

MACROECONOMICS 042EC

02 – Analysis in the short run

IS-LM Equilibrium in goods & financial markets (Ch 5,6)

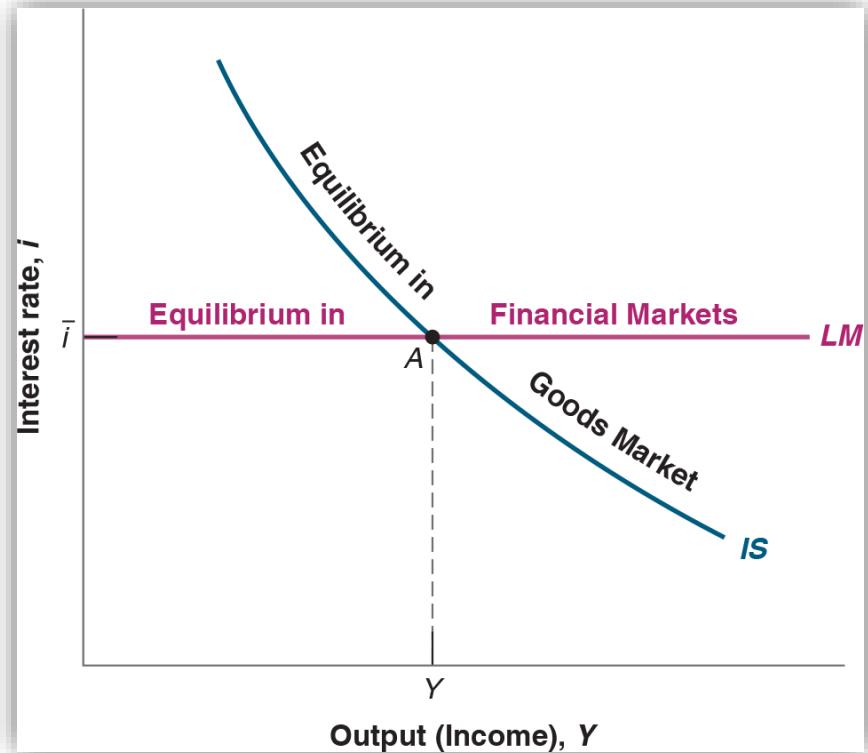
Ludovico Carrino

Towards the IS-LM model

- Chapter 3 looked at the goods market.
- Chapter 4 looked at the financial market.
- We now look at goods and financial markets together.
- We aim at a framework that models the SHORT RUN equilibrium in our economy (in both the goods and the financial markets), and how it is affected by changes in demand and supply (of goods and of money/bonds).

We want to answer this question:

- What can affect and determine the joint equilibrium in both goods and financial markets?
- What's the role of
 - Fiscal policy (G, T)
 - Monetary policy (i)
- Graphically, we will highlight the link between interest rate i and overall output Y



The goods market and the IS relation

The goods market and the IS relation

- In equilibrium: production $Y =$ demand Z , which we defined as ...

