Problems and Applications

1. a. If the central bank increases the money supply, then the *LM* curve shifts downward, as shown in Figure 11–4. Income increases and the interest rate falls. The increase in disposable income causes consumption to rise; the fall in the interest rate causes investment to rise as well.
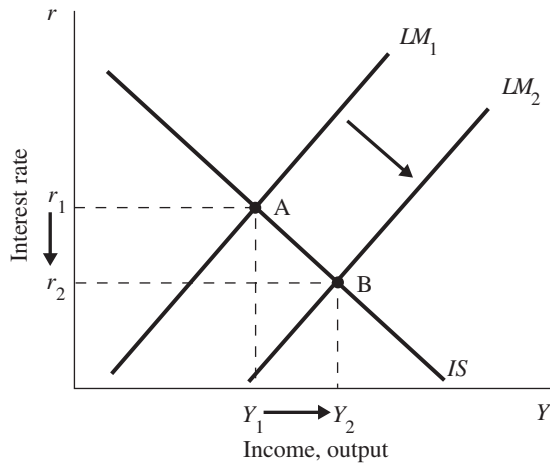

Figure 11–4

b. If government purchases increase, then the government-purchases multiplier tells us that the *IS* curve shifts to the right by an amount equal to $[1/(1 - MPC)]\Delta G$. This is shown in Figure 11–5. Income and the interest rate both increase. The increase in disposable income causes consumption to rise, while the increase in the interest rate causes investment to fall.
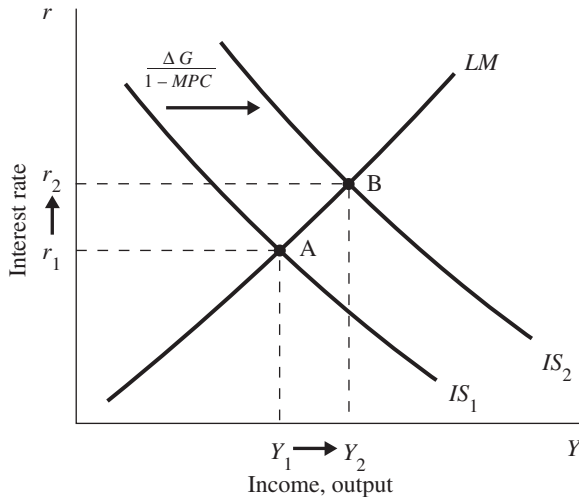

Figure 11–5

c. If the government increases taxes, then the tax multiplier tells us that the *IS* curve shifts to the left by an amount equal to $[- MPC/(1 - MPC)]\Delta T$. This is shown in Figure 11–6. Income and the interest rate both fall. Disposable income falls because income is lower and taxes are higher; this causes consumption to fall. The fall in the interest rate causes investment to rise.
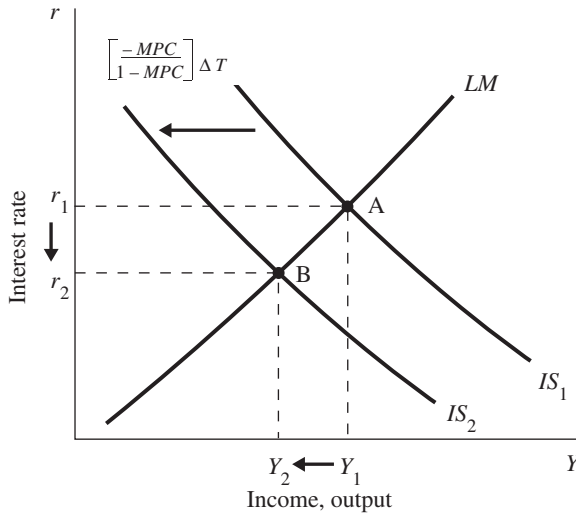

Figure 11–6

d.   We can figure out how much the *IS* curve shifts in response to an equal increase in government purchases and taxes by adding together the two multiplier effects that we used in parts (b) and (c):

$$\Delta Y = [(1/(1 - MPC))]\Delta G - [(MPC/(1 - MPC))\Delta T]$$

Because government purchases and taxes increase by the same amount, we know that $\Delta G = \Delta T$. Therefore, we can rewrite the above equation as:

$$\Delta Y = [(1/(1 - MPC)) - (MPC/(1 - MPC))]\Delta G$$

$$\Delta Y = \Delta G.$$

This expression tells us how output changes, holding the interest rate constant. It says that an equal increase in government purchases and taxes shifts the *IS* curve to the right by the amount that *G* increases.

This shift is shown in Figure 11–7. Output increases, but by less than the amount that *G* and *T* increase; this means that disposable income $Y - T$ falls. As a result, consumption also falls. The interest rate rises, causing investment to fall.
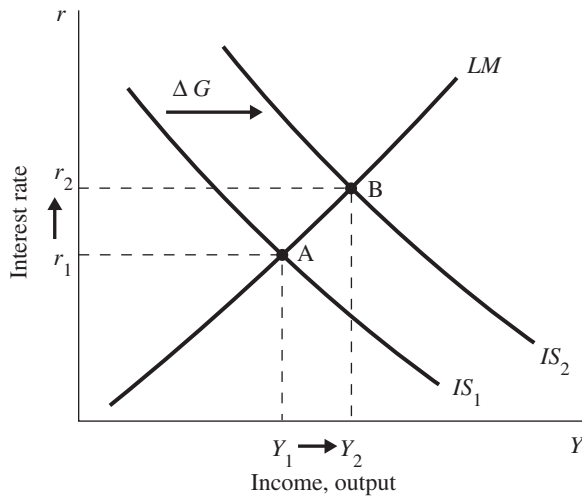

