

Chapter 12:

1. Questions For Review numbers 1,4 (p. 359).

1. We want to explain why an increase in the general price level (P) would cause equilibrium spending (Y) to fall. The IS-LM model provides one explanation.

According to IS-LM, an increase in P lowers the real money supply ($\frac{M}{P}$). This drives up interest rates (LM shifts upward), driving down interest sensitive spending (I). See Figure 12-5 on page 343 of Mankiw.

The increase in prices reduces the purchasing power of the money in people's pockets. However, their demand for real money balances is unchanged. Consequently, they try to sell bonds (in an attempt to restore their real money balances), driving interest rates up. At the high interest rates, businesses cut their purchases of plant and equipment, and consumers buy fewer new homes (recall that purchases of new homes are classified as residential investment – part of I).¹

2. Problems and Applications number 3c–g, 6–8 (p. 360–361).

3. This is similar to #2 in chapter 11. In that problem, we held the interest rate constant, and so we were in the Keynesian Cross framework. We now allow the interest rate to vary, which transforms the Keynesian Cross model into the IS model. We then add LM in order to be able to explain both interest rates and output.

IS is a description of product market equilibrium. It is all the combinations of output and interest rates for which the product market is in equilibrium (output equals spending).² Thus, we proceed just as we did with the Keynesian Cross, but allow the interest rate to vary (i.e., leave it as an undetermined variable).³

IS:

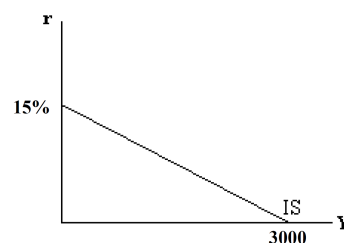
$$\begin{aligned} Y &= PE \\ &= C + I + G + NX \\ &= 1200 + .6Y - 80r \end{aligned}$$

Note that the slope of the expenditure line PE in the Keynesian Cross diagram is $.6$, and so the Keynesian Cross multiplier is 2.5 .

Consolidating Y in the equation above,

IS:

$$Y = 3000 - 200r$$



This says that equilibrium spending (Y) falls as interest rates (r) rise. An increase in the interest rate (say by 1 percentage point) will cause investment spending to fall (by 80), which reduces equilibrium spending and output (by $2.5 \times 80 = 200$) through the Keynesian Cross multiplier.

¹ Notice that in the IS-LM model, the increase in the price level does **NOT** have a direct effect on spending. E.g., it does not reduce the purchasing power of people's *incomes* directly. (We can see this in the model, since real planned expenditure $PE(Y, r)$ does not depend directly on P .) Rather, the effect of P on spending is indirect. An increase in the general price level P causes interest rates to rise, which in turn causes spending to fall.

² Equivalently, the loanable funds market is in equilibrium: $S = I + CF$.

³ Note that we are assuming a closed economy in this chapter, so $NX=0$ (and $CF=0$).

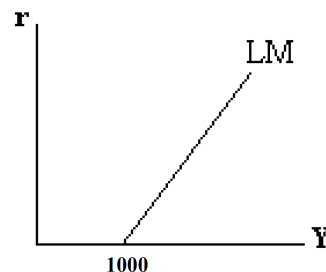
LM is a description of money market (and equivalently bond market) equilibrium. It is all the combinations of output and interest rates for which the money market is in equilibrium:

LM:

$$\left(\frac{M}{P}\right)^s = \left(\frac{M}{P}\right)^d$$

$$\frac{3000}{3} = Y - 200r$$

$$Y = 1000 + 200r$$



The LM says that interest rates (r) rise as spending (Y) increases. An increase in Y (say by 100) will cause money demand to rise (by 100), causing the interest rate to rise (by one half of 1 percentage point) as the public sells bonds in an effort to acquire the extra demanded money balances.