$$Y = Z = C(Y - T) + \bar{I} + G$$

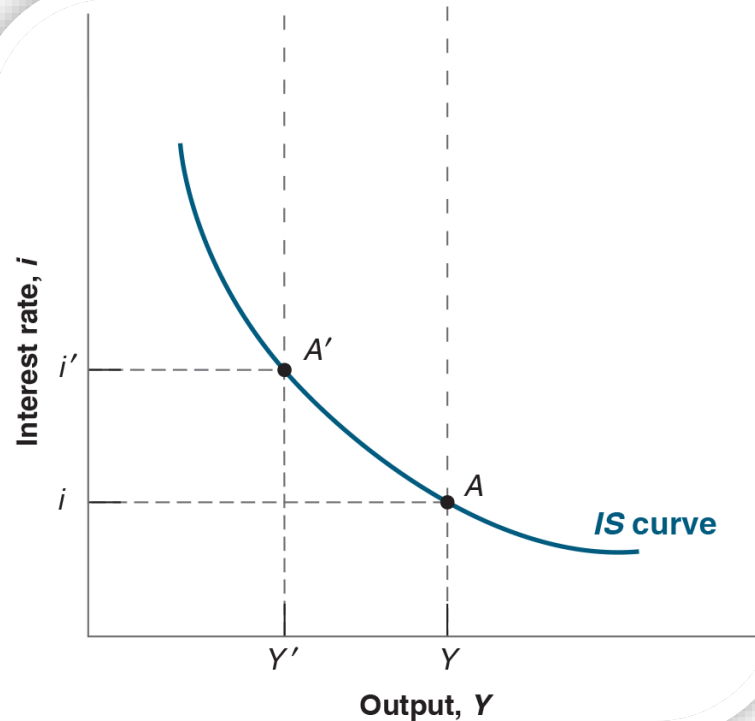
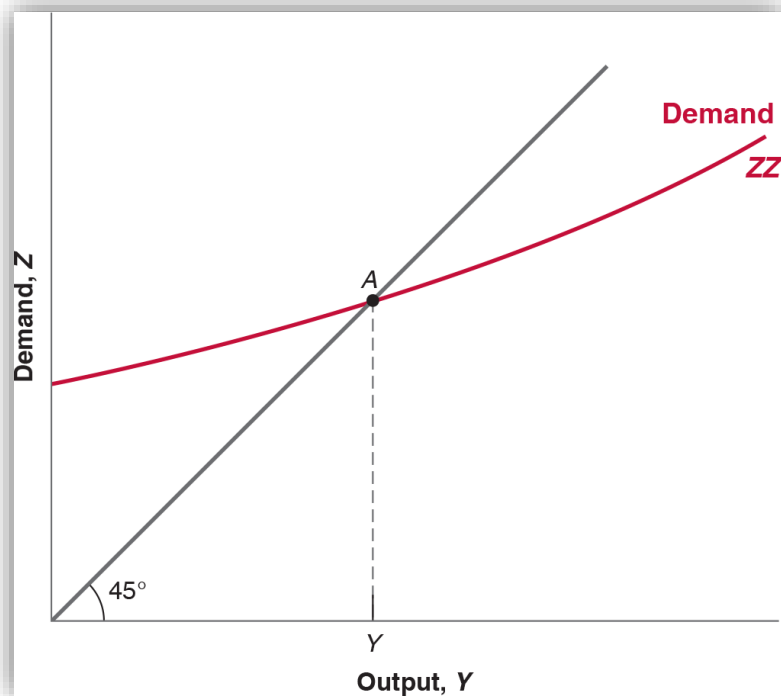
- For now we drop the explicit linear consumption function, back to a generic “ C ” function of Y_D
- In the model developed in Chapter 3, investment was assumed to be constant for simplicity.
- We now realise that investment-spending depends on production Y (or sales) and the interest rate i .

$$I = I(Y, i)$$

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- Higher production might require new machines or plants
- Higher interest rates makes it harder to borrow money to fund investment spending, and makes lending more attractive than purchasing investment goods.
- We do not distinguish yet between nominal and real interest rate

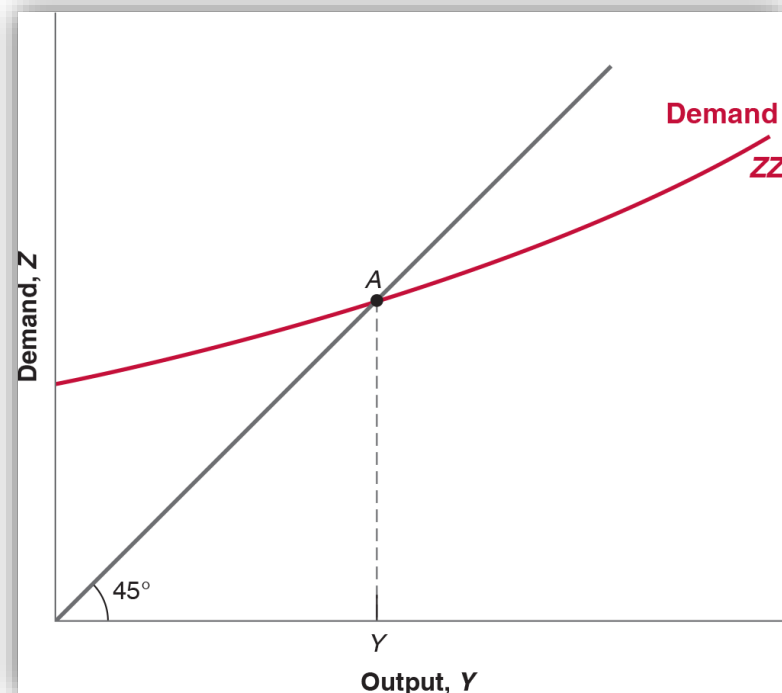
From the ZZ curve to the IS curve: same model, different graphical space



- The demand function (call it ZZ) is $ZZ = C(Y - T) + I(Y, i) + G$
- So equilibrium in the goods market becomes:

$$Y = C(Y - T) + I(Y, i) + G$$

- Draw the ZZ in the (Y, ZZ) space
 - ZZ is a generic curve, we do not know its specific shape (no assumptions yet)
- Why demand is increasing in output?
 - Multiplier effect: output \rightarrow income \rightarrow \rightarrow increase in consumption \rightarrow demand...
 - New assumption on investment (invisible in the graph):
output increases \rightarrow I increases \rightarrow \rightarrow demand increases



- Equilibrium still requires that demand for goods is equal to output ("A")

- We now ask: how does output respond to changes in the interest rate?

