CHAPTER **14** A Dynamic Model of Aggregate Demand and Aggregate Supply

Questions for Review

1. The equation for the dynamic aggregate supply curve is:

$$\pi_t = \pi_{t-1} + \phi(Y_t - \overline{Y}_t) + \upsilon_t.$$

Recall that ϕ is a positive parameter that measures how rapidly firms adjust their prices in response to output fluctuations. When output in the economy rises above its natural level, firms experience rising marginal costs and will increase prices. There is therefore a positive relationship between the level of output and inflation in the economy. The dynamic aggregate supply curve is upward sloping. The steepness of the dynamic aggregate supply curve depends on how quickly marginal costs rise when output is above its natural level and on how quickly firms respond to the rising marginal cost with an increase in prices. The dynamic aggregate supply curve will be steeper if marginal costs rise more quickly and if firms respond by increasing prices more quickly. The dynamic aggregate supply curve is illustrated in Figure 14.1.

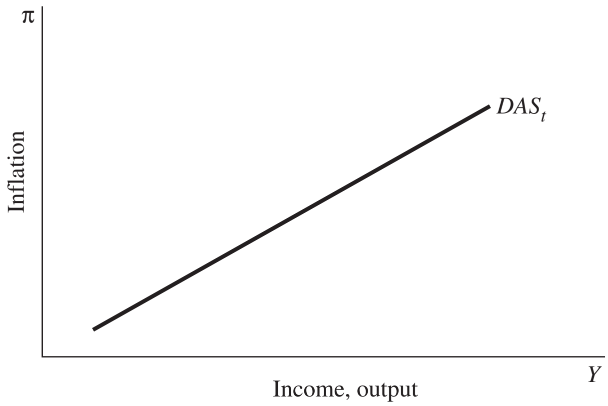


Figure 14–1

2. The equation for the dynamic aggregate demand curve is:

$$Y_t = \bar{Y} - \left[\frac{\alpha\theta_\pi}{1+\alpha\theta_Y}\right](\pi_t - \pi_t^*) + \left[\frac{1}{(1+\alpha\theta_y)}\right]\varepsilon_t.$$

The dynamic aggregate demand curve is defined by a given monetary policy rule and illustrates a negative relationship between the quantity of output demanded and inflation. When inflation changes, the central bank follows its monetary policy rule and changes the nominal interest rate. The monetary policy rule specifies that the nominal interest rate will change by more than the inflation rate so that there is a change in the real interest rate, and hence the demand for goods and services. If inflation rises, the central bank will follow its monetary policy rule, the real interest rate will rise, the amount of goods and services demanded will fall, and the level of output will fall. The dynamic aggregate demand curve is steeper if the central bank is more tolerant of high inflation (θ_π is smaller), if the central bank is less tolerant of deviations in output away from the natural level (θ_Y is larger), and if the public's spending is less responsive to changes in the real interest rate (α is smaller). The dynamic aggregate demand curve is illustrated in Figure 14.2.

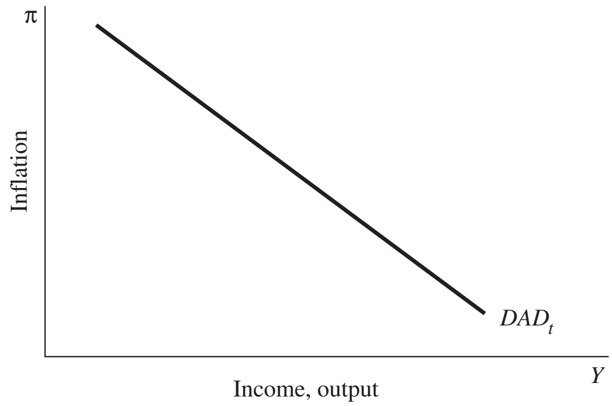


Figure 14–2

3. The dynamic aggregate demand curve is drawn for a given monetary policy rule. If the central bank changes the rule by increasing the target inflation rate, then the dynamic aggregate demand curve will shift to the right. Looking at the equation for the dynamic aggregate demand curve, an increase in the target inflation rate will increase output for any given level of the inflation rate. When the central bank increases the target inflation rate, the current inflation rate will be below the target. As a result, the central bank will lower both nominal and real interest rates. The lower real interest rate will increase the demand for goods and services at the current inflation rate and output will rise. The shift in the aggregate demand curve is illustrated in Figure 14.3. Since output is above its natural level, marginal costs will rise and firms will increase prices. The economy moves from its original equilibrium at point A to its new short-run equilibrium at point B. As the level of inflation rises, so will the expected inflation rate, and the dynamic aggregate supply curve will shift up and to the left, as illustrated in Figure 14.3. As inflation rises, the central bank will follow its new policy rule and increase the nominal interest rate. Eventually, the economy reaches its new long-run equilibrium, identified by point Z. Notice that inflation has risen from 2 percent to 3 percent.