3c. Solve IS and LM simultaneously. For example, substitute an expression for Y from the LM into the IS:

$$1000 + 200r = 3000 - 200r$$

$$400r = 2000$$

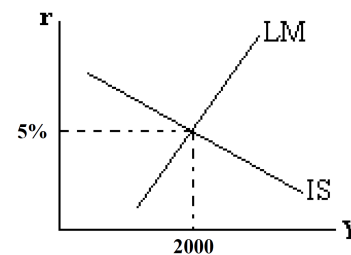
$$r = 5\%$$

Now plug this back into either the IS or LM to get the equilibrium value of Y :

$$Y = 3000 - 200r$$

$$= 3000 - 200 \times 5$$

$$= 2000$$



3d. Government purchases (G) have risen by 200. This shifts IS to the right by 200 times the Keynesian Cross multiplier: $2.5 \times 200 = 500$. That is, if the interest rate stayed constant at 5%, spending would rise by 500 in equilibrium. However, as spending increases, interest rates rise,⁴ dampening the increase in spending in the full IS-LM equilibrium (some investment spending is crowded out, partly offsetting the increase in government spending).

To calculate the new equilibrium Y and r , we need to re-solve the model using the new IS equation.

IS:

$$Y = 1400 + .6Y - 80r$$

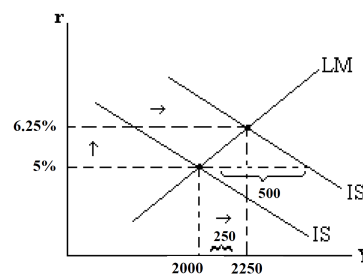
$$Y = 3500 - 200r$$

Setting IS and LM equal:

$$1000 + 200r = 3500 - 200r$$

$$400r = 2500$$

$$r = 6.25\%$$



Plugging this back into either the IS or LM, we get the equilibrium value of spending and output:

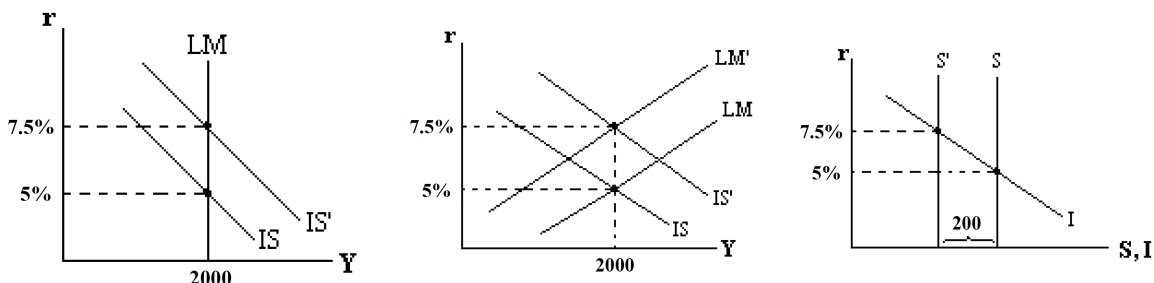
$$Y = 2250$$

⁴ The increase in Y drives money demand up, which in turn drives interest rates up as the public sells bonds in an attempt to hold more money.

Notice, then, that output rose by only 250 in equilibrium. One way of saying this is that the IS-LM multiplier is smaller than the Keynesian Cross multiplier (half the size of it in this example). If interest rates were held constant, output would increase by 500: the increase in government spending of 200 plus 300 of extra consumption spending through the Keynesian Cross multiplier process. However, in IS-LM, the interest rate was pushed up by 1.25 percentage point, reducing investment spending by 100, which is multiplied into an offsetting reduction in total spending (investment plus consumption) of 250.

Notice also, then, that the increase in government purchases of 200 (real dollars) crowded out 100 (real dollars) of investment spending (e.g., purchases of plant and equipment and new homes). The increase in G (by 200) is also a reduction in national saving S (by 200). Recall that in the long run model of Chapter 3, a reduction in national saving would cause interest rates to rise enough to cause an equal reduction in investment spending. I.e., increases in government purchases would crowd out investment spending one for one. In short run models (Chapters 11,12) however, crowding out is less than complete because output is variable. An exogenous increase in spending (i.e., an exogenous decrease in saving) must lead to an increase in interest rates, output, or both. I.e., it must either crowd out some other spending, or cause output to increase, or both, in order for spending and output to remain equal. In the long run model of Chapter 3, output is constant, so the interest rate must adjust enough to cause complete crowding out. In the Keynesian Cross model, the interest rate is fixed, so there is no crowding out and output must rise enough to cover the extra spending (or equivalently to restore saving to its original level). In the IS-LM model, we get an intermediate solution, with output rising some, but interest rates also rising some, so that we have both an expansion of output and some crowding out. Both increases (in Y and r) clearly must fall between the two extremes.