Figure 11–7

2. a.   The invention of the new high-speed chip increases investment demand, which shifts the *IS* curve out. That is, at every interest rate, firms want to invest more. The increase in the demand for investment goods shifts the *IS* curve out, raising income and employment. Figure 11–8 shows the effect graphically.
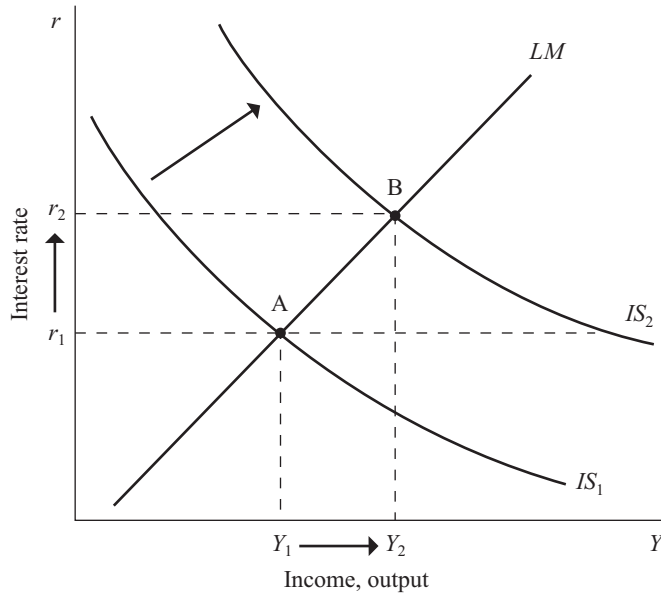

Figure 11–8

The increase in income from the higher investment demand also raises interest rates. This happens because the higher income raises demand for money; since the supply of money does not change, the interest rate must rise in order to restore equilibrium in the money market. The rise in interest rates partially offsets the increase in investment demand, so that output does not rise by the full amount of the rightward shift in the *IS* curve.

Overall, income, interest rates, consumption, and investment all rise.

b.   The increased demand for cash shifts the *LM* curve up. This happens because at any given level of income and money supply, the interest rate necessary to equilibrate the money market is higher. Figure 11–9 shows the effect of this *LM* shift graphically.
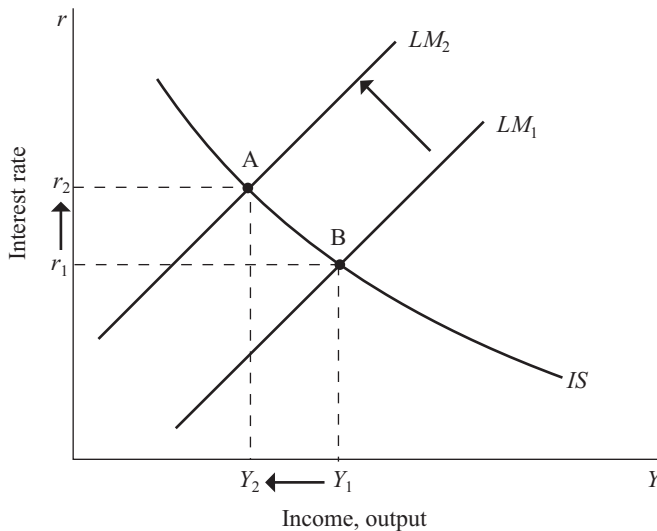

Figure 11–9

The upward shift in the *LM* curve lowers income and raises the interest rate. Consumption falls because income falls, and investment falls because the interest rate rises.

c. At any given level of income, consumers now wish to save more and consume less. Because of this downward shift in the consumption function, the *IS* curve shifts inward. Figure 11–10 shows the effect of this *IS* shift graphically.
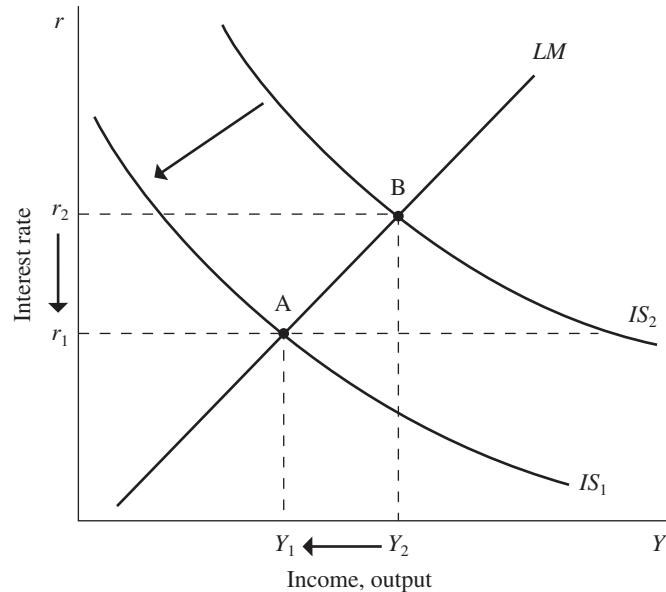

Figure 11–10

Income, interest rates, and consumption all fall, while investment rises. Income falls because at every level of the interest rate, planned expenditure falls. The interest rate falls because the fall in income reduces demand for money; since the supply of money is unchanged, the interest rate must fall to restore money-market equilibrium. Consumption falls both because of the shift in the consumption function and because income falls. Investment rises because of the lower interest rates and partially offsets the effect on output of the fall in consumption.

