ECOS2002 - Intermediate Macroeconomics

Week 3: 'The IS-LM Model'

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Quiz 1

- Due: 21st August 6pm Sydney time
- Portal opens August 16th
- 30 mins; 1 Attempt
- 12 equally weighted questions which address the topics we covered in Week 1-3

Class Outline

- Deriving the IS-Curve
- Deriving the LM-Curve
- Equilibrium in the IS-LM model
- Policy in the IS-LM model
- Extensions to the Model
  - Endogeneity of Money
  - The Zero Lower Bound
- Outlook

Readings: Blanchard and Sheen Chapter 5

The IS-LM Model

- This model is the mathematical representation of Keynesian macroeconomic theory described by J.M. Keynes in *The General Theory*
- It is a pure demand side model meaning that in its most basic form it does not ask about supply constraints in the economy
- By itself the model used to study the short run but it is often considered as a path to explain the AS-AD model (next week)
- Assumptions:
  - Price level exogenous (no inflation considered)
  - No supply constraints

The IS-LM Model

- Two markets:
  - The Goods Market: IS curve
  - The Money Market: LM curve

Deriving the IS-Curve

- Let's start with the equilibrium condition from the Keynesian Cross:

$$Y = \frac{1}{1 - c_1}(c_0 - c_1 T + \bar{I} + \bar{G}) \quad (1)$$

- So far, investment was exogenous, however, this is not realistic
- Investment (I):
  - Depends negatively on the interest rate i

$$I = I(\underline{i})$$

$$I = I_0 - I_1 i \quad (2)$$

- Taxes T and government spending G remain exogenous (for now)

Deriving the IS-Curve algebraically

- The new goods market equilibrium can be described as

$$Y = \frac{1}{1-c_1}[c_0 - c_1\bar{T} + I_0 - I_1 i + \bar{G}] \tag{3}$$

- To derive the IS curve, we have to solve the goods market equilibrium after i:

$$Y(1-c_1) = [c_0 - c_1\bar{T} + I_0 - I_1 i + \bar{G}] \tag{4}$$

$$I_1 i = [c_0 - c_1\bar{T} + I_0 + \bar{G}] - (1-c_1)Y \tag{5}$$

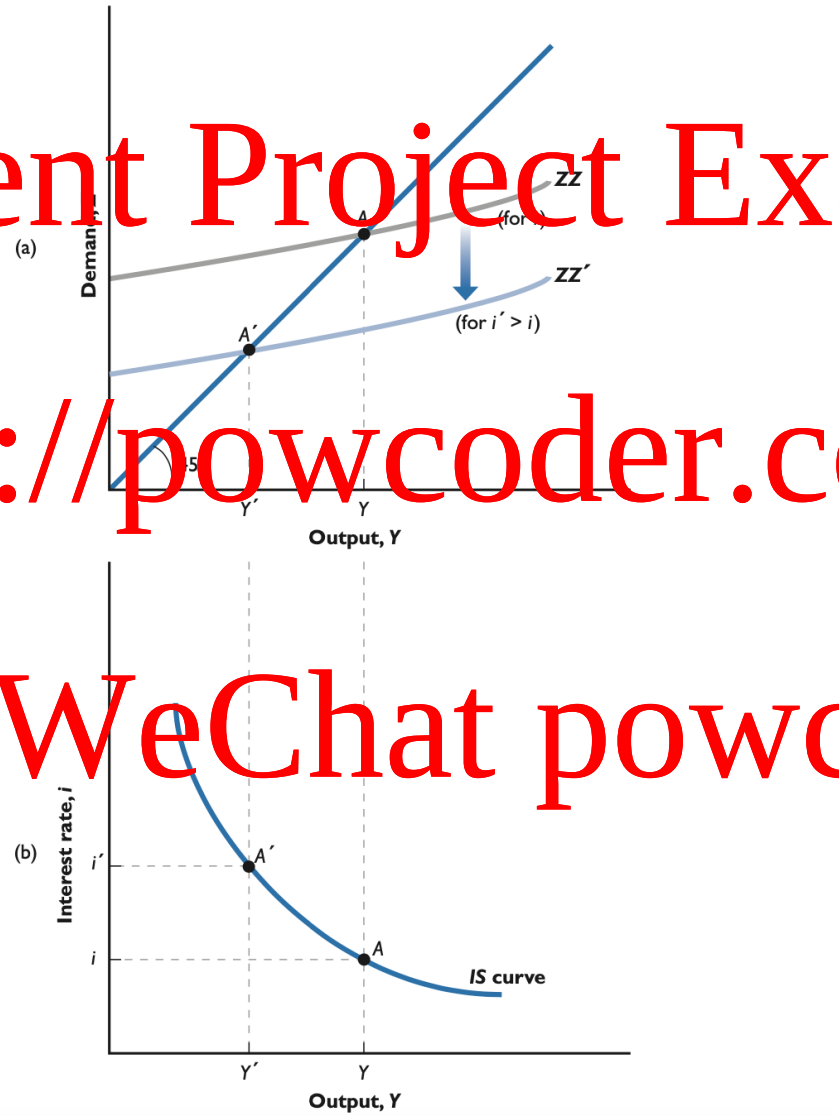
$$i = \frac{[c_0 - c_1\bar{T} + I_0 + \bar{G}]}{I_1} - \frac{(1-c_1)}{I_1}Y \tag{6}$$