Finally notice that we get exactly the long run model result from IS-LM if either LM is vertical, or if the LM shifts up to leave Y unchanged after the expansionary fiscal policy change (e.g., if the Fed engages in offsetting tightening, or if prices adjust in the long run to restore the original level of Y). See the diagram below. Similarly, we get the Keynesian Cross model result from the IS-LM if either LM is horizontal or LM shifts downward to leave r unchanged after the expansionary fiscal policy change (e.g., if the Fed accommodates the fiscal expansion by easing monetary policy to keep interest rates from rising).



3e. Again, we need to re-solve IS-LM using the new LM equation.

LM:

$$Y = 1500 + 200r$$

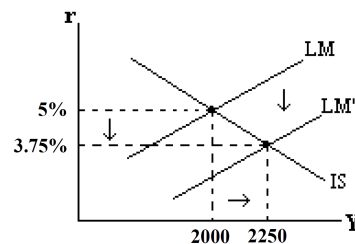
Setting IS equal to LM:

$$1500 + 200r = 3000 - 200r$$

$$1500 = 400r$$

$$r = 3.75$$

$$Y = 2250$$



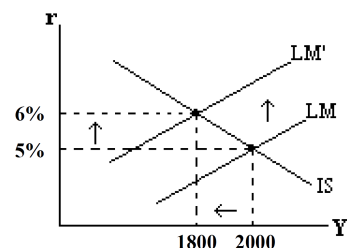
The increase in the nominal money supply M (by 1500), raises the real money supply M/P (by 500), which depresses interest rates r (by 1.25 percentage points), which in turn causes businesses to increase their investment spending (by 100), leading to an equilibrium expansion of output and spending (by $.5 \times 100 = 250$).

3f. Again, re-solve IS-LM using the new LM equation.

LM:
$$Y = 600 + 200r$$

Setting IS equal to LM:

$$\begin{aligned} 600 + 200r &= 3000 - 200r \\ 2400 &= 400r \\ r &= 6 \\ Y &= 1800 \end{aligned}$$



The increase in the general price level lowers the real money supply M/P (i.e., lowers the purchasing power of the money in people's pockets and checking accounts), which pushes interest rates upward (to 6.00%), which in turn causes businesses to cut their investment spending (by 80), leading to an equilibrium contraction of output and spending (by $2.5 \times 80 = 200$).

3g. Recall from the first question on this handout, that the IS-LM provides a foundation for aggregate demand. As the price level rises, LM shifts upward, driving interest rates up and thus spending and output down.

To derive the aggregate demand curve from the IS-LM model, we simply need to solve the IS-LM model leaving the general price level P as a variable. I.e., we want to solve for the equilibrium level of Y as a function of the price level P . This relationship between P and Y is the Aggregate Demand relationship.

IS:
$$Y = 3000 - 200r$$

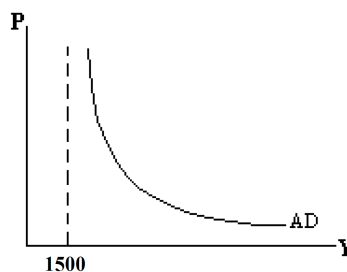
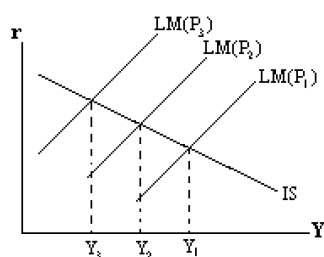
LM:
$$Y = \frac{3000}{P} + 200r$$

We can proceed as above, setting $Y_{LM} = Y_{IS}$, solving for r as a function of P , and then plugging this back in to IS or LM to get Y as a function of P . A bit more direct route is to get an expression for the interest rate from either IS or LM and plug this into the other relationship. For example, LM says that $200r = Y - 3000/P$. Plug this expression for $200r$ into the IS equation:

$$\begin{aligned} Y &= 3000 - \left(Y - \frac{3000}{P} \right) \\ &= 3000 - Y + \frac{3000}{P} \end{aligned}$$

