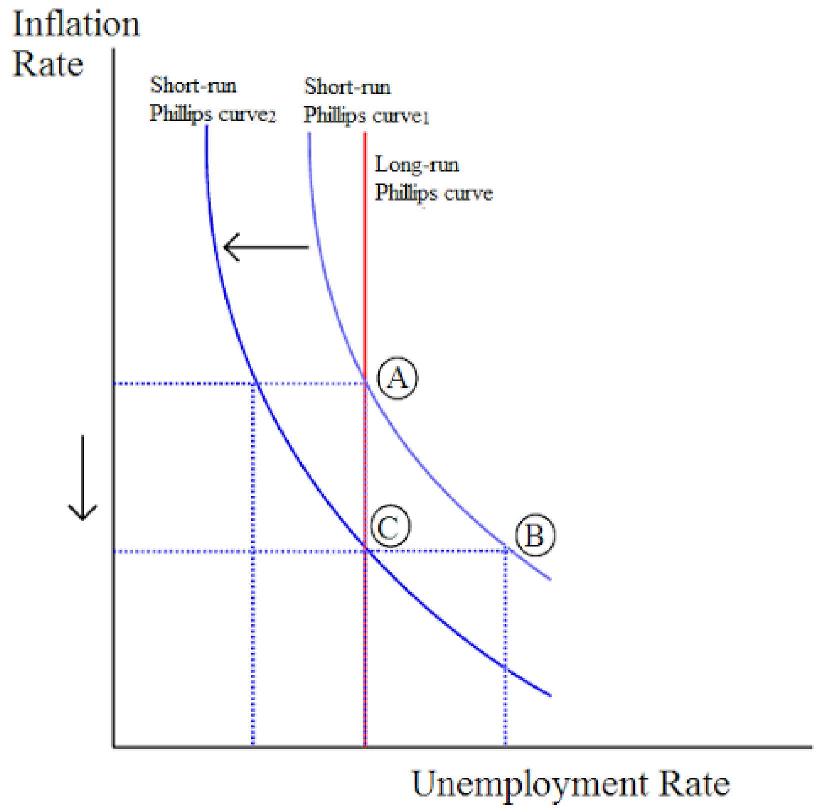
Disinflation can be caused by

- decreases in the supply of money available in an economy.
- It can also be caused by contractions in the business cycle, otherwise known as recessions.

The Phillips curve can illustrate this last point more closely.



Consider an economy initially at point A on the long-run Phillips curve in. Suppose that during a recession, the rate that aggregate demand increases relative to increases in aggregate supply declines. This reduces price levels, which diminishes supplier profits. As profits decline, employers lay off employees, and unemployment rises, which moves the economy from point A to point B on the graph.



Eventually, though, firms and workers adjust their inflation expectations, and firms experience profits once again. As profits increase, employment also increases, returning the unemployment rate to the natural rate as the economy moves from point B to point C. The expected rate of inflation has also decreased due to different inflation expectations, resulting in a shift of the short-run Phillips curve.

Inflation vs. Deflation vs. Disinflation

To illustrate the differences between *inflation, deflation, and disinflation*, consider the following example. Assume the following annual price levels as compared to the prices in year 1:

Year 1: 100% of Year 1 prices
Year 2: 104% of Year 1 prices
Year 3: 106% of Year 1 prices
Year 4: 107% of Year 1 prices
Year 5: 105% of Year 1 prices

As the economy moves through Year 1 to Year 4, there is a continued growth in the price level. This is an example of inflation; the price level is continually rising. However, between Year 2 and Year 4, the rise in price levels slows down. Between Year 2 and Year 3, the price level only increases by two percentage points, which is lower than the four percentage point increase between Years 1 and 2. The trend continues between Years 3 and 4, where there is only a one percentage point increase. This is an example of disinflation; the overall price level is rising, but it is doing so at a slower rate. Between Years 4 and 5, the price level does not increase, but decreases by two percentage points. This is an example of deflation; the price rise of previous years has reversed itself.