  - Negative slope: $-\frac{(1-c_1)}{I_1}$

Deriving the IS-Curve graphically

- Steps:
  1. Start with goods market graph
  2. Draw a new graph below
  3. Label x-axis Y and the y-axis i
  4. Pick an initial nominal interest rate, i
  5. Use this value to draw in a planned expenditure or goods market demand curve
  6. Now change $i \Rightarrow i' > i$
  7. Now we can find two points in (Y, i) space

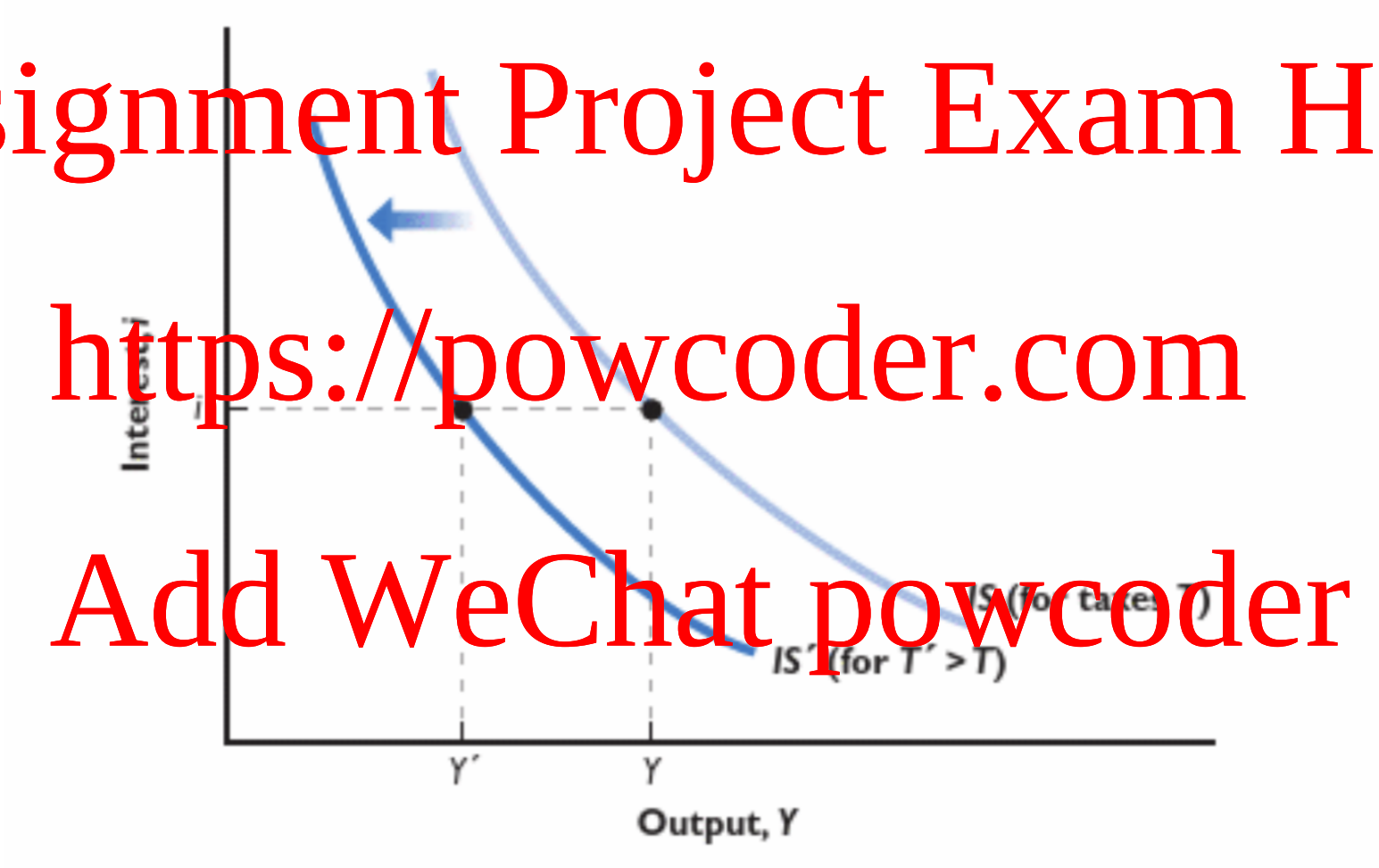
Deriving the IS-Curve



Shifts of the IS-Curve

- In general:
  - Movement along curve: Endogenous Variables
  - Shifts: Exogenous Variables
- The IS curve shifts due to changes in taxation $\bar{T}$ and government spending $\bar{G}$