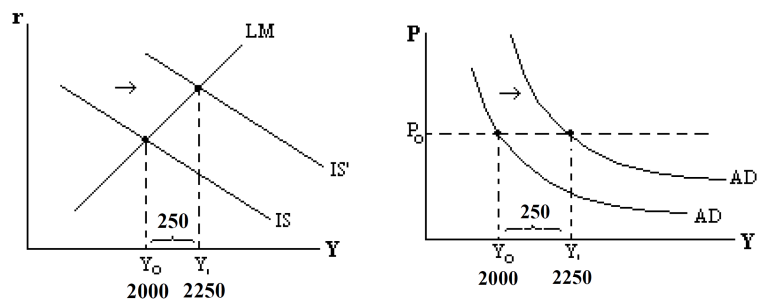
$$2Y = 3000 + \frac{3000}{P}$$

AD:
$$Y = 1500 + \frac{1500}{P}$$

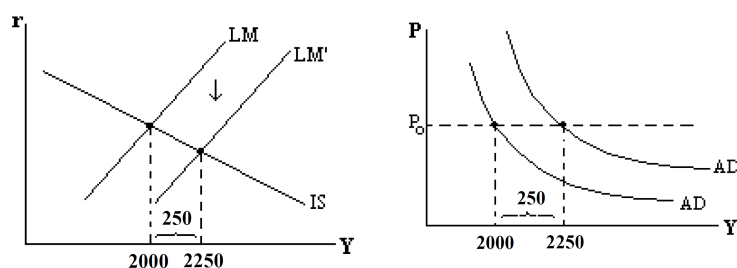


I sketched out the AD graph (above) by considering what happens to Y as P becomes small and large according to the AD equation.

An increase in G will increase the equilibrium level of Y in IS-LM at any given level of P . Consequently, AD shifts to the right by this amount (e.g., 250 in part d).



An increase in M will also increase the equilibrium level of Y in IS-LM at any given level of P . Consequently, AD shifts to the right by this amount (e.g., 250 in part e).



What we have, then, is a sequence of related models, based on the product market equilibrium relationship, which says that spending (PE) must equal production (Y). For the closed economy ($NX=0$) we have:

$$\begin{aligned} Y &= PE \\ &= C + I + G + NX \\ &= C(Y - \bar{T}) + I(r) + \bar{G} + 0 \end{aligned}$$

Holding r fixed, this is the Keynesian Cross model, and Y is fully determined. Leaving r variable this is the IS relationship between Y and r . To pin down Y and r in that case, we add the LM relationship between r and Y (money market equilibrium)

$$\frac{M}{P} = L(r, Y)$$

giving us the IS-LM model. If we hold P fixed, Y and r are fully determined. Leaving P variable, IS-LM gives us the aggregate demand AD relationship between P and equilibrium spending Y .⁵

Finally, if we add a model of the general price level P (which, in relationship to Y , we typically call an aggregate supply AS relationship), we have a full model of the economy which describes the equilibrium behavior of output, interest rates, and prices.

The way that we will model prices in this course is to assume that prices are either fully or partially fixed ('sticky') in the short run with respect to demand shocks, and rise or fall in the long run depending on the output gap ($Y - \bar{Y}$) and inflationary expectations. If prices are fully fixed in the short run with respect to demand shocks (the simplest case), then short run aggregate supply is always horizontal, but can shift over time as we move from the short run to the long run as well as in response to supply shocks. See 7 below and the next set of practice problems.

⁵ When we open the economy to trade (see 4 below) we will have the same sequence of models as well.