3. a.   The *IS* curve is given by:

$$Y = C(Y - T) + I(r) + G.$$

We can plug in the consumption and investment functions and values for G and T as given in the question and then rearrange to solve for the *IS* curve for this economy:

$$Y = 200 + 0.75(Y - 100) + 200 - 25r + 100$$
$$Y - 0.75Y = 425 - 25r$$
$$(1 - 0.75)Y = 425 - 25r$$
$$Y = (1/0.25)(425 - 25r)$$
$$Y = 1,700 - 100r.$$

This *IS* equation is graphed in Figure 11–11 for r ranging from 0 to 8.

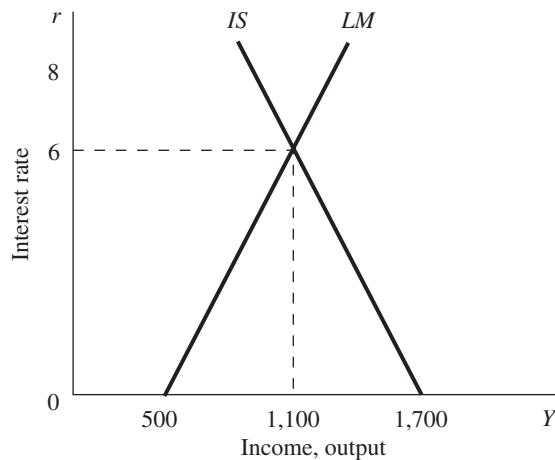Figure 11–11

b.   The *LM* curve is determined by equating the demand for and supply of real money balances. The supply of real balances is $1,000/2 = 500$. Setting this equal to money demand, we find:

$$500 = Y - 100r.$$
$$Y = 500 + 100r.$$

This *LM* curve is graphed in Figure 11–11 for r ranging from 0 to 8.

c.   If we take the price level as given, then the *IS* and the *LM* equations give us two equations in two unknowns, Y and r. We found the following equations in parts (a) and (b):

$$IS: Y = 1,700 - 100r.$$
$$LM: Y = 500 + 100r.$$

Equating these, we can solve for r:

$$1,700 - 100r = 500 + 100r$$
$$1,200 = 200r$$
$$r = 6.$$

Now that we know r, we can solve for Y by substituting it into either the *IS* or the *LM* equation. We find

$$Y = 1,100.$$

Therefore, the equilibrium interest rate is 6 percent and the equilibrium level of output is 1,100, as depicted in Figure 11–11.

d.   If government purchases increase from 100 to 150, then the *IS* equation becomes:

$$Y = 200 + 0.75(Y - 100) + 200 - 25r + 150.$$

Simplifying, we find:

$$Y = 1,900 - 100r.$$

This *IS* curve is graphed as IS_2 in Figure 11–12. We see that the *IS* curve shifts to the right by 200.
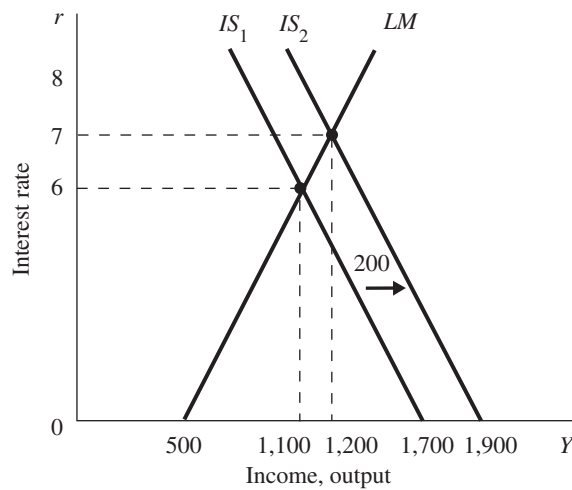

Figure 11–12

By equating the new *IS* curve with the *LM* curve derived in part (b), we can solve for the new equilibrium interest rate:

$$1,900 - 100r = 500 + 100r$$
$$1,400 = 200r$$
$$7 = r.$$

We can now substitute *r* into either the *IS* or the *LM* equation to find the new level of output. We find

$$Y = 1,200.$$

Therefore, the increase in government purchases causes the equilibrium interest rate to rise from 6 percent to 7 percent, while output increases from 1,100 to 1,200. This is depicted in Figure 11–12.

e.   If the money supply increases from 1,000 to 1,200, then the *LM* equation becomes:

$$(1,200/2) = Y - 100r,$$

or

$$Y = 600 + 100r.$$

This *LM* curve is graphed as LM_2 in Figure 11–13. We see that the *LM* curve shifts to the right by 100 because of the increase in real money balances.
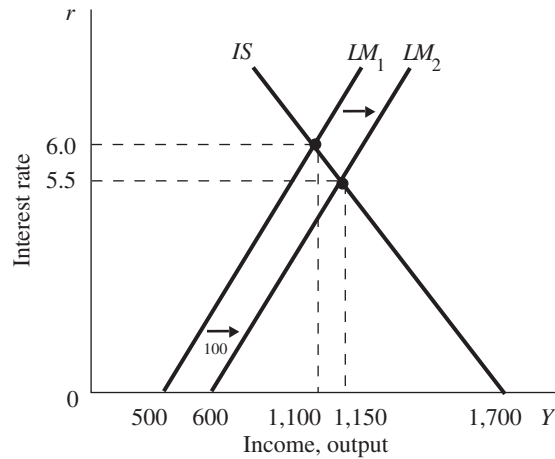