Increase in Taxation



Deriving the LM-Curve

- Let's start with the equilibrium condition in the money market:

$$\left(\frac{M}{P}\right)^D = L_0 Y - L_1 i \tag{7}$$

$$\left(\frac{M}{P}\right)^S = \left(\frac{M}{P}\right) \tag{8}$$

- LM relation: Real money supply equals real money demand

$$\left(\frac{M}{P}\right)^S = \left(\frac{M}{P}\right)^D \tag{9}$$

Deriving the LM-Curve

$$\left(\frac{M}{P}\right)^S = \left(\frac{M}{P}\right)^D$$

$$\left(\frac{M}{P}\right) = L_0 Y - L_1 i$$

$$L_1 i = L_0 Y - \left(\frac{M}{P}\right)$$

$$i = \frac{L_0}{L_1} Y - \left(\frac{M}{L_1 P}\right)$$

- L_0: The responsiveness of money demand to income
- L_1: The responsiveness of money demand to the nominal interest rate

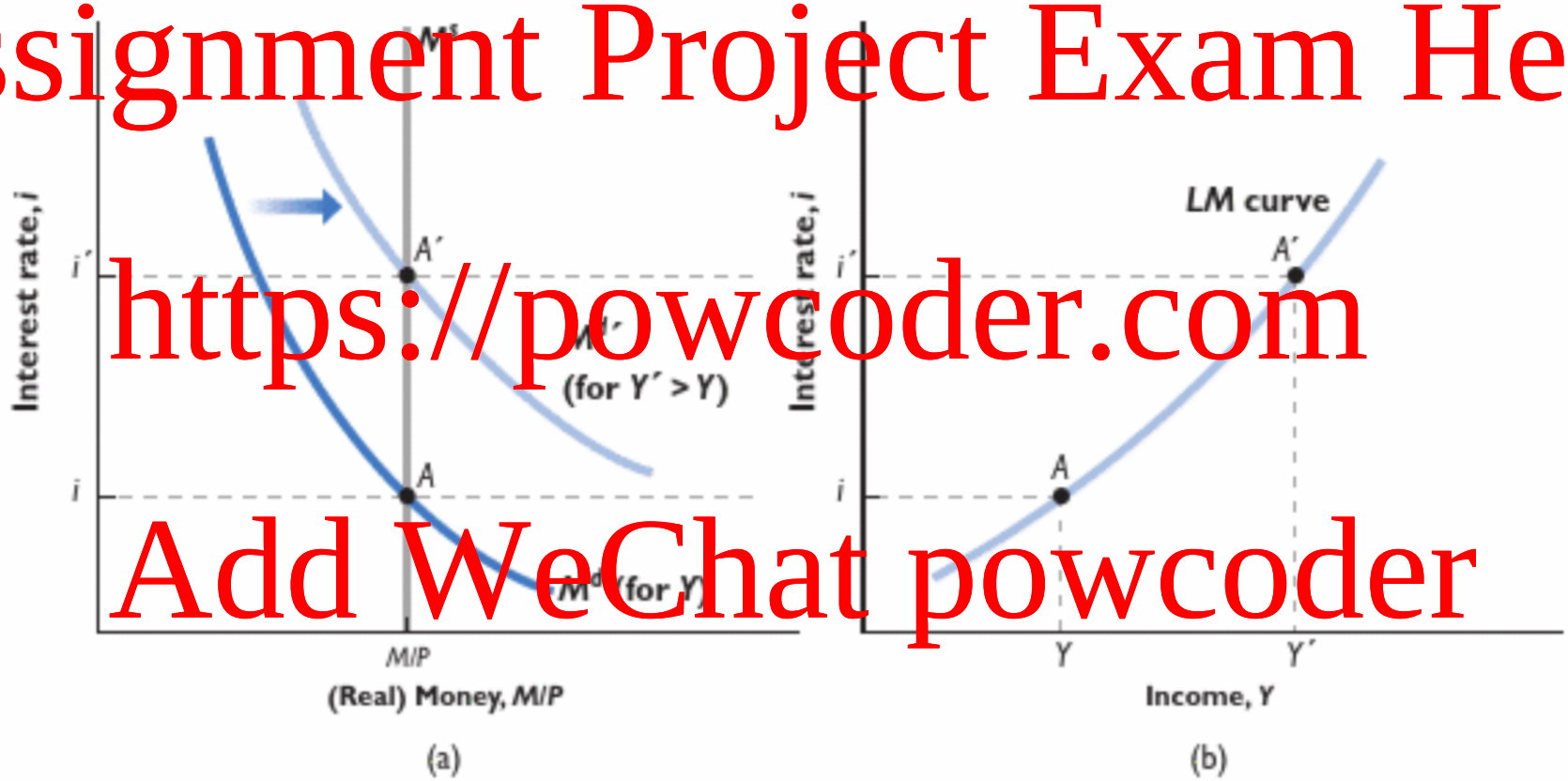
- The LM (Liquidity Money) curve describes the relationship between the interest rate, the stock of money, and output:

$$i = \frac{L_0}{L_1} Y - \left(\frac{M}{L_1 P}\right) \tag{10}$$

Deriving the LM-Curve

- Steps:
  1. Start with the money market graph
  2. Draw a new graph to the right
  3. Label x-axis Y and the y-axis i
  4. Pick an initial nominal interest rate i and income level Y in the money market graph
  5. Place an initial point in the (Y, i) space
  6. Now change $Y \Rightarrow Y' > Y$
  7. Now we can find two points in (Y, i) space

Deriving the LM-Curve



Shifts of the LM-Curve

- Changes in $\frac{M}{P}$ will shift the LM curve
  - Changes in the nominal money stock M
  - Changes in the price level P

Equilibrium in the IS-LM model

- An algebraic example

$$Y = C + I + G$$

$$C = c_0 + c_1(Y - \bar{T})$$

$$I = I_0 - I_1 i$$

$$\bar{T} = \bar{T}$$

$$G = \bar{G}$$

$$\left(\frac{M}{P}\right)^S = \left(\frac{M}{P}\right)^D$$

$$\left(\frac{M}{P}\right)^D = -L_0 Y + L_1 i$$

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

Equilibrium in the IS-LM model

- Goods market equilibrium:

$$Y = \frac{1}{1 - c_1}[c_0 - c_1 \bar{T} + I_0 - I_1 i + \bar{G}]$$

- Money market equilibrium:

$$i = \frac{L_0}{L_1} Y - \left(\frac{M}{L_1 P}\right)$$

Equilibrium in the IS-LM model

- General Equilibrium in the Economy:

$$Y = \frac{1}{1-c_1}[c_0 - c_1\bar{T} + I_0 - I_1 i + \bar{G}]$$

$$Y = \frac{1}{1-c_1}\left[c_0 - c_1\bar{T} + I_0 - I_1\left(\frac{L_0}{L_1}Y - \left(\frac{M}{L_1 P}\right)\right) + \bar{G}\right]$$

- Solve for Y:

$$Y(1-c_1) = [c_0 - c_1\bar{T} + I_0 - I_1\frac{L_0}{L_1}Y + \left(\frac{I_1 M}{L_1 P}\right) + \bar{G}]$$

$$Y(1-c_1) + I_1\frac{L_0}{L_1}Y = [c_0 - c_1\bar{T} + I_0 + \left(\frac{I_1 M}{L_1 P}\right) + \bar{G}]$$

$$Y = \frac{1}{1-c_1+\frac{I_1 L_0}{L_1}}[c_0 - c_1\bar{T} + I_0 + \left(\frac{I_1 M}{L_1 P}\right) + \bar{G}]$$