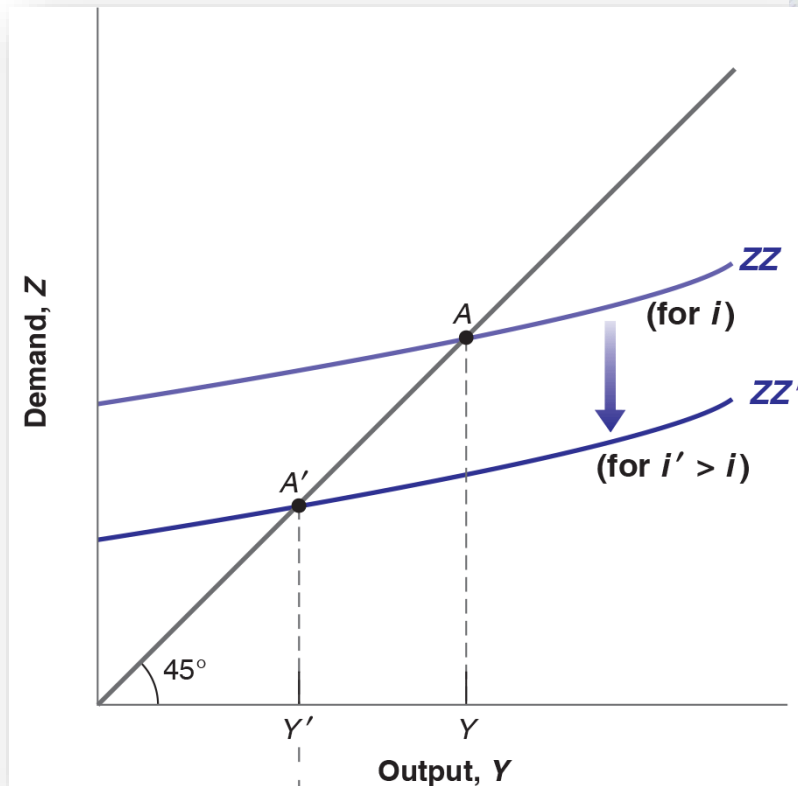
- We will call this the “IS relation”, which will model how output responds to changes in the interest rate

- We already have all the info to work it out

$$Y = C(Y - T) + I(Y, i) + G$$

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- If i increases, I and ZZ drop $\rightarrow Y$ drops



- We now ask: how does output respond to changes in the interest rate?