Figure 11–13

To determine the new equilibrium interest rate and level of output, equate the *IS* curve from part (a) with the new *LM* curve derived above:

$$1,700 - 100r = 600 + 100r$$
$$1,100 = 200r$$
$$5.5 = r.$$

Substituting this into either the *IS* or the *LM* equation, we find

$$Y = 1,150.$$

Therefore, the increase in the money supply causes the interest rate to fall from 6 percent to 5.5 percent, while output increases from 1,100 to 1,150. This is depicted in Figure 11–13.

f.   If the price level rises from 2 to 4, then real money balances fall from 500 to 1,000/4 = 250. The *LM* equation becomes:

$$Y = 250 + 100r.$$

As shown in Figure 11–14, the *LM* curve shifts to the left by 250 because the increase in the price level reduces real money balances.
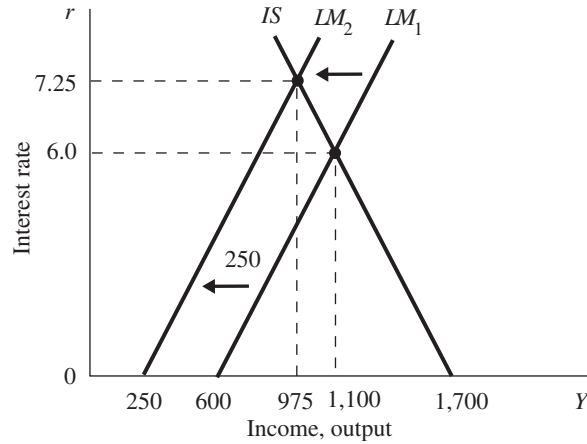

Figure 11–14

To determine the new equilibrium interest rate, equate the *IS* curve from part (a) with the new *LM* curve from above:

$$1{,}700 - 100r = 250 + 100r$$

$$1{,}450 = 200r$$

$$7.25 = r.$$

Substituting this interest rate into either the *IS* or the *LM* equation, we find

$$Y = 975.$$

Therefore, the new equilibrium interest rate is 7.25, and the new equilibrium level of output is 975, as depicted in Figure 11–14.

g. The aggregate demand curve is a relationship between the price level and the level of income. To derive the aggregate demand curve, we want to solve the *IS* and the *LM* equations for Y as a function of P. That is, we want to substitute out for the interest rate. We can do this by solving the *IS* and the *LM* equations for the interest rate:

IS: $\quad Y = 1{,}700 - 100r$

$\quad\quad 100r = 1{,}700 - Y.$

LM: $\quad (M/P) = Y - 100r$

$\quad\quad 100r = Y - (M/P).$

Combining these two equations, we find

$$1{,}700 - Y = Y - (M/P)$$

$$2Y = 1{,}700 + M/P$$

$$Y = 850 + M/2P.$$

Since the nominal money supply M equals 1,000, this becomes

$$Y = 850 + 500/P.$$

This aggregate demand equation is graphed in Figure 11–15.

Figure 11–15
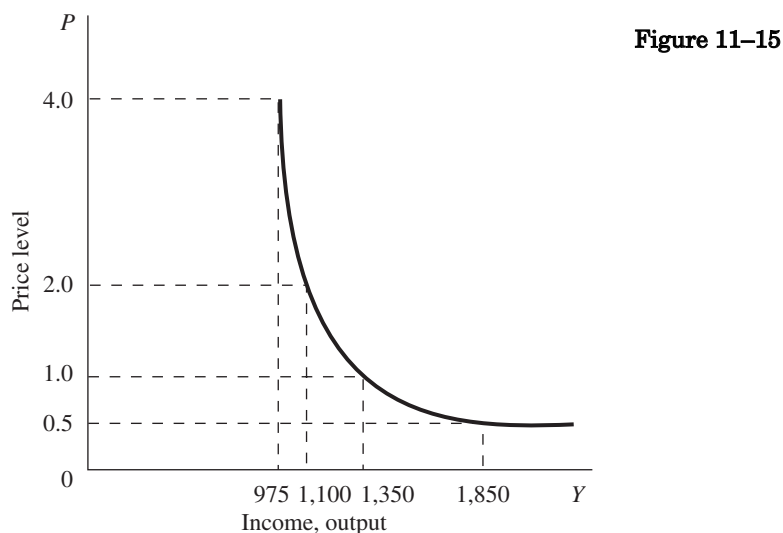
How does the increase in fiscal policy of part (d) affect the aggregate demand curve? We can see this by deriving the aggregate demand curve using the *IS* equation from part (d) and the *LM* curve from part (b):

$$IS: \quad Y = 1{,}900 - 100r$$
$$100r = 1{,}900 - Y.$$

$$LM: \quad (1{,}000/P) = Y - 100r$$
$$100r = Y - (1{,}000/P).$$

Combining and solving for *Y*:

$$1{,}900 - Y = Y - (1{,}000/P),$$

or

$$Y = 950 + 500/P.$$

By comparing this new aggregate demand equation to the one previously derived, we can see that the increase in government purchases by 50 shifts the aggregate demand curve to the right by 100.

How does the increase in the money supply of part (e) affect the aggregate demand curve? Because the *AD* curve is $Y = 850 + M/2P$, the increase in the money supply from 1,000 to 1,200 causes it to become

$$Y = 850 + 600/P.$$

By comparing this new aggregate demand curve to the one originally derived, we see that the increase in the money supply shifts the aggregate demand curve to the right.