Equilibrium in the IS-LM model

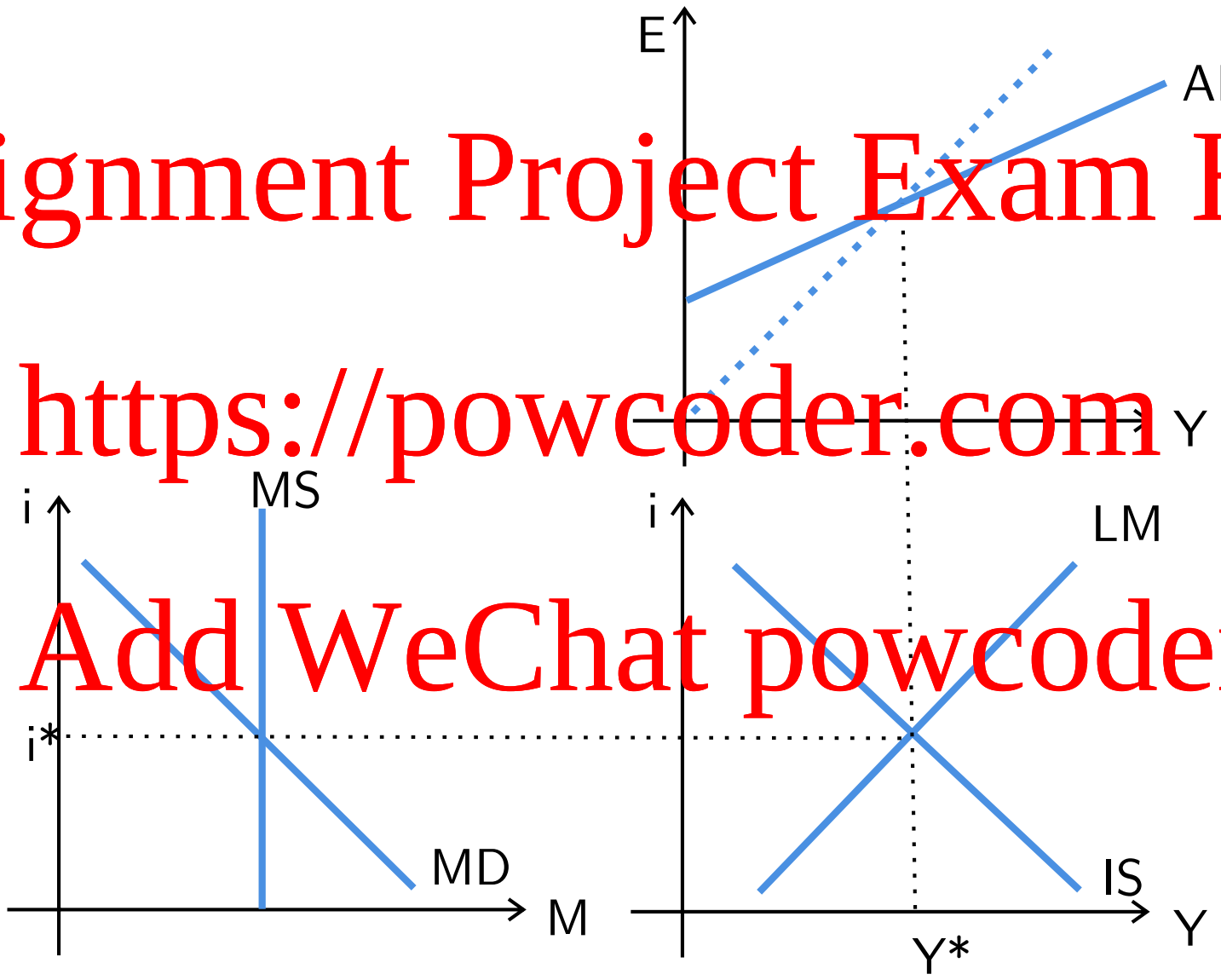
- General Equilibrium in the Economy:

$$Y = \underbrace{\frac{1}{1 - c_1 + \frac{l_1 L_0}{L_1}}}_{\text{IS-LM Multiplier}} \underbrace{\left[c_0 - c_1 \bar{T} + l_0 + \left(\frac{l_1 M}{L_1 P}\right) + \bar{G}\right]}_{\text{IS-LM Autonomous Spending}}$$

- The multiplier is smaller than in the traditional Keyensian-Cross model

$$\frac{1}{1 - c_1 + \frac{l_1 L_0}{L_1}} < \frac{1}{1 - c_1}$$

Equilibrium in the IS-LM model



Policy in the IS-LM Model

- **Fiscal Policy:** The use of government spending and taxation to influence macroeconomic conditions
- **Contractionary fiscal policy**:
  - Fiscal policy that decreases the demand for goods and services by the government, business, or consumers $\Rightarrow G \downarrow, T \uparrow$

- **Expansionary fiscal policy**:
  - Fiscal policy that increases the demand for goods and services by the government, business, or consumers $\Rightarrow G \uparrow, T \downarrow$

- Let's consider that the government increases taxes to consolidate the budget

Policy in the IS-LM Model

- Let's consider the IS/LM GDP Equilibrium

$$Y = \frac{1}{1 - c_1 + \frac{l_1 L_0}{L_1}} \left[c_0 - c_1 \bar{T} + l_0 + \left(\frac{l_1 M}{L_1 P} \right) + \bar{G} \right]$$

$$\Delta Y = \frac{1}{1 - c_1 + \frac{l_1 L_0}{L_1}} \left[\Delta c_0 - c_1 \Delta \bar{T} + l_0 + \left(\frac{l_1}{L_1} \right) \Delta \frac{M}{P} + \Delta \bar{G} \right]$$