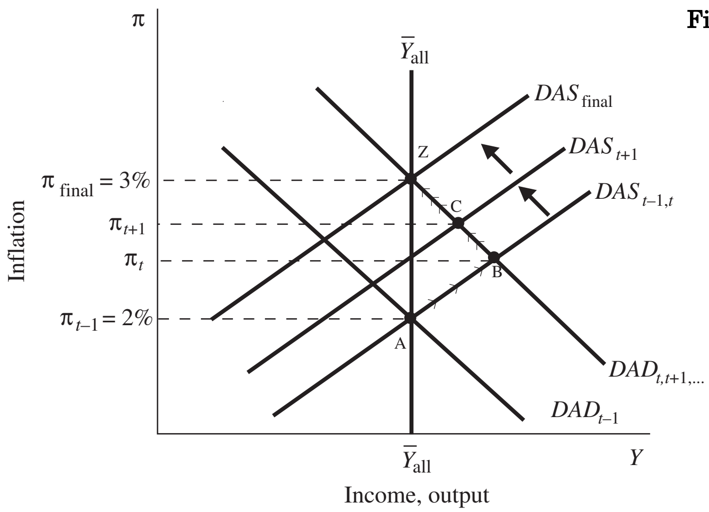


Figure 14–3

The nominal interest rate will be higher in the long run because there is no change in the long run real interest rate, and the nominal interest rate in the long run is equal to the real interest rate plus the target inflation rate.

4. If the central bank decides to increase the response of interest rates to changes in inflation (the parameter θ_π), then the central bank has become less tolerant of inflation. In this case, any increase in inflation will elicit a larger increase in nominal and real interest rates in an attempt to reduce the demand for goods and services and prevent further increases in inflation, such that the dynamic aggregate demand curve is flatter. Mathematically, the slope of the dynamic aggregate demand curve is given by:

$$-\frac{1+\alpha\theta_Y}{\alpha\theta_\pi}.$$

When the parameter θ_π increases in value, the slope becomes smaller in absolute-value terms and the dynamic aggregate demand curve becomes flatter. Intuitively, when the central bank is less tolerant of inflation, they are willing to put up with larger deviations of output from the natural rate, making the dynamic aggregate demand curve flatter. In this case, a supply shock that shifts the dynamic aggregate supply curve up and to the left will cause a larger reduction in the level of output and a smaller increase in the inflation rate, as illustrated in Figure 14.4. Under the new policy, the economy moves from A to C in response to the supply shock, as opposed to moving from A to B under the old policy. Note that, if the economy is in long-run equilibrium at the time of the central bank policy change, the economy will still remain in long-run equilibrium, but with a flatter dynamic aggregate demand curve.

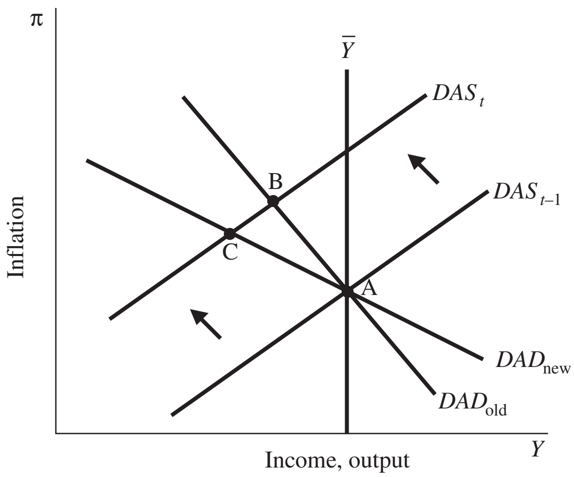


Figure 14–4

Problems and Applications

1. The five equations that make up the dynamic aggregate demand–aggregate supply model can be manipulated to derive long-run values for the variables. In this problem, it is assumed that there are no shocks to demand or supply and inflation has stabilized. Since inflation has stabilized, it must be true that inflation in time t is equal to inflation in time $t-1(\pi_t = \pi_{t-1})$. We also know that expected inflation is equal to last period's inflation, or $E_{t-1}\pi_t = \pi_{t-1}$. Start with the Phillips curve equation on line 1 below and use these two facts to find the following:

$$\pi_t = E_{t-1}\pi_t + \phi(Y_t - \bar{Y}_t) + \upsilon_t$$
$$\pi_t = \pi_{t-1} + \phi(Y_t - \bar{Y}_t) + \upsilon_t$$
$$\pi_t = \pi_t + \phi(Y_t - \bar{Y}_t) + \upsilon_t.$$

From here, it follows that output must equal natural output since the supply shock parameter υ_t equals zero. Moving to the demand for goods and services equation below, it now follows that the real interest rate equals the natural rate of interest since the demand shock parameter ε_t equals zero and $Y_t = \bar{Y}_t$:

$$Y_t = \bar{Y}_t - \alpha(r_t - \rho) + \varepsilon_t.$$

Turning to the Fisher equation on line 1 below, we can show the nominal interest rate is equal to the natural interest rate plus the current inflation rate. Since inflation has stabilized, expected inflation equals current inflation ($E_t\pi_{t+1} = \pi_t$) and we have just demonstrated that the real interest rate is equal to the natural rate of interest ($r_t = \rho$):

$$\begin{aligned} r_t &= i_t - E_t\pi_{t+1} \\ r_t &= i_t - \pi_t \\ i_t &= r_t - \pi_t \\ i_t &= \rho - \pi_t. \end{aligned}$$

Moving now to the monetary policy rule equation on line 1 below, it must be true that current inflation equals the target inflation rate so that the third term on the right zeros out. Likewise, the fourth term on the right side will zero out since output is at the natural level:

$$\begin{aligned} i_t &= \pi_t + \rho + \theta_\pi\left(\pi_t - \pi_t^*\right) + \theta_Y\left(Y_t - \bar{Y}_t\right) \\ i_t &= \pi_t + \rho. \end{aligned}$$

The final values are as follows:

$$\begin{aligned} Y_t &= \bar{Y}_t \\ r_t &= \rho \\ \pi_t &= \pi_t^* \\ E_t\pi_{t+1} &= \pi_t^* \\ i_t &= \rho + \pi_t^*. \end{aligned}$$

2. If the central bank has the wrong natural rate of interest, then it is using a value ρ' that is different from the real value ρ. Suppose that the wrong natural rate of interest is defined as follows:

$$\rho' = \rho + \Delta\rho$$

In this case, if $\Delta\rho$ equals zero, then the central bank has the correct natural rate of interest. If the natural rate of interest is wrong, then the long-run equilibrium values will change. The five equations that make up the dynamic aggregate demand–aggregate supply model can be manipulated to derive long-run values for the variables. In this problem, it is assumed that there are no shocks to demand or supply and inflation has stabilized. Since inflation has stabilized, it must be true that inflation in time t is equal to inflation in time $t - 1(\pi_t = \pi_{t-1})$. We also know that expected inflation is equal to last period's inflation, or $E_{t-1}\pi_t = \pi_{t-1}$. Start with the Phillips curve on line 1 below and use these two facts to find the following:

$$\begin{aligned} \pi_t &= E_{t-1}\pi_t + \phi\left(Y_t - \bar{Y}_t\right) + \upsilon_t \\ \pi_t &= \pi_{t-1} + \phi\left(Y_t - \bar{Y}_t\right) + \upsilon_t \\ \pi_t &= \pi_t + \phi\left(Y_t - \bar{Y}_t\right) + \upsilon_t. \end{aligned}$$

From here it follows that output must equal natural output since the supply shock parameter υ_t equals zero. Moving to the demand for goods and services equation below it now follows that the real interest rate equals the natural rate of interest since the demand shock parameter ε_t equals zero and $Y_t = \bar{Y}_t$:

$$Y_t = \bar{Y}_t - \alpha(r_t - \rho) + \varepsilon_t.$$

Turning to the Fisher equation on line 1 below, we can show the natural interest rate is equal to the nominal interest rate minus the current inflation rate. Since inflation has stabilized, expected inflation equals current inflation ($E_t\pi_{t+1} = \pi_t$, and we have just demonstrated that the real interest rate is equal to the natural rate of interest ($r_t = \rho$):

$$\begin{aligned} r_t &= i_t - E_t\pi_{t+1} \\ r_t &= i_t - \pi_t \\ \rho &= i_t - \pi_t. \end{aligned}$$