4. a.   The *IS* curve represents the relationship between the interest rate and the level of income that arises from equilibrium in the market for goods and services. That is, it describes the combinations of income and the interest rate that satisfy the equation

$$Y = C(Y - T) + I(r) + G.$$

If investment does not depend on the interest rate, then *nothing* in the *IS* equation depends on the interest rate; income must adjust to ensure that the quantity of goods produced, *Y*, equals the quantity of goods demanded, $C + I + G$. Thus, the *IS* curve is vertical at this level, as shown in Figure 11–16.
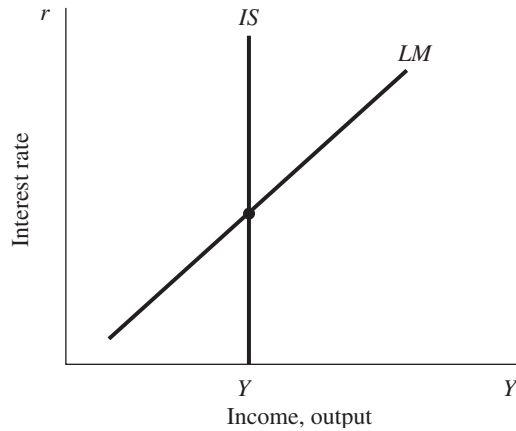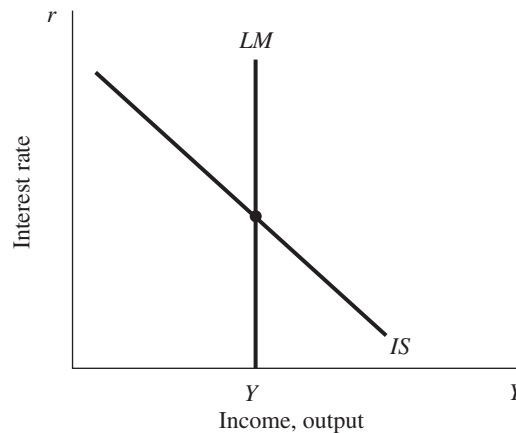
Figure 11–16

Monetary policy has no effect on output, because the *IS* curve determines *Y*. Monetary policy can affect only the interest rate. In contrast, fiscal policy is effective: output increases by the full amount that the *IS* curve shifts.

b.   The *LM* curve represents the combinations of income and the interest rate at which the money market is in equilibrium. If money demand does not depend on the interest rate, then we can write the *LM* equation as

$$M/P = L(Y).$$

For any given level of real balances M/P, there is only one level of income at which the money market is in equilibrium. Thus, the *LM* curve is vertical, as shown in Figure 11–17.

Fiscal policy now has no effect on output; it can affect only the interest rate. Monetary policy is effective: a shift in the *LM* curve increases output by the full amount of the shift.

c.   If money demand does not depend on income, then we can write the *LM* equation as

$$M/P = L(r).$$

For any given level of real balances M/P, there is only one level of the interest rate at which the money market is in equilibrium. Hence, the LM curve is horizontal, as shown in Figure 11–18.
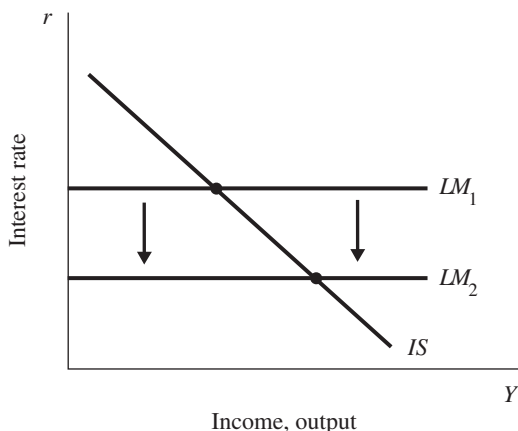

Figure 11–18

      Fiscal policy is very effective: output increases by the full amount that the IS curve shifts. Monetary policy is also effective: an increase in the money supply causes the interest rate to fall, so the LM curve shifts down, as shown in Figure 11–18.

d.   The LM curve gives the combinations of income and the interest rate at which the supply and demand for real balances are equal, so that the money market is in equilibrium. The general form of the LM equation is

$$M/P = L(r, Y).$$

Suppose income Y increases by \$1. How much must the interest rate change to keep the money market in equilibrium? The increase in Y increases money demand. If money demand is extremely sensitive to the interest rate, then it takes a *very* small increase in the interest rate to reduce money demand and restore equilibrium in the money market. Hence, the LM curve is (nearly) horizontal, as shown in Figure 11–19.
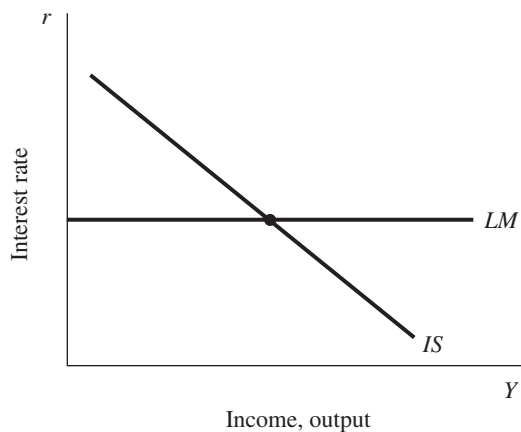

Figure 11–19

An example may make this clearer. Consider a linear version of the *LM* equation:

$$M/P = eY - fr.$$

Note that as *f* gets larger, money demand becomes increasingly sensitive to the interest rate. Rearranging this equation to solve for *r*, we find

$$r = (e/f)Y - (1/f)(M/P).$$

We want to focus on how changes in each of the variables are related to changes in the other variables. Hence, it is convenient to write this equation in terms of changes:

$$\Delta r = (e/f)\Delta Y - (1/f)\Delta(M/P).$$

The slope of the *LM* equation tells us how much *r* changes when *Y* changes, holding *M* fixed. If $\Delta(M/P) = 0$, then the slope is $\Delta r/\Delta Y = (e/f)$. As *f* gets very large, this slope gets closer and closer to zero.