- Because we are considering only a change in ΔT all other changes are equal to zero

$$\Delta Y = \frac{1}{1 - c_1 + \frac{l_1 L_0}{L_1}} \left[- c_1 \Delta \bar{T} \right]$$

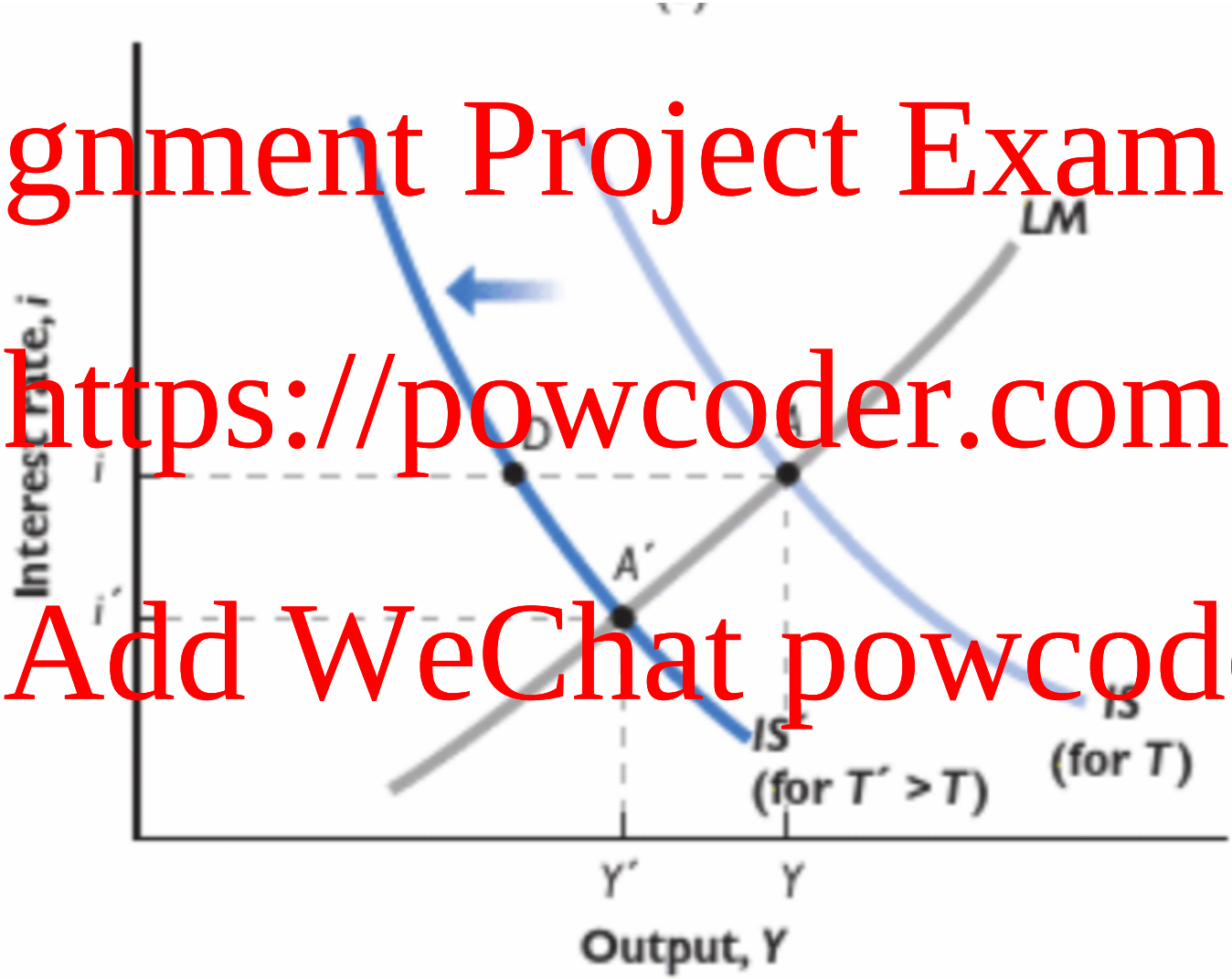
Policy in the IS-LM Model

- An increase in taxation reduces output by:

$$\frac{\Delta Y}{\Delta T} = \frac{-c_1}{1 - c_1 - \frac{l_1 l_0}{L_1}}$$

- Note that the change in taxation is negative
- If taxes increase, then output will decrease