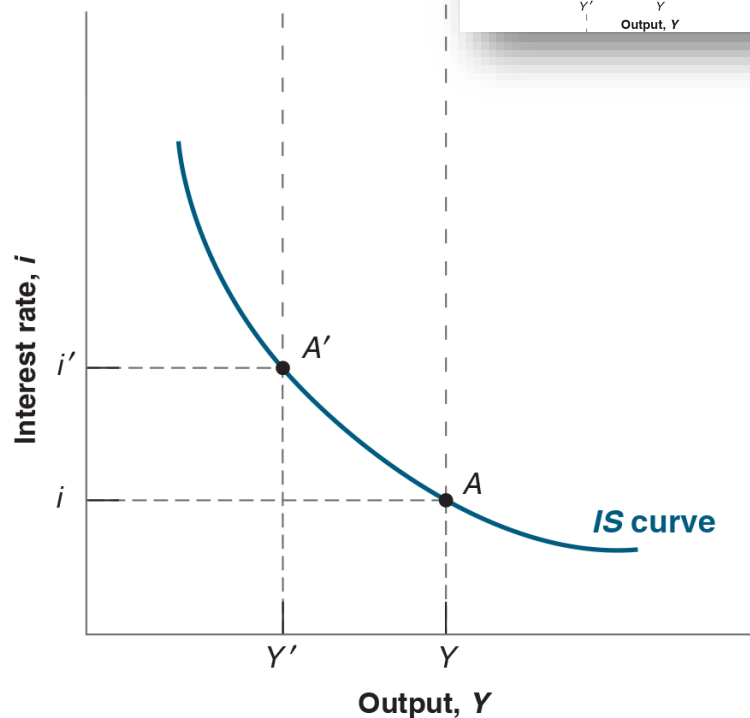
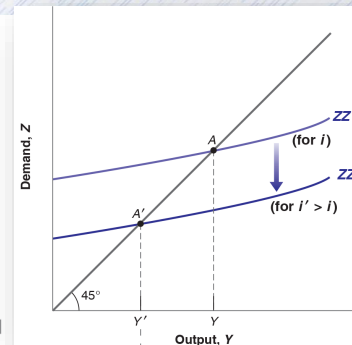
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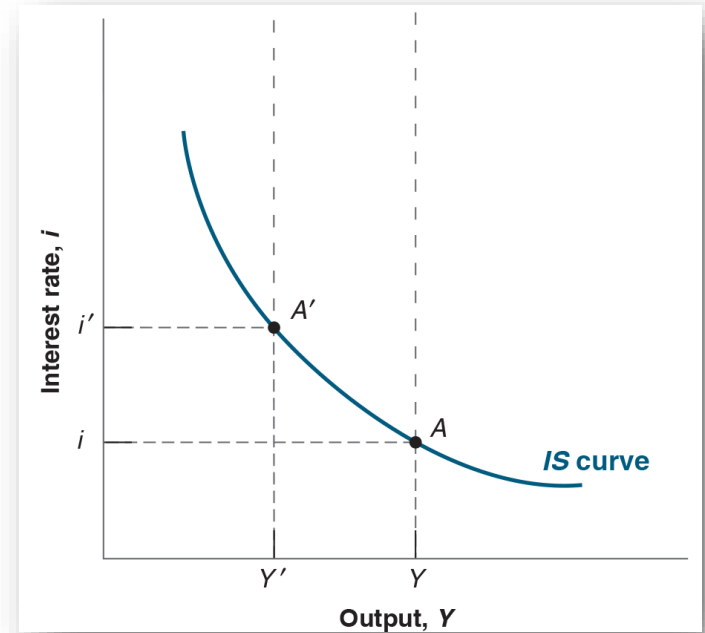
- If i increases, I and ZZ drop \rightarrow Y drops
- We can draw the same relationship in the space (Y, i) : **that's the IS curve**
 - We do not specify an analytic form



$$Y = C(Y - T) + I(Y, i) + G$$

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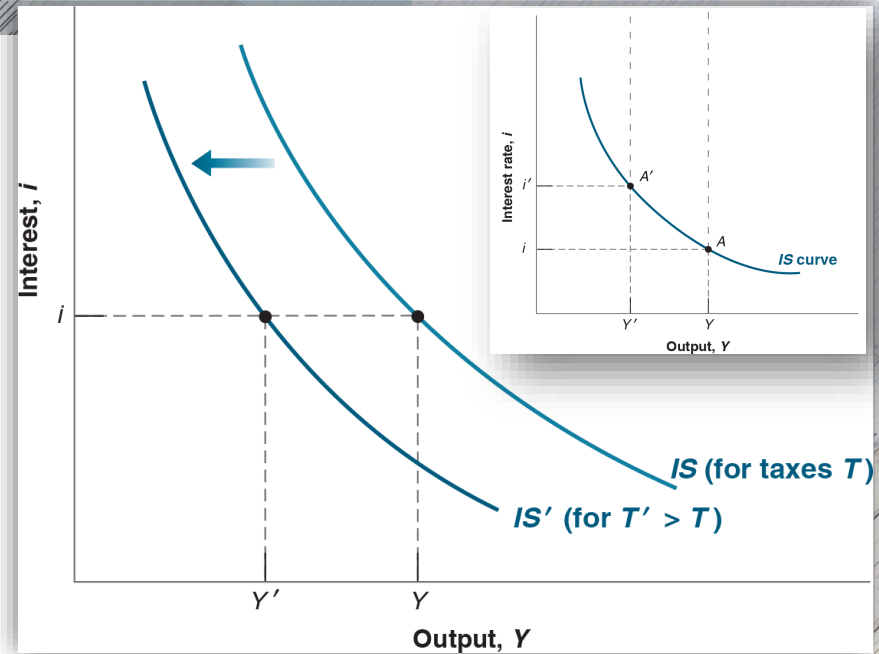
- The IS relation models how output responds to changes in the interest rate
- An increase in the interest rate decreases the demand for goods at any level of output, leading to a decrease in the equilibrium level of output.
- Equilibrium in the goods market implies that an increase in the interest rate leads to a decrease in output.
- The IS curve is therefore downward sloping.



$$Y = C(Y - T) + I(Y, i) + G$$

+ + -

- The IS curve shows the direct link between Y and i
- What if something other than i changes, such as G , or T ?
- Suppose taxes increase from T to T' . At a given interest rate, disposable income drops \rightarrow consumption drops \rightarrow demand for goods drops \rightarrow (multiplier) \rightarrow equilibrium output drops from Y to Y' .
 - The IS curve shifts to the left: at a given interest rate, the equilibrium level of output is lower than it was before the increase in taxes
- **More generally, any factor that, for a given interest rate, decreases (increases) the equilibrium level of output causes the IS curve to shift to the left (right).**