If money demand is very sensitive to the interest rate, then fiscal policy is very effective: with a horizontal *LM* curve, output increases by the full amount that the *IS* curve shifts. Monetary policy is now completely ineffective: an increase in the money supply does not shift the *LM* curve at all. We see this in our example by considering what happens if *M* increases. For any given *Y* (so that we set $\Delta Y = 0$), $\Delta r/\Delta(M/P) = (-1/f)$; this tells us how much the *LM* curve shifts down. As *f* gets larger, this shift gets smaller and approaches zero. (This is in contrast to the horizontal *LM* curve in part (c), which does shift down.)

5. To raise investment while keeping output constant, the government should adopt a loose monetary policy and a tight fiscal policy, as shown in Figure 11–20. In the new equilibrium at point B, the interest rate is lower, so that investment is higher. The tight fiscal policy—reducing government purchases, for example—offsets the effect of this increase in investment on output.
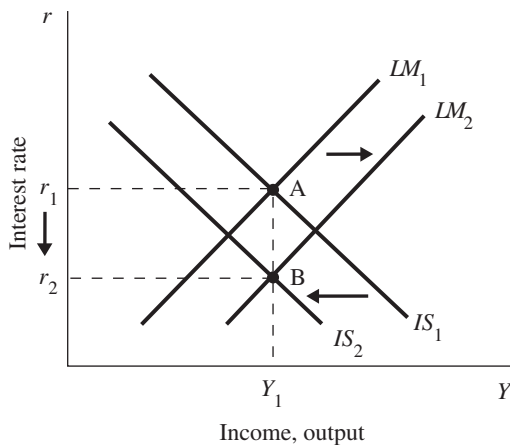
Figure 11–20

The policy mix in the early 1980s did exactly the opposite. Fiscal policy was expansionary, while monetary policy was contractionary. Such a policy mix shifts the *IS* curve to the right and the *LM* curve to the left, as in Figure 11–21. The real interest rate rises and investment falls.
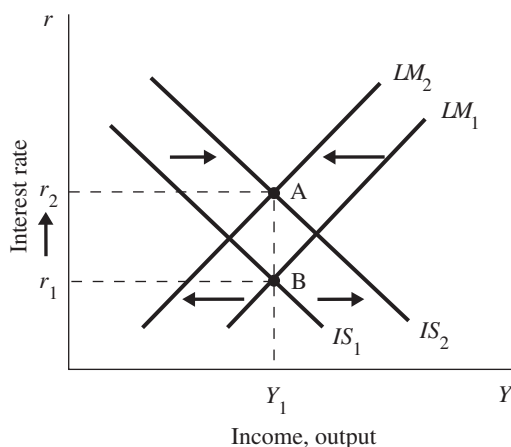

Figure 11–21

6. a.   An increase in the money supply shifts the *LM* curve to the right in the short run. This moves the economy from point A to point B in Figure 11–22: the interest rate falls from r_1 to r_2, and output rises from $\overline{Y}$ to Y_2. The increase in output occurs because the lower interest rate stimulates investment, which increases output.
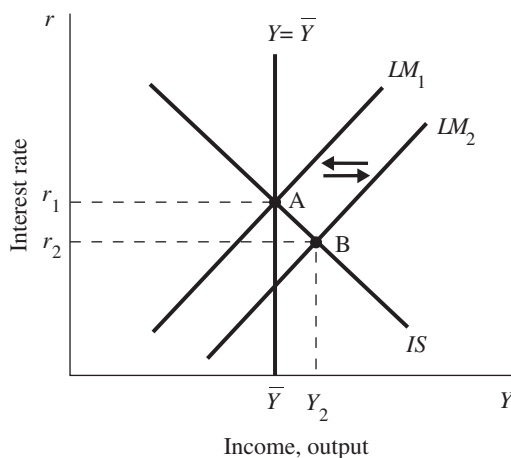

Figure 11–22

Since the level of output is now above its long-run level, prices begin to rise. A rising price level lowers real balances, which raises the interest rate. As indicated in Figure 11–22, the *LM* curve shifts back to the left. Prices continue to rise until the economy returns to its original position at point A. The interest rate returns to r_1, and investment returns to its original level. Thus, in the long run, there is no impact on real variables from an increase in the money supply. (This is what we called *monetary neutrality* in Chapter 4.)

b.   An increase in government purchases shifts the *IS* curve to the right, and the
economy moves from point A to point B, as shown in Figure 11–23. In the short
run, output increases from $\overline{Y}$ to Y_2, and the interest rate increases from r_1 to r_2.