Contractionary Fiscal Policy in the IS-LM Model



Policy in the IS-LM model

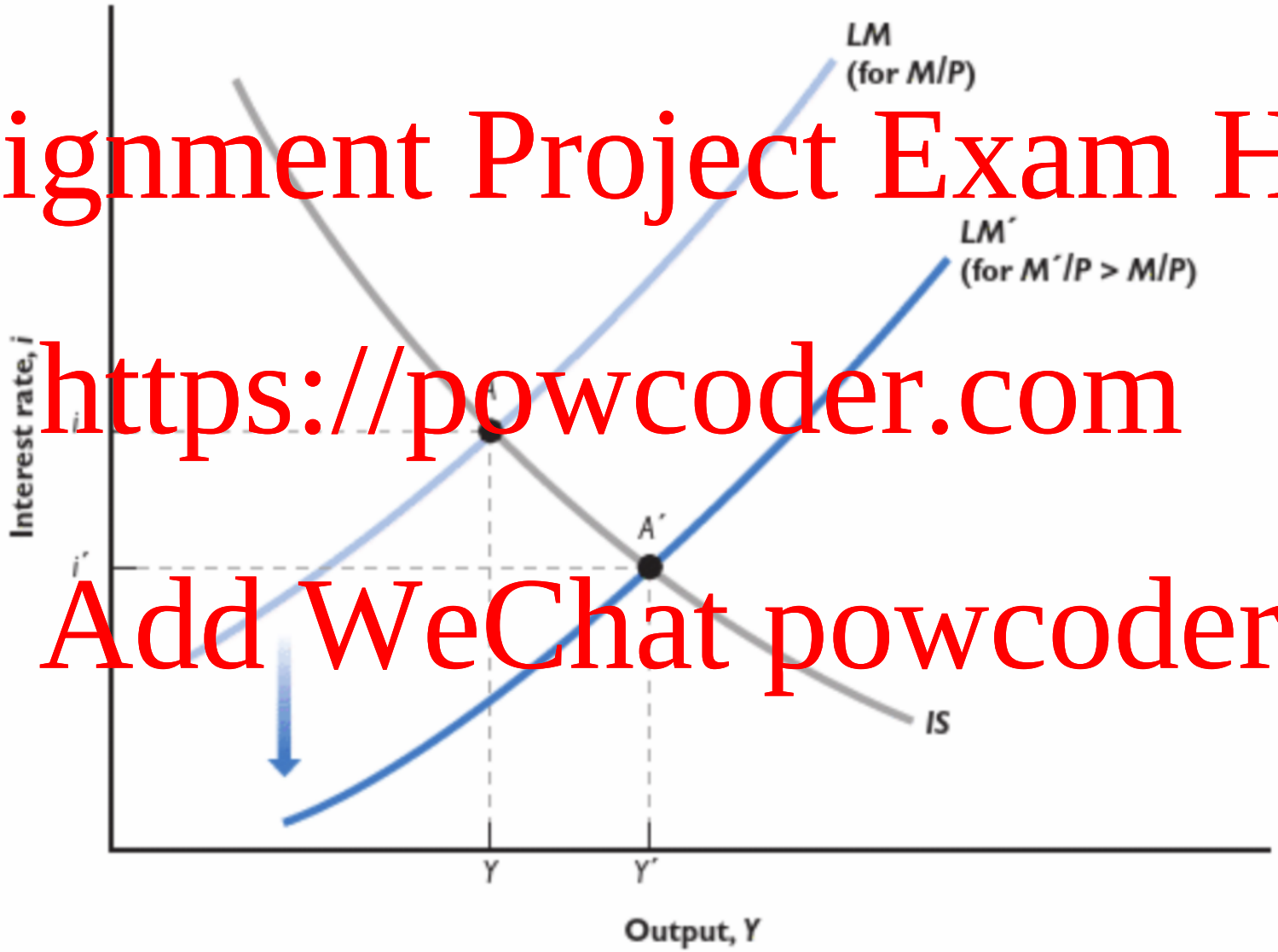
- Spending multipliers and crowding out
- The IS-LM model predicts that an increase in public spending increases the nominal interest rate
- A higher nominal interest rate *crowds out* private investment
- When interest rates increase, it is more expensive to get a loan or build up capital
- Crowding out is explicit in the IS/LM model and results in a smaller multiplier

$$\frac{1}{1 - c_1 + \underbrace{\frac{l_1 L_0}{L_1}}_{\text{Crowding out}}}$$

Policy in the IS-LM Model

- **Monetary Policy:** Monetary policy in the IS/LM is conducted through changes in the money supply M.
- These are shifting the **LM curve** up or down
- **Contractionary monetary policy**:
  - Decrease in money supply and an subsequent increase in interest rates $\Rightarrow M \downarrow \rightarrow i \uparrow$ (LM curve shifts upward/leftward)
- **Expansionary fiscal policy**:
  - Increase in money supply (and a subsequent decrease in interest rates) $\Rightarrow M \uparrow \rightarrow i \downarrow$ (LM curve shifts downward/rightward)