The monetary policy rule equation on line 1 below has the wrong natural rate of interest ρ'. Substitute in the relationship between the correct and incorrect rates of natural interest and rearrange terms:

$$\begin{aligned} i_t &= \pi_t + \rho' + \theta_\pi\left(\pi_t - \pi_t^*\right) + \theta_Y\left(Y_t - \bar{Y}_t\right) \\ i_t &= \pi_t + (\rho + \Delta\rho) + \theta_\pi\left(\pi_t - \pi_t^*\right) + \theta_Y\left(Y_t - \bar{Y}_t\right) \\ i_t - \pi_t &= (\rho + \Delta\rho) + \theta_\pi\left(\pi_t - \pi_t^*\right) + \theta_Y\left(Y_t - \bar{Y}_t\right). \end{aligned}$$

The third term on the right side will zero out since output is at the natural level. Now, combine the rewritten Fisher equation with the rewritten monetary policy rule equation above:

$$\begin{aligned} i_t &= \pi_t + (\rho + \Delta\rho) + \theta_\pi\left(\pi_t - \pi_t^*\right) + \theta_Y\left(Y_t - \bar{Y}_t\right) \\ \rho &= (\rho + \Delta\rho) + \theta_\pi\left(\pi_t - \pi_t^*\right) \\ 0 &= \Delta\rho + \theta_\pi\pi_t - \theta_\pi\pi_t^* \\ \pi_t &= \pi_t^* - \frac{\Delta\rho}{\theta_\pi}. \end{aligned}$$

The final values are as follows:

$$\begin{aligned} Y_t &= \bar{Y}_t \\ r_t &= \rho \\ \pi_t &= \pi_t^* - \frac{\Delta\rho}{\theta_\pi} \\ E_t\pi_{t+1} &= \pi_t^* - \frac{\Delta\rho}{\theta_\pi} \\ i_t &= \rho + \pi_t^* - \frac{\Delta\rho}{\theta_\pi}. \end{aligned}$$

Intuitively, if the central bank thinks that the natural rate of interest is higher than it really is, then it will be setting interest rates higher than they should be set, and $\Delta\rho$ is greater than zero. The higher interest rates will result in lower demand for goods and services, and in the long run, this will result in an inflation rate that is lower than the target inflation rate. In the short run, higher interest rates will temporarily cause real interest rates to be higher than normal, causing the dynamic aggregate demand curve to shift down and to the left. In being wrong about the natural rate, the central bank has effectively forced the economy through a recessionary cycle, which has resulted in the inflation rate coming in below the target rate. As the lower inflation rate persists, the expected inflation rate will decrease and the dynamic aggregate supply curve will shift down and to the right until a new long run equilibrium is reached. This is illustrated in Figure 14.5. From the derived long-run values above, the inflation rate is below the target rate, expected inflation equals actual inflation and is also below the target rate, and the nominal interest rate is lower than it would otherwise be.