Figure 11–23

Income, output
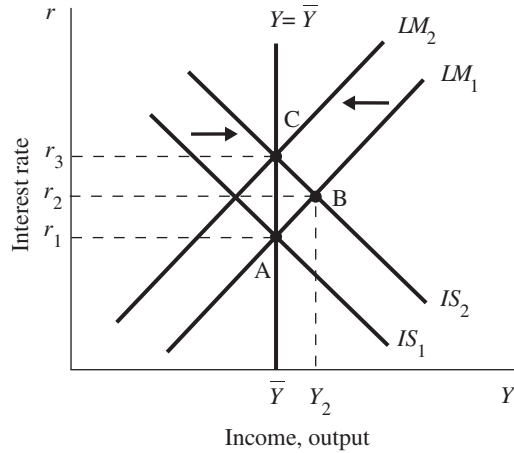
The increase in the interest rate reduces investment and "crowds out" part of the
expansionary effect of the increase in government purchases. Initially, the *LM*
curve is not affected because government spending does not enter the *LM* equa-
tion. After the increase, output is above its long-run equilibrium level, so prices
begin to rise. The rise in prices reduces real balances, which shifts the *LM* curve
to the left. The interest rate rises even more than in the short run. This process
continues until the long-run level of output is again reached. At the new equilibri-
um, point C, interest rates have risen to r_3, and the price level is permanently
higher. Note that, like monetary policy, fiscal policy cannot change the long-run
level of output. Unlike monetary policy, however, it can change the *composition*
of output. For example, the level of investment at point C is lower than it is at
point A.

c.   An increase in taxes reduces disposable income for consumers, shifting the *IS*
curve to the left, as shown in Figure 11–24. In the short run, output and the inter-
est rate decline to Y_2 to r_2 as the economy moves from point A to point B.

Figure 11–24

Income, output
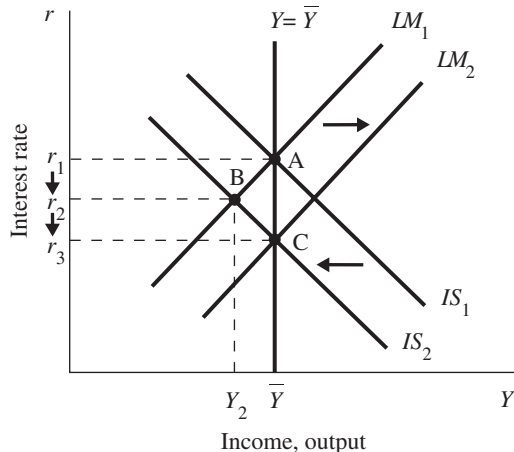
Initially, the *LM* curve is not affected. In the longer run, prices begin to decline because output is below its long-run equilibrium level, and the *LM* curve then shifts to the right because of the increase in real money balances. Interest rates fall even further to r_3 and, thus, further stimulate investment and increase income. In the long run, the economy moves to point C. Output returns to $\overline{Y}$, the price level and the interest rate are lower, and the decrease in consumption has been offset by an equal increases in investment.

7. Figure 11–25(A) shows what the *IS–LM* model looks like for the case in which the Fed holds the money supply constant. Figure 11–25(B) shows what the model looks like if the Fed adjusts the money supply to hold the interest rate constant; this policy makes the effective *LM* curve horizontal.

Figure 11–25
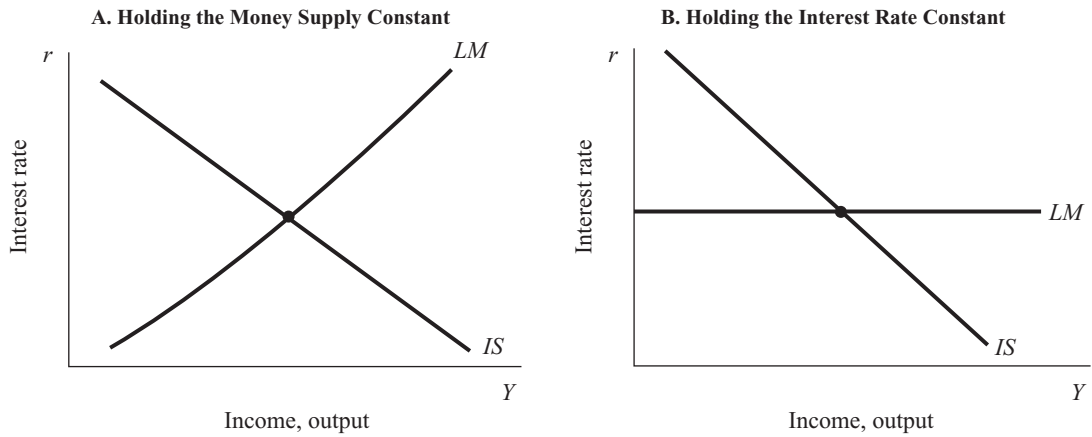
a.   If all shocks to the economy arise from exogenous changes in the demand for goods and services, this means that all shocks are to the *IS* curve. Suppose a shock causes the *IS* curve to shift from IS_1 to IS_2. Figures 11–26(A) and (B) show what effect this has on output under the two policies. It is clear that output fluctuates less if the Fed follows a policy of keeping the money supply constant. Thus, if all shocks are to the *IS* curve, then the Fed should follow a policy of keeping the money supply constant.
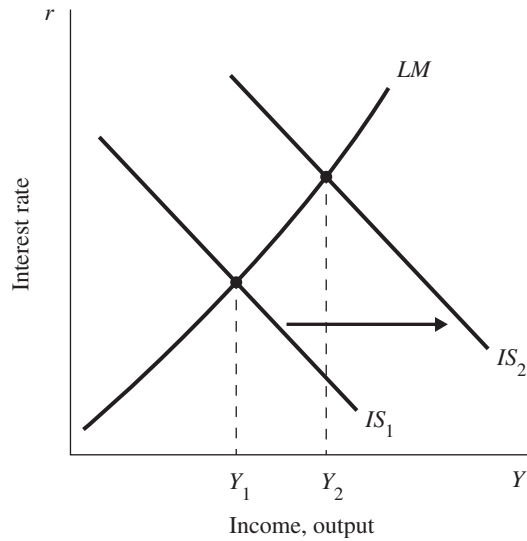
Figure 11–26
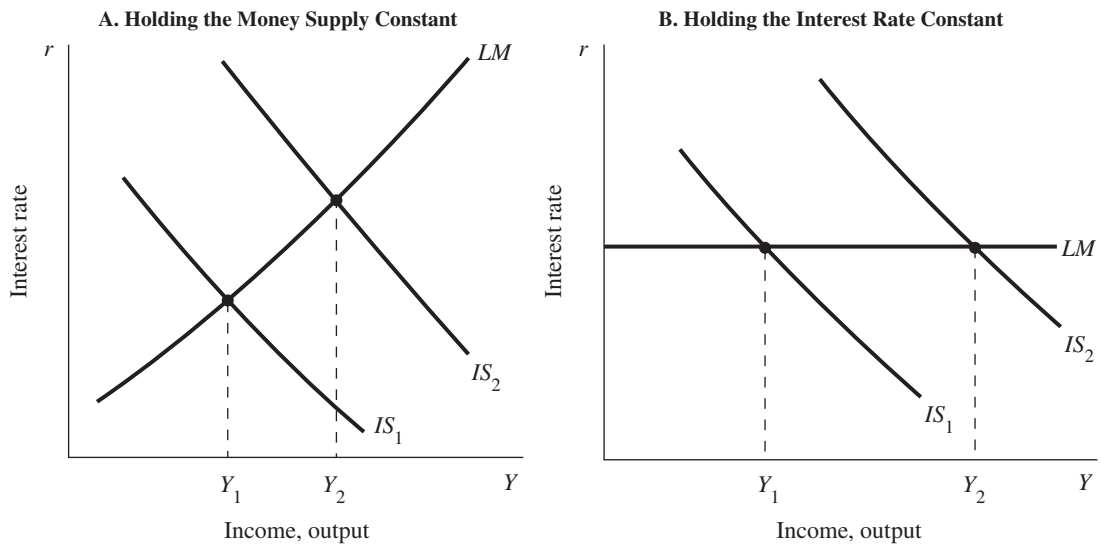
b.   If all shocks in the economy arise from exogenous changes in the demand for money, this means that all shocks are to the *LM* curve. If the Fed follows a policy of adjusting the money supply to keep the interest rate constant, then the *LM* curve does not shift in response to these shocks—the Fed immediately adjusts the money supply to keep the money market in equilibrium. Figures 11–27(A) and (B) show the effects of the two policies. It is clear that output fluctuates less if the Fed holds the interest rate constant, as in Figure 11–27(B). If the Fed holds the interest rate constant and offsets shocks to money demand by changing the money supply, then all variability in output is eliminated. Thus, if all shocks are to the *LM* curve, then the Fed should adjust the money supply to hold the interest rate constant, thereby stabilizing output.