Expansionary Monetary Policy in the IS-LM Model



Policy in the IS-LM Model

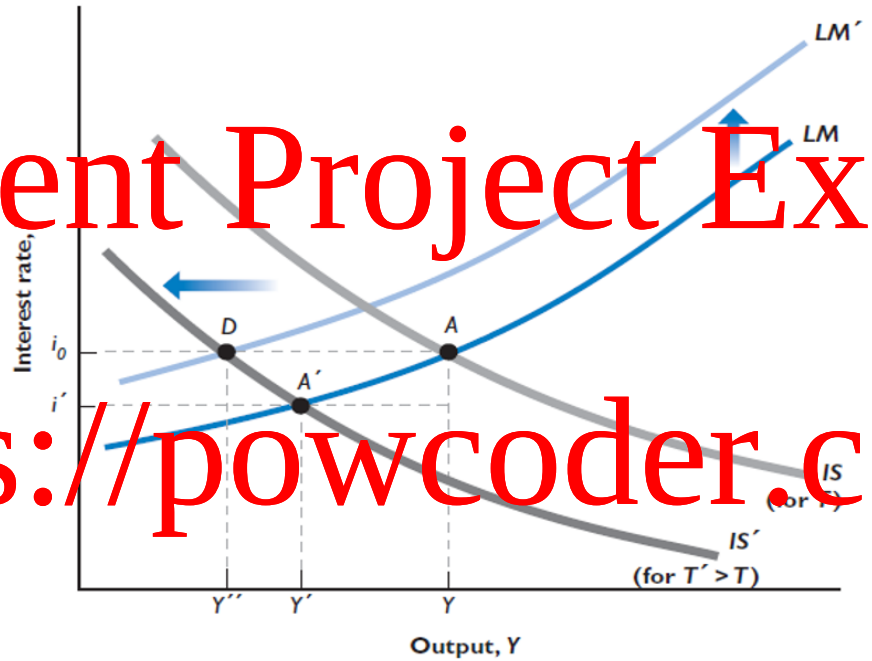
Table 5.1 The effects of fiscal and monetary policy

	Shift of *IS*	Shift of *LM*	Movement in output	Movement in interest rate
Increase in taxes	left	none	down	down
Decrease in taxes	right	none	up	up
Increase in spending	right	none	up	up
Decrease in spending	left	none	down	down
Increase in money	none	down	up	down
Decrease in money	none	up	down	up

Using Policy Mix

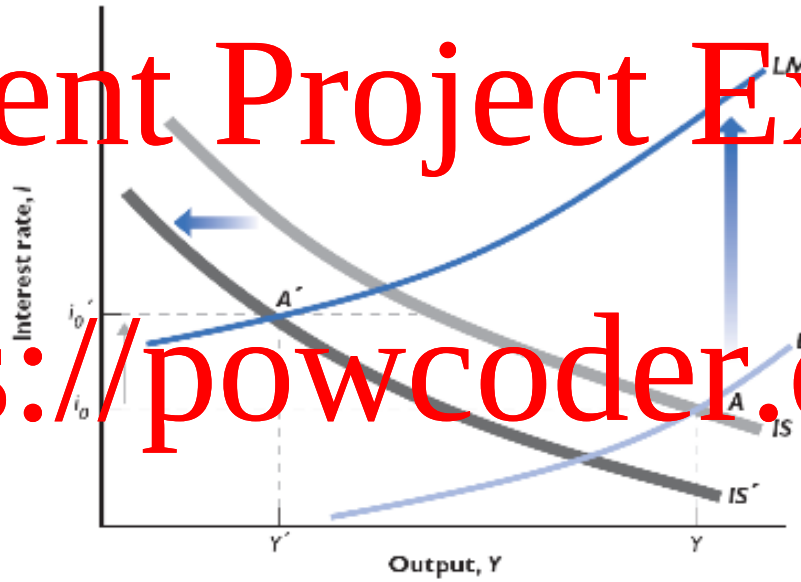
- Monetary and fiscal policy is never conducted in complete isolation.
- The combination of monetary and fiscal policies is known as the monetary–fiscal policy mix, or simply, the policy mix.
- Up until now, we have assumed that the central bank chooses the nominal money supply, M, and sticks with it.
- But, normally, the central bank decides to keep the interest rate constant rather than M constant (or more precisely, the interest rate equal to some short-term target, i_0).
- Consider a fiscal contraction ($G \downarrow$ or $T \uparrow$), with 2 alternative approaches to monetary policy:
  1. Central bank keeps M constant
  2. Central bank keeps i constant at i_0

Policy Mix