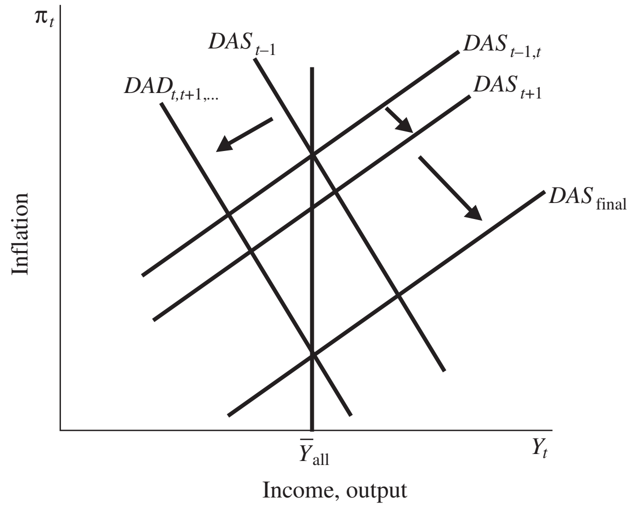


Figure 14–5

3. “If a central bank wants to achieve lower nominal interest rates, it has to raise the nominal interest rate.” In long-run equilibrium, the nominal rate of interest is equal to the natural rate of interest plus the target inflation rate. To lower the long-run nominal interest rate, the central bank must lower the target inflation rate and, ultimately, the actual inflation rate. In the short run, the central bank must increase the nominal interest rate in order to reduce spending and output in the economy. This will reduce inflation and, ultimately, expected inflation. The economy will adjust to a new long-run equilibrium in which the nominal interest rate, the target inflation rate, and the actual inflation rate are all lower. Graphically, lowering the target inflation rate will shift the dynamic aggregate demand curve down and to the left, forcing the economy through a recessionary cycle, and in the short run, output and inflation will be lower. As expected inflation adjusts over the long run, the dynamic aggregate supply curve will shift down and to the right. In the long run, output is equal to the natural level and inflation is lower.
4. The sacrifice ratio measures the accumulated loss in output associated with a one-percentage-point reduction in the target inflation rate. Graphically, the reduction in the target inflation rate will shift the dynamic aggregate demand curve down and to the left, resulting in a short-run equilibrium with a lower level of output and a lower inflation rate. Over time, expected inflation will adjust and the dynamic aggregate supply curve will shift down and to the right until output again equals potential output. For each year that output remains below potential, the percentage deviation of actual output from potential output can be calculated, and these results can be summed to find the accumulated lost output in percentage terms. For the twelve years included in the text simulation, the accumulated lost output is 2.59 percent. During this same period, the inflation rate fell from 2 percent to 1.35 percent, which is a decrease of 0.65 percent. The implied sacrifice ratio is therefore 2.59/0.65 = 3.98. We can derive this same result directly from the dynamic aggregate demand–aggregate supply model. Start with the Phillips curve equation on line 1 below and use the adaptive expectations assumption to rewrite as follows:

$$\pi_t = E_{t-1}\pi_t + \phi\left(Y_t - \bar{Y}_t\right) + \upsilon_t$$

$$\pi_t = \pi_{t-1}\pi_t + \phi\left(Y_t - \bar{Y}_t\right) + \upsilon_t.$$

From this equation, we see that, in the absence of supply shocks ($\upsilon_\tau = 0$), a one-percentage-point decrease in output below its natural level causes inflation to decrease by θ percentage points. (Recall that the natural level of output is 100 so that a one-unit deviation of output from its natural level is equivalent to a one-percentage-point deviation.) Turning this result around, we find that, in order to reduce the inflation rate by one percentage point, output must decline by $1/\theta$. percentage points. From the simulation, the value of θ is 0.25 so that $1/\theta$ is equal to 4. Note that this is very close to the value of 3.98 that was obtained directly from the simulation results.

5. Follow the hint given in the problem and solve for the long-run equilibrium with the new assumption that the demand shock parameter ε_t is not zero. Since inflation has stabilized, it must be true that inflation in time t is equal to inflation in time $t-1(\pi_t = \pi_{t-1})$. We also know that expected inflation is equal to last period's inflation, or $E_{t-1}\pi_t = \pi_{t-1}$. Start with the Phillips curve on line 1 below and use these two facts to find the following:

$$\pi_t = E_{t-1}\pi_t + \phi\left(Y_t - \bar{Y}_t\right) + \upsilon_t$$
$$\pi_t = \pi_{t-1} + \phi\left(Y_t - \bar{Y}_t\right) + \upsilon_t$$
$$\pi_t = \pi_t + \phi\left(Y_t - \bar{Y}_t\right) + \upsilon_t.$$

From here, it follows that output must equal natural output since the supply shock parameter υ_t equals zero. From the demand for goods and services equation on line 1 below, it now follows that the real interest rate equals the natural rate of interest plus a new term:

$$Y_t = \bar{Y}_t - \alpha\left(r_t - \rho\right) + \varepsilon_t$$
$$0 = -\alpha r_t + \alpha\rho + \varepsilon_t$$
$$\alpha r_t = \alpha\rho + \varepsilon_t$$
$$r_t = \rho + \frac{\varepsilon_t}{\alpha}.$$