Figure 11–27
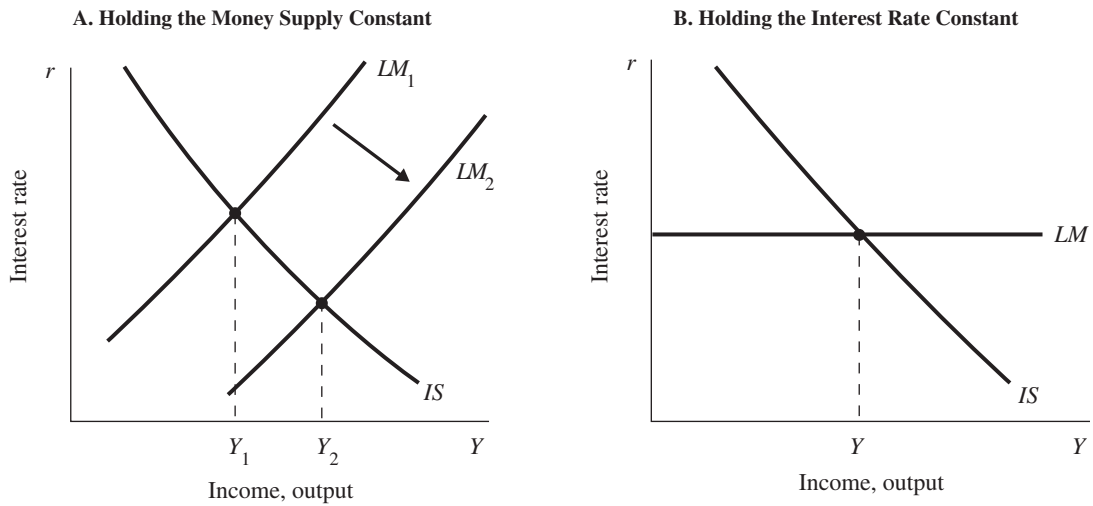
8. a.   The analysis of changes in government purchases is unaffected by making money demand dependent on disposable income instead of total expenditure. An increase in government purchases shifts the *IS* curve to the right, as in the standard case. The *LM* curve is unaffected by this increase. Thus, the analysis is the same as it was before; this is shown in Figure 11–28.

Figure 11–28

b. A tax cut causes disposable income $Y - T$ to increase at every level of income Y. This increases consumption for any given level of income as well, so the *IS* curve shifts to the right, as in the standard case. This is shown in Figure 11–29. If money demand depends on disposable income, however, then the tax cut increases money demand, so the *LM* curve shifts upward, as shown in the figure.

Thus, the analysis of a change in taxes is altered drastically by making money demand dependent on disposable income. As shown in the figure, it is possible for a tax cut to be contractionary.

Figure 11–29