IS relation: what happens to Y when i changes

$$Y = \underset{+}{C(Y - T)} + \underset{+ -}{I(Y, i)} + G$$

- Can we guess the shape for the IS relation? Not without assumptions.
 - Assumptions: both consumption and investment are linear functions

$$C(Y - T) = c_0 + c_1(Y - T) \quad I(Y, i) = d_0 + d_1Y - d_2i$$

- with $c_0 > 0$; $0 < c_1 < 1$; $d_0, d_1, d_2 > 0$; $c_1 + d_1 < 1$

- Then

$$Y = [c_0 + c_1(Y - T)] + (d_0 + d_1Y - d_2i) + G$$

- Solve for y:

$$Y = \frac{1}{1 - (c_1 + d_1)} (c_0 + d_0 - c_1T + G) - \frac{d_2}{1 - (c_1 + d_1)} i$$

if G or c_0 or d_0 increase by 1, Y increases by this amount

if i increases by 1, Y decreases by this amount

IS relation

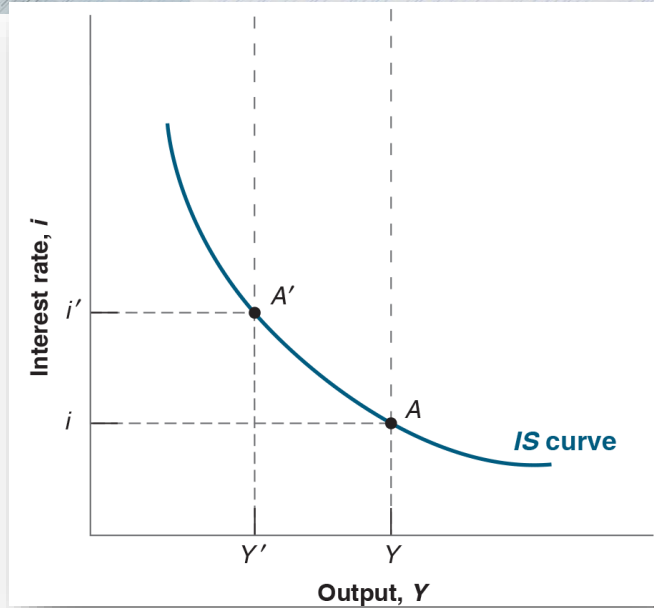
$$Y = C(Y - T) + I(Y, i) + G$$

+ + -

- Can we guess the shape for the IS relation?
- Under linear assumptions for C and I, we found:

$$Y = \frac{1}{1 - (c_1 + d_1)} (c_0 + d_0 - c_1 T + G) - \frac{d_2}{1 - (c_1 + d_1)} i$$

- Is this the equation for the curve plotted in the diagram in this slide?
- No: the diagram has i on the vertical axis, so we should solve for i



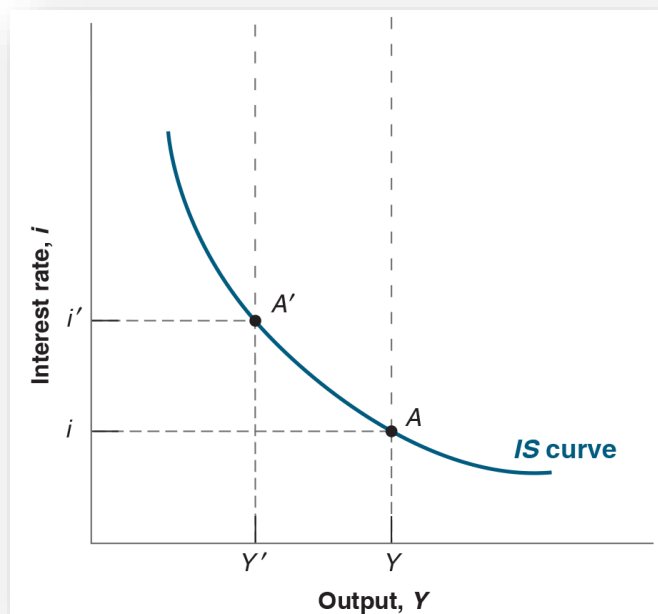
$$i = \frac{1}{d_2} (c_0 + d_0 - c_1 T + G) - \frac{1 - (c_1 + d_1)}{d_2} Y$$

if Y increases by 1, i decreases by this amount.
This is the slope we see in the curve we draw

- This formula is only used to graph the IS relationship
- We prefer to use the equation where Y is on the left and i on the right, because the variable which the policy can easily change is i . So it makes sense to ask: what happens to Y if i changes?