Turning to the Fisher equation on line 1 below, we can show the nominal interest rate is equal to the natural interest rate plus the current inflation rate plus a new term. Since inflation has stabilized, expected inflation equals current inflation ($E_t\pi_{t+1} = \pi_t$, and we have just demonstrated that the real interest rate is equal to the natural rate of interest plus a new term

$$\left(r_t = \rho + \frac{\varepsilon_t}{\alpha}\right):$$
$$r_t = i_t - E_t\pi_{t+1}$$
$$r_t = i_t - \pi_t$$
$$i_t = r_t + \pi_t$$
$$i_t = \rho + \pi_t + \frac{\varepsilon_t}{\alpha}.$$

Moving now to the monetary policy rule equation on line 1 below, substitute in for the nominal rate of interest from the rewritten Fisher equation above, and then note that the fourth term on the right side will zero out since output is at the natural level:

$$i_t = \pi_t + \rho + \theta_\pi\left(\pi_t - \pi_t^*\right) + \theta_Y\left(Y_t - \bar{Y}_t\right)$$
$$\rho + \frac{\varepsilon_t}{\alpha} + \pi_t = \pi_t + \rho + \theta_\pi\left(\pi_t - \pi_t^*\right)$$
$$\frac{\varepsilon_t}{\alpha} = \theta_\pi\pi_t^*$$
$$\pi_t = \pi_t^* + \frac{\varepsilon_t}{\theta_\pi\alpha}.$$

The final values are as follows:

$$Y_t = \bar{Y}_t$$
$$r_t = \rho + \frac{\varepsilon_t}{\alpha}$$
$$\pi_t = \pi_t^* + \frac{\varepsilon_t}{\theta_\pi \alpha}$$
$$E_t\pi_{t+1} = \pi_t^* + \frac{\varepsilon_t}{\theta_\pi \alpha}$$
$$i_t = \rho + \pi_t^* + \frac{\varepsilon_t}{\alpha}.$$

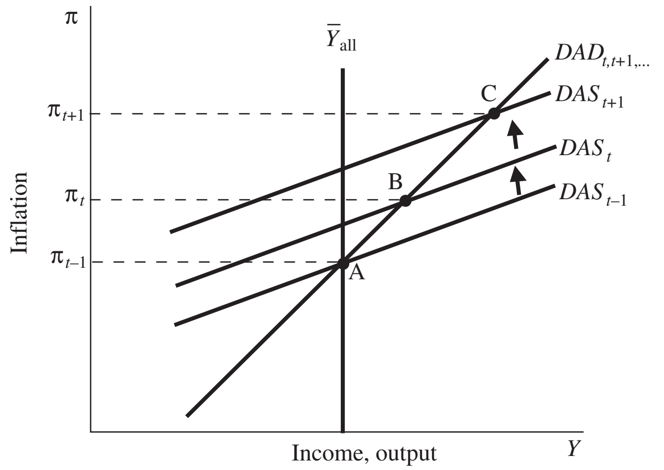
If the demand shock parameter ε_t were to increase permanently, such that it remained a constant positive number, the dynamic aggregate demand curve would shift to the right permanently. This would cause a short-run increase in output and inflation and a long-run increase in the inflation rate as the economy adjusted to its new long run equilibrium. This is consistent with the newly derived long-run values above, where the inflation rate is higher than the target inflation rate. Note that expected inflation is also higher, as is the nominal and the real interest rate. To deal with this issue, the central bank could decrease its target inflation rate. This would effectively offset the permanent increase in the demand shock parameter .t and shift the dynamic aggregate demand curve back to its original position.

6. The equation for the dynamic aggregate demand curve is given below:

$$Y_t = \bar{Y}_t - \left[\frac{\alpha\theta_\pi}{(1+\alpha\theta_Y)}\right](\pi_t - \pi_t^*) + \left[\frac{1}{(1+\alpha\theta_Y)}\right]\varepsilon_t.$$

The parameter θ_π measures the central bank's responsiveness to changes in the inflation rate. When θ_π is large, the central bank aggressively responds to changes in the inflation rate. When θ_π is small but still positive, the central bank has a weak response to changes in the inflation rate, and the dynamic aggregate demand curve becomes very steep. If θ_π becomes negative, the dynamic aggregate demand curve actually has a positive slope, as can be seen in the equation above. In this case, a supply shock that shifts the dynamic aggregate supply curve up and to the left will lead to ever-increasing inflation, even if the shock is temporary. This is due to the fact that output remains above its natural level since the central bank's increase in nominal interest rates is not enough to increase real interest rates. The supply shock will shift the dynamic aggregate supply curve up and to the right as rising production costs increase the inflation rate. Since nominal interest rates rise by less than the inflation rate, real interest rates will fall and therefore output will rise. In Figure 14.6, this is shown as a movement from point A to point B. Since output is above the natural rate, inflation will continue to rise, and the dynamic aggregate supply curve will continue to shift up and to the left as people adjust their expectations about inflation. This analysis reinforces the Taylor principle as a guideline for the design of monetary policy in that the central bank wants to maintain low and stable inflation.