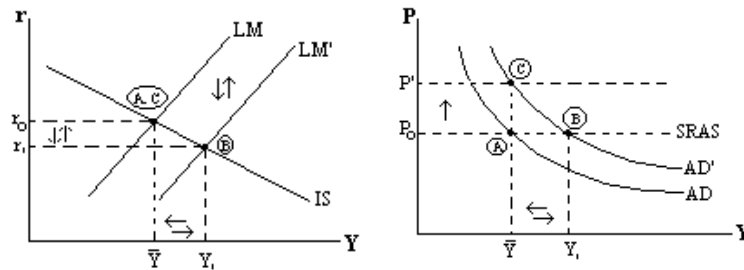
6. Tight fiscal policy (raise T and/or reduce G) in combination with loose monetary policy (raise M) will depress interest rates and thus stimulate investment spending. In the right combination, these policies can leave output unchanged, i.e., the loose monetary policy can exactly offset the recessionary effect of tight fiscal policy. See Figure 12-4, Panel C on page 338 of Mankiw.

The policy mix in the 1980s (tight monetary policy, loose fiscal policy) was just the opposite of this. According to the IS-LM model, this policy mix should have pushed up real interest rates. Indeed, while nominal interest rates fell in the 80s as the inflation rate came down, real interest rates rose dramatically. In terms of output, the tight monetary policy appears to have dominated other factors, causing a protracted recession in 1982–83. Over the course of the decade, the mix left r high and Y at \bar{Y} on average. It is also worth noting that the high interest rates of the 1980s depressed not only investment spending I but also net exports NX . The trade deficit soared in the 1980s. See problem 3 below.

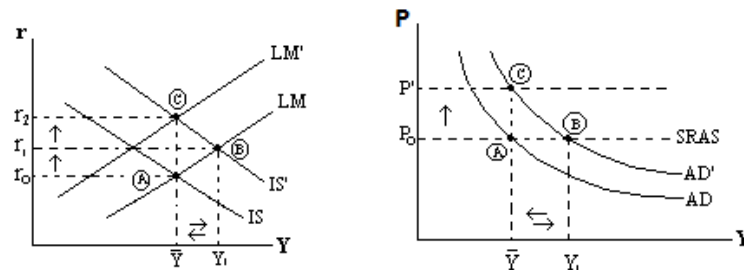
Subsequently, during the 1990s, Federal Reserve chair Alan Greenspan took the public position that if Congress and the Administration acted to reduce the federal budget deficit, then the Fed would allow interest rates to fall (i.e., use monetary policy to avoid a subsequent recession). However, he also indicated that the Fed would push up interest rates in the face of any further fiscal expansion to avoid inflation (i.e., he would use monetary policy to keep output from rising above its ‘natural’ rate, and sparking inflation).

In 2003, Greenspan reversed this position, publicly supporting the Bush tax cuts while the Fed held interest rates low. This was partly in response to the weak recovery after the 2001 recession and to projections (at the time) of future budget surpluses.

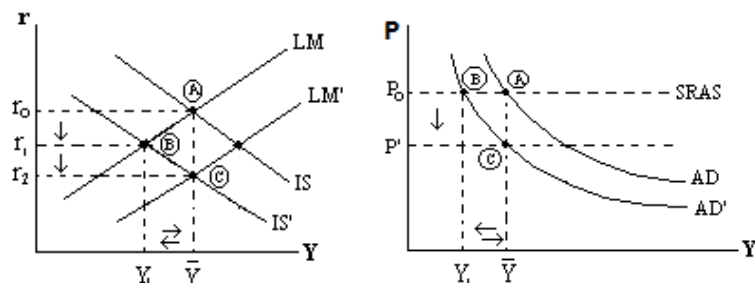
7. Start in long run equilibrium for each case (i.e., $Y = \bar{Y}$). On the graphs below, the short run movement is from point **A** to point **B**, and the long run movement is from point **B** to point **C**.
- An increase in M will cause interest rates to fall (LM shifts downward), and consequently spending and output to rise in the short run. Output is above its natural rate \bar{Y} , and so in the long run prices will rise over time. This causes an offsetting reduction of the real money supply, shifting LM back upward and raising interest rates back up, until output has returned to \bar{Y} .



- An increase in G will cause output to increase (IS shifts to the right) and consequently interest rates to increase somewhat in the short run. Output is again temporarily above \bar{Y} , and so in the long run prices will rise over time. As above, this shifts LM upward, raising interest rates and reducing spending, until output has returned to \bar{Y} . In the long run, we have a one-for-one crowding out of investment spending by the increase in government spending.