Wrap-up: the IS relation

- IS relation: all the combinations of i and Y that are consistent with equilibrium in the goods markets (demand of goods = supply of goods)

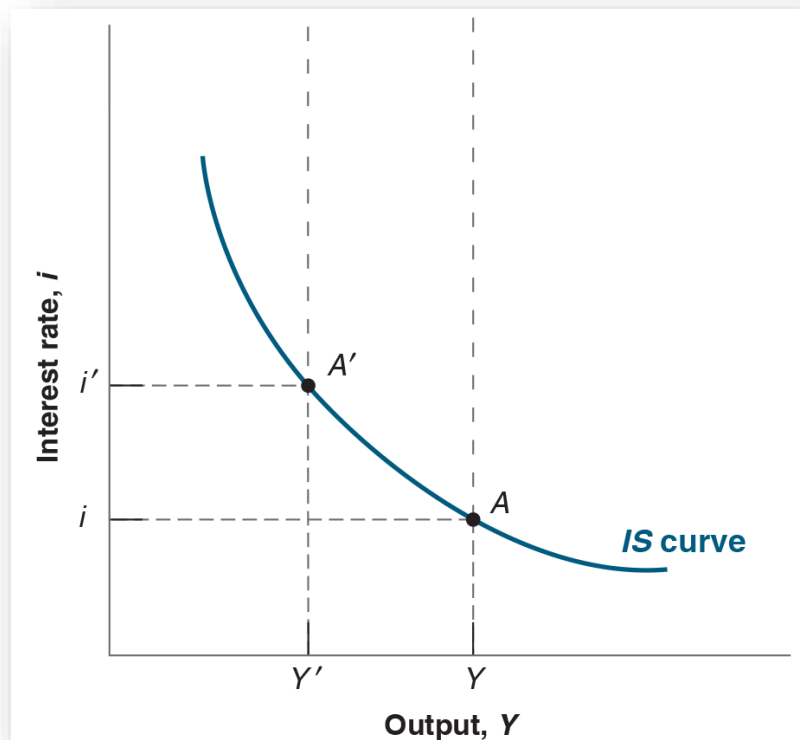


The Financial markets and the LM relation

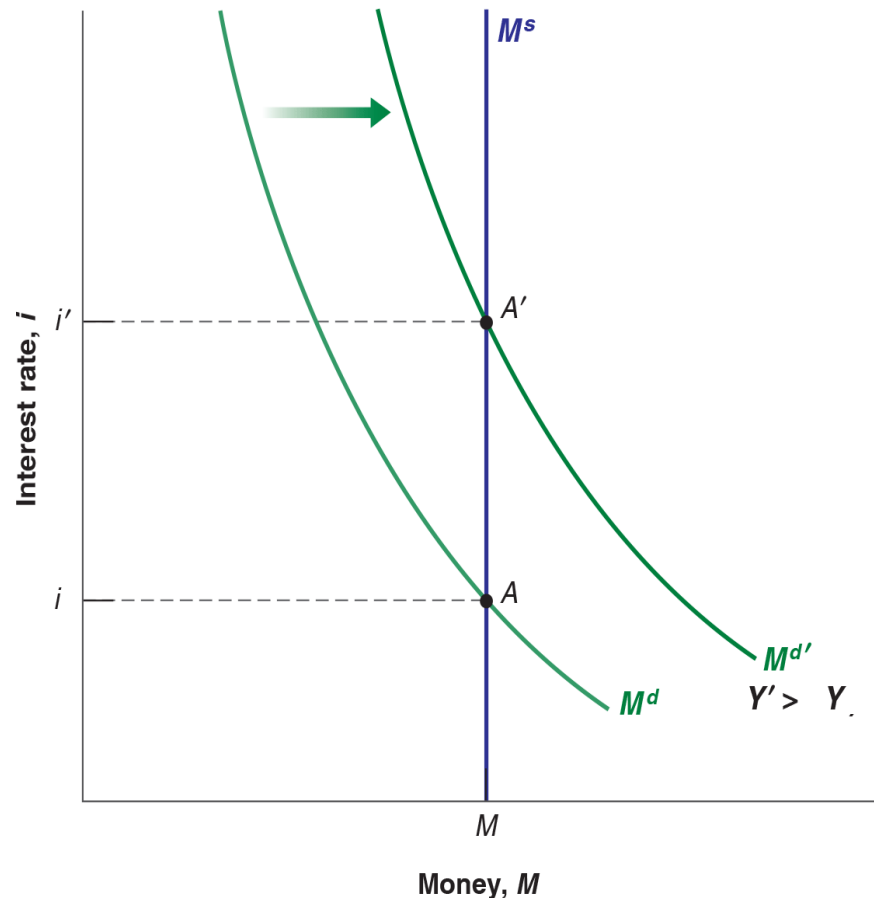
The Financial markets and the LM relation