Figure 14–6



7. Suppose that the natural rate of interest is not a constant parameter but varies over time so that it is now written as ρ_t.

a. The equation for dynamic aggregate supply is not affected by this change because its derivation does not involve the natural rate of interest. The equation for dynamic aggregate demand is not affected by this change either because, although the variable ρ_t is involved in the derivation of the dynamic aggregate demand curve, it cancels out and does not end up as part of the final equation.

b. A shock to ρ_t would not cause a shift to either dynamic aggregate demand or dynamic aggregate supply because the variable does not appear in either equation. Output and inflation would not be affected. However, the real and nominal interest rates would both change by the amount of the change in ρ_t.

c. If the natural rate of interest varied over time, it would make the setting of monetary policy more difficult. If the central bank knows that the natural rate of interest is 4 percent, for example, and it is aiming for target inflation rate of 2 percent, then a nominal interest rate of 6 percent will be the long-run target. If, on the other hand, the natural rate of interest varies over time, then the target long-run interest rate will also vary over time. It is more difficult to hit a moving target than a target that is standing still. In particular, in contrast to what is implicitly assumed above, if the natural rate of interest is always moving, the central bank might have trouble knowing the natural rate of interest at every point in time.

8. Suppose people's expectations of inflation are subject to random shocks so that

$$E_{t-1}\pi_t = \pi_{t-1} + \eta_{t-1}.$$

a. The dynamic aggregate supply curve equation is derived from the Phillips curve and the expectations equation. In this case, start with the Phillips curve equation on line 1 below and substitute in for the expected inflation term using the expression above:

$$\pi_t = E_{t-1}\pi_t + \phi\left(Y_t - \overline{Y}_t\right) + \upsilon_t$$
$$\pi_t = \pi_{t-1} + \eta_{t-1} + \phi\left(Y_t - \overline{Y}_t\right) + \upsilon_t.$$

The dynamic aggregate demand curve is derived from the demand for goods and services equation, the Fisher equation, and the monetary policy rule equation. In this problem, the Fisher equation will be modified to include the new expected inflation equation. Start with the demand for goods and services equation on line 1 below, then use the Fisher equation and monetary policy rule equation to make the necessary substitutions:

$$Y_t = \bar{Y}_t - \alpha(r_t - \rho) + \varepsilon_t$$
$$Y_t = \bar{Y}_t - \alpha(i_t - E_t\pi_{t+1} - \rho) + \varepsilon_t$$
$$Y_t = \bar{Y}_t - \alpha(i_t - (\pi_t + \eta_t) - \rho) + \varepsilon_t$$
$$Y_t = \bar{Y}_t - \alpha\left((\pi_t + \rho + \theta_\pi(\pi_t - \pi_t^*) + \theta_Y(Y_t - \bar{Y}_t)) - (\pi_t + \eta_t) - \rho\right) + \varepsilon_t$$
$$Y_t = \bar{Y}_t - \alpha\left(\theta_\pi(\pi_t - \pi_t^*) + \theta_Y(Y_t - \bar{Y}_t) - \eta_t\right) + \varepsilon_t.$$

With a few more algebraic manipulations, you end up with the following equation for the dynamic aggregate demand curve:

$$Y_t = \bar{Y}_t - [\alpha\theta_\pi/(1+\alpha\theta_Y)](\pi_t - \pi_t^*) + [\alpha/(1+\alpha\theta_Y)]\eta_t + [1/(1+\alpha\theta_Y)]\varepsilon_t.$$

b. If η_t is greater than zero for one period only, then the dynamic aggregate demand curve will shift to the right and the dynamic aggregate supply curve will not shift. Note that the dynamic aggregate supply curve depends on the lagged value of this shock parameter so that it will be affected in period $t + 1$. As the dynamic aggregate demand curve shifts to the right, output and inflation will both rise. Based on the central bank's monetary policy rule, nominal and real interest rates will both increase. Intuitively, if people expect inflation to be higher next year, then they will increase purchases today to take advantage of the still-lower prices.