- c. An increase in T will cause consumption spending and thus output to decrease (IS shifts to the left) and consequently interest rates to decrease somewhat in the short run. Output is now below \bar{Y} , and so in the long run prices will fall over time, shifting LM downward, depressing interest rates and thus stimulating spending, until output has returned to \bar{Y} . In the long run, we have a one-for-one crowding in of investment spending by the direct fall in consumption spending induced by the tax hike.

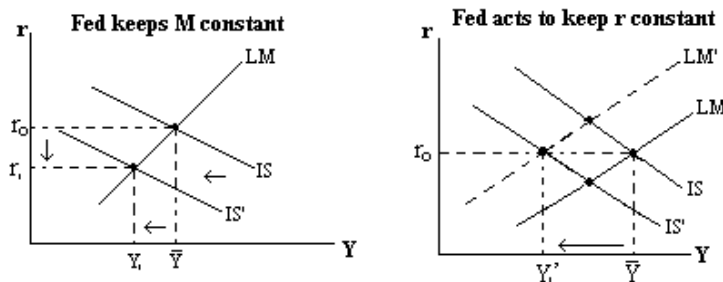


Note that if both G and T were to increase by the same amount, we would get a net expansion as in part **b**,⁶ but the expansion would be smaller (AD would shift to the right by a smaller amount and prices would have to rise less in the long run to bring output back to \bar{Y}).

Note that, once we assume that the general price level P adjusts in the long run to leave output unchanged at a ‘natural’ rate \bar{Y} in the long run, then we are back to the long run model of Chapter 3. The long run behavior of interest rates and spending are exactly those of that model. This is because that model was just the IS relationship (product market equilibrium: spending equals production) with a fixed level of production Y .

8.

- a. Here, the business cycle (i.e., output fluctuations) is caused by shifts of IS . For example, businesses or consumers may suddenly become optimistic or pessimistic, and make more or less purchases (respectively), shifting IS out or in (respectively). The IS-LM model predicts that, if the Fed does nothing (i.e., holds M constant), interest rates will play a stabilizing role in this case. For example, if spending falls and IS shifts to the left, interest rates will fall, stimulating spending somewhat and dampening the recession. Similarly, if spending rises and IS shifts to the right, interest rates will rise, dampening spending somewhat and thus dampening the expansion.



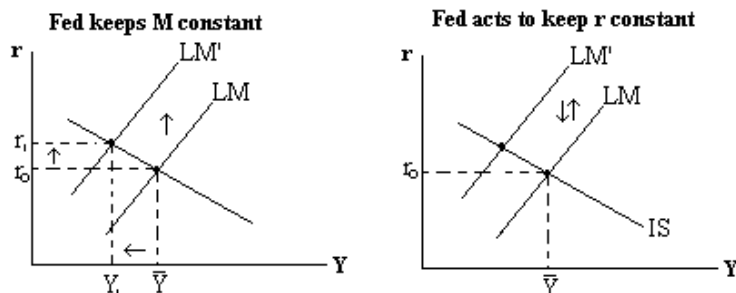
If, on the other hand, the Fed acts to stabilize interest rates (in this case by decreasing the money supply during recessions and increasing the money supply during expansions), it will be destabilizing output, making recessions deeper and expansions more vigorous.

- b. Here, the business cycle (i.e., output fluctuations) is caused by shifts of LM . For example, businesses or consumers may suddenly decide to hold more or less money, shifting LM up or down respectively. The IS-LM model predicts that, if the Fed does nothing (i.e., holds M constant), interest rates will play a destabilizing role in this case. For example, if money demand rises (shifting LM upward),

⁶ Recall **2f** from Practice Problems 4.

interest rates will rise, depressing spending and thus causing a recession. Similarly, if money demand falls (shifting LM downward), interest rates will fall, stimulating spending and thus causing an expansion.

If, on the other hand, the Fed acts to stabilize interest rates (in this case by increasing the money supply during recessions and decreasing the money supply during expansions), it will be stabilizing output, eliminating recessions and expansions altogether if successful.