- Recall equilibrium in financial markets: $M^S = M^D \rightarrow M = \epsilon Y L(i)$
- We prefer to deal with real income (Y) for practical purposes (in the goods market we focused on real income).
 - Recall that $Y = \epsilon Y / \text{GDP deflator } (=P)$, therefore $\epsilon Y = Y * P$
- Dividing both sides of the equation by P , we get $\frac{M^S}{P} = \frac{M^D}{P} \rightarrow \frac{M}{P} = YL(i)$
 - real money supply equals the real money demand, which depends on real income Y , and the interest rate i
- $\frac{M}{P} = YL(i)$ is the equation we use for finding the *LM* relation
- *LM* relation: all the combinations of i and Y that are consistent with equilibrium in financial markets (demand of money = supply of money)

- $\frac{M}{P} = YL(i)$
- LM relation: all the combinations of i and Y that are consistent with equilibrium in financial markets (demand of money = supply of money)
- We want to draw the LM relation in the same space of the IS



- $\frac{M}{P} = YL(i)$
- We want to draw the LM relation in the same space of the IS
- Old textbooks: central banks control the money supply.
- Suppose we are in A, the central bank wants the money supply = M
- An exogenous shock increases income
- Demand for money rises
- Dis-equilibrium: demand > supply of money.
- To go back to equilibrium **by keeping the money supply intact**, the interest rate should increase



- Therefore the LM curve would be positively sloped: equilibrium in the financial markets require that, if Y rises, the interest rate rises (and viceversa)

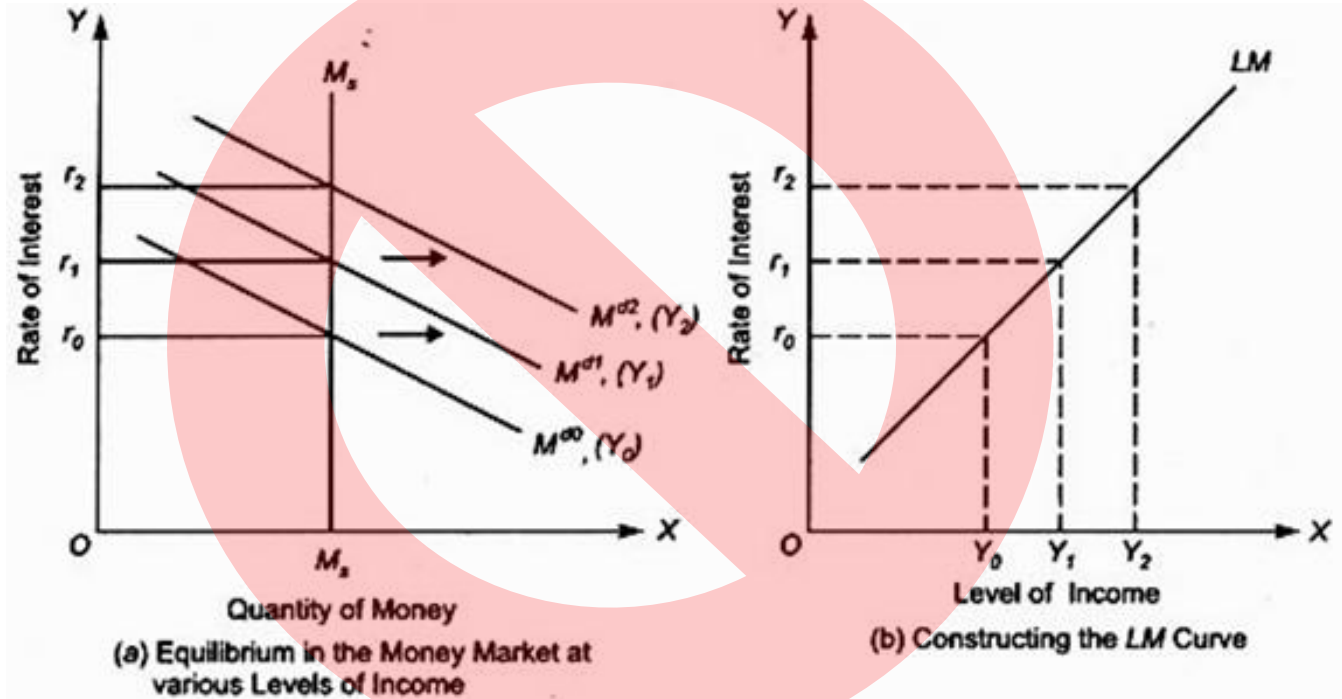
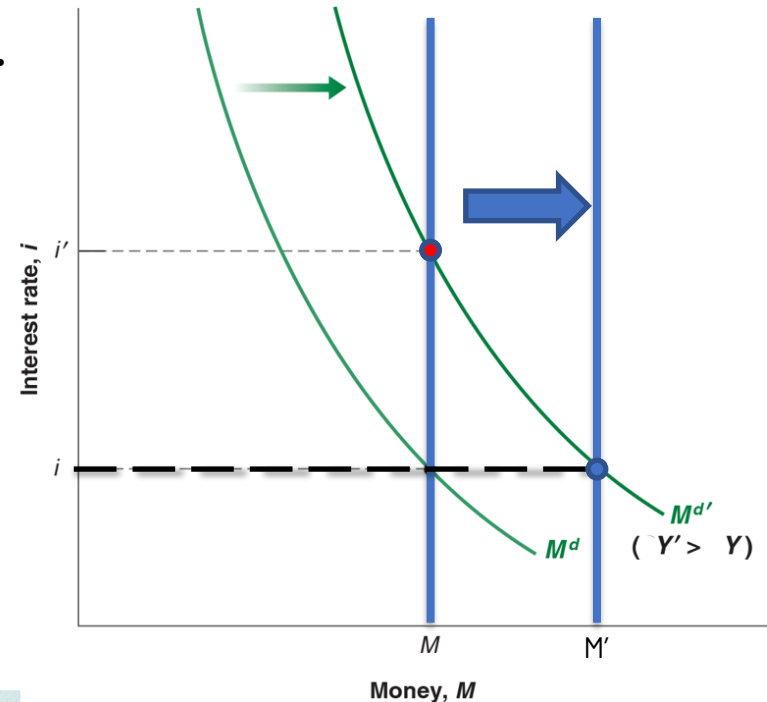