c. In period $t + 1$, the dynamic aggregate demand curve will shift back to its original position (because η_{t+1} is zero), and the dynamic aggregate supply curve will shift to the left (because η_t is positive and also because lagged inflation has increased). In comparison to long-run equilibrium, output will be lower and inflation will be higher. The economy is experiencing stagflation. Inflation is higher because of higher expectations of inflation, and output is lower because of the higher real interest rates that resulted from higher inflation.

d. In subsequent time periods, the dynamic aggregate supply curve will slowly shift back to its original position as the lower level of output reduces inflation, and hence expectations of future inflation. Although the parameter η_{t+1} was positive for only one time period, the dynamic aggregate supply curve does not immediately return to its original position because the short-run increase in inflation has caused expected inflation to rise above its long-run value.

e. This problem shows that inflation scares are self-fulfilling. When people believe inflation will rise, they act in such a way that inflation does actually rise, and the economy goes through a period of higher inflation.

9. Use the dynamic *AD–AS* model to solve for inflation as a function of only lagged inflation and the two shocks. Start with the dynamic aggregate supply curve and substitute in for Y_t using the dynamic aggregate demand curve equation as is done on line 1 below. Now, solve for inflation through a few algebraic manipulations:

$$\pi_t = \pi_{t-1} + \phi\left[\bar{Y}_t - [\alpha\theta_\pi/(1+\alpha\theta_Y)](\pi_t - \pi_t^*) + [1/(1+\alpha\theta_Y)]\varepsilon_t - \bar{Y}_t\right] + \upsilon_t$$
$$\pi_t\left[1 + (\phi\alpha\theta_\pi/(1+\alpha\theta_Y))\right] = \pi_{t-1} + (\phi\alpha\theta_Y)\pi_t^* + [\phi/(1+\alpha\theta_Y)]\varepsilon_t + \upsilon_t$$
$$\pi_t = \frac{(1+\alpha\theta_Y)}{(1+\alpha\theta_Y+\phi\alpha\theta_\pi)}\pi_{t-1} + \frac{(\phi\alpha\theta_\pi)}{(1+\alpha\theta_Y+\phi\alpha\theta_\pi)}\pi_t^* + \frac{\phi}{(1+\alpha\theta_Y+\phi\alpha\theta_\pi)}\varepsilon_t + \frac{(1+\alpha\theta_Y)}{(1+\alpha\theta_Y+\phi\alpha\theta_\pi)}\upsilon_t.$$

a. A supply or demand shock will lead to an increase in current inflation. As the economy adjusts and returns to long-run equilibrium, the inflation rate will return to its target level. Note that the coefficient on the lagged inflation variable in the equation above is positive but less than 1. This means that inflation in time $t + 1$ will be less than inflation in time t, and that inflation will eventually return to its target rate.

b. If the central bank does not respond to changes in output so that θ_Y is zero, then the economy will still return to its target inflation rate after a supply or demand shock because the coefficient on the lagged inflation variable in the equation above is still positive but less than 1. In this case, inflation should return more quickly to its target rate. This is because the coefficient on lagged inflation has become smaller (the change in the numerator is larger in comparison to the change in the denominator). The dynamic aggregate demand curve is relatively flat when the central bank only cares about inflation.

c. If the central bank does not respond to changes in inflation so that θ_π is zero, then the coefficient on lagged inflation in the above inflation equation equals 1. In this case, the economy will not return to its target inflation rate after a demand or supply shock. The demand or supply shock will increase inflation in time t. When θ_π is zero, inflation in time $t + 1$ is equal to inflation in time t.

d. The Taylor rule says that a one-percentage-point increase in inflation will increase the nominal interest rate by $1 + \theta_\pi$ percentage points. If the central bank increases the nominal interest rate by only 0.8 percentage points for each one-percentage-point increase in the nominal interest rate, then this means θ_π is equal to –0.2. When θ_π is negative, the dynamic aggregate demand curve is upward sloping. A shock to demand or supply will set the economy on a path of ever-increasing inflation. This path of ever-increasing inflation will occur because real interest rates will continue to fall and output will remain above the natural level. You can see this phenomenon in the above equation for inflation: If θ_π is negative, the coefficient on lagged inflation is greater than 1. That larger-than-one coefficient is the mathematical manifestation of explosive inflation.