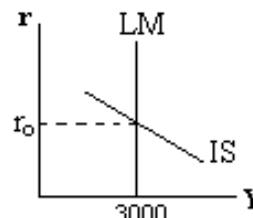
3.

3a. Recalling that $m = \frac{1+cr}{cr+rr}$, the nominal money supply M is

$$\begin{aligned} M &= m \times B \\ &= 2 \times 1200 \\ &= 2400 \end{aligned}$$

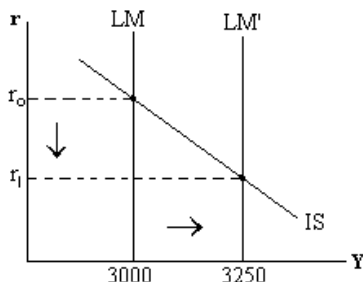
and the price level P is 1. Equating real money supply (M/P) and money demand, we get $Y = 2400/0.8 = 3000$.

Notice that since LM is vertical, equilibrium output Y is determined solely by LM , but interest rates r depend also on spending (IS).

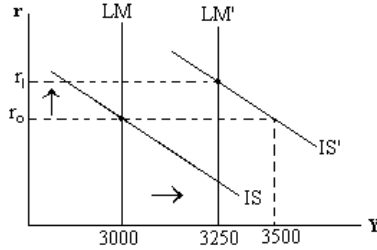


3b. The Fed is increasing the monetary base B by 100. Since the money multiplier is 2, this increases the money supply by 200. Equating the new money supply (2600) with money demand, we get $Y = 3250$. Output increases by 250.

The money supply expands by the increase in the base (100) plus a further increase (100) through the process of deposit creation via banks loans. This expansion of the money supply depresses interest rates, stimulating investment spending, and thus causing output to increase.



3c. Now we have an increase in the monetary base by 100 as above but also an increase in government purchases by 100. If the K-Cross multiplier is 5, then IS shifts to the right by 500 (i.e., spending rises by 500 if interest rates stay constant). Interest rates will rise, however, unless the money supply rises sufficiently (i.e., LM is shifted out sufficiently) to offset the pressure of increased spending on interest rates. But LM has only shifted to the right by 250, so interest rates do increase, though not by as much as if the increase in the deficit was not monetized (i.e., if the Fed left M constant).



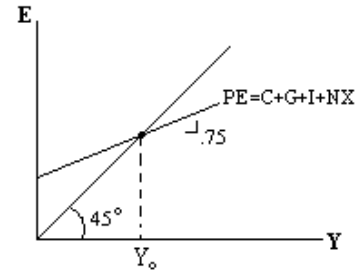
Note then, that the effect on interest rates depends on both IS and LM – they may increase or decrease in the new equilibrium depending on the relative sizes of the two shifts. This is the case even though the Fed is buying exactly the same amount of bonds that the Treasury is selling and so the direct impact of these bond purchases and sales on interest rates is a wash.

4. Consider the product market equilibrium condition that spending (PE) equals production (Y). We now have

$$Y = PE \\ = C(Y - \bar{T}, r) + I(Y, r) + \bar{G} + NX(Y, r)$$

which, as before, says that equilibrium spending and output (Y) depends on various factors such as taxes, government purchases, and interest rates.

- 4a. If we hold interest rates (r) constant, we are in the Keynesian Cross framework. The slope of the planned expenditure line (PE) in terms of Y is the sum of the slopes of consumption, investment and net exports respectively, which here is $MPC + MPI + MPNX = .8 + .1 - .15 = .75$.



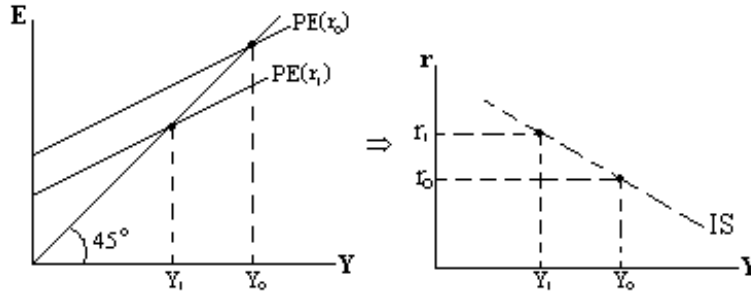
Consequently, the Keynesian Cross multiplier is $1/(1 - .75) = 4$. The multiplier is higher, the higher are the marginal propensities to consume and invest, but lower, the higher is the marginal propensity to import. You can think of this in terms of rounds of spending in the multiplier process. A one dollar increase in exogenous spending (e.g., government spending or exogenous consumption spending) will lead to a subsequent 80 cent increase in consumption and a 10 cent increase in investment. However, 15 cents of this extra spending is on imports, and so spending on domestically produced goods and services (Y) has only risen by 75 cents. This subsequently causes a further increase in spending of $.75 \times 75 = 56.25$ cents, and so forth.