Fig. 20.2. Derivation of LM Curve

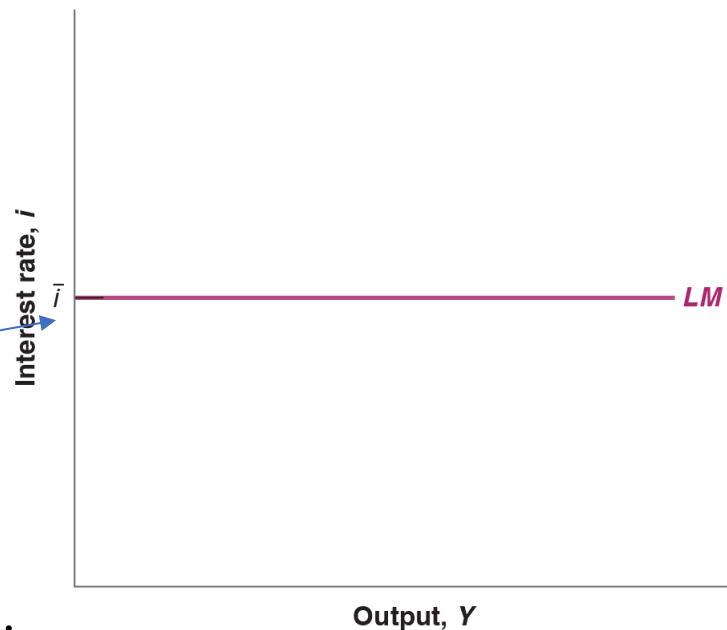
- $\frac{M}{P} = YL(i)$
- **Assume that, as in reality, the central bank aims at a given level of i , not of M . They are ready to adjust the money supply to achieve it.**
- Suppose we are in A, Money supply = M
- an exogenous shock increases income
- To keep the money supply intact, the interest rate should increase to i'
- BUT if the central bank wants to keep i constant, they can increase money supply!
 - From M to M'
- So they adjust M to keep i constant
- Hence: Y increased from Y to Y' , but the equilibrium in the financial market is maintained at the same interest rate (because M has increased)



- Therefore, the LM relation can be represented with this peculiar curve
- The central bank chooses an interest rate, \bar{i} , and adjusts the money supply so as to achieve it. For any level of production.

- This is why, even though the LM relationship is $\frac{M}{P} = YL(i)$, you will often see it written and drawn as

$$i = \bar{i}$$



- The latter conceals the mechanics of change (effects on money supply and Y), so it's better to remember both the equations



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