- 4b. To derive the shape of the IS, pick two interest rates. Call the lower interest rate r_0 and the higher interest rate r_1 . We want to know whether equilibrium output in the Keynesian Cross model rises or falls as the interest rate rises from r_0 to r_1 .

According to the assumptions given in the problem, the increase in the interest rate from r_0 to r_1 will cause consumption, investment, and net exports⁷ to fall *ceteris paribus*. Thus, spending PE will be lower at the current level of output and income Y. This is a downward shift of the expenditure line PE in the Keynesian Cross diagram. According to part a, equilibrium output will fall by this vertical shift (initial fall in spending) times four. Since equilibrium Y falls as r rises, the IS is negatively sloped, just as before.⁸

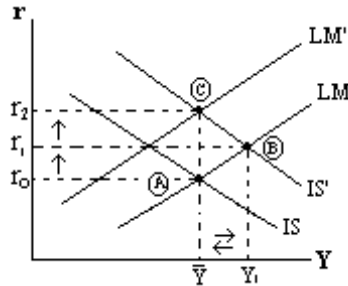
⁷ The effect on NX is as follows: the increase in r causes a capital inflow (i.e., a fall in net capital outflow (CF)), which drives up the real exchange rate ϵ , which drives down NX.

⁸ When interest rates rise, consumption and net exports now fall in addition to investment spending. This flattens out the IS curve somewhat. Additionally, the multiplier is now larger due to the MPI and smaller due to the MPIM (with the latter effect beating out the former effect in the current example). A larger (smaller) multiplier makes the IS curve flatter (steeper). The net effect is that the IS curve might be flatter or steeper than before.



What we have is a modified IS-LM model whose essential properties are the same as those of the simpler model that we have studied, but which is richer in detail. The effects of most changes (e.g., in M , G , T , P) on output and interest rates will be qualitatively the same as before, but there are differences in magnitudes as well as in compositional effects.

- 4c. A tax cut raises consumption spending, leading to an increase in output at current interest rates (IS shifts to the right — by the amount predicted by the Keynesian Cross). The increase in output drives interest rates up, leading to a partially offsetting reduction in interest sensitive spending, which now includes consumption, investment, and net exports rather than just investment.



In the short run, output and interest rates both increase (to Y_1 and r_1 on the diagram). Government spending is unchanged. Net exports have fallen, since both Y and r have risen. The effect on investment is unclear (Y has risen, stimulating I , but r has also risen, depressing I). If the LM is relatively flat (so r doesn't rise much) or investment is relatively interest insensitive, then I will actually be crowded in (rise). Consumption has risen, since it is the initial tax induced increase in consumption that drives the expansion of output (to Y_1 in the diagram).

In the long run, prices rise to bring Y back to \bar{Y} (LM shifts upward). Thus, interest rates rise more and Y returns to its original value. Investment is now unambiguously lower than its original value before the tax cut (Y is unchanged, r is higher), as are net exports. Consumption is still higher than its original value before the tax cut ($Y-T$ has risen, stimulating C , and r has risen, depressing C , but since I and NX have fallen, and Y and G are unchanged, C must be higher).

Suppose that we start with a balanced federal budget ($T = G$) and balanced trade ($NX = 0$). Then notice that the effect of cutting taxes in both the short and long run in this model is to run both a budget and a trade deficit. This appears to be what happened in the 1980s, following the tax cuts of 1981 and 1986. Real interest rates rose, the dollar appreciated, and we ran a large trade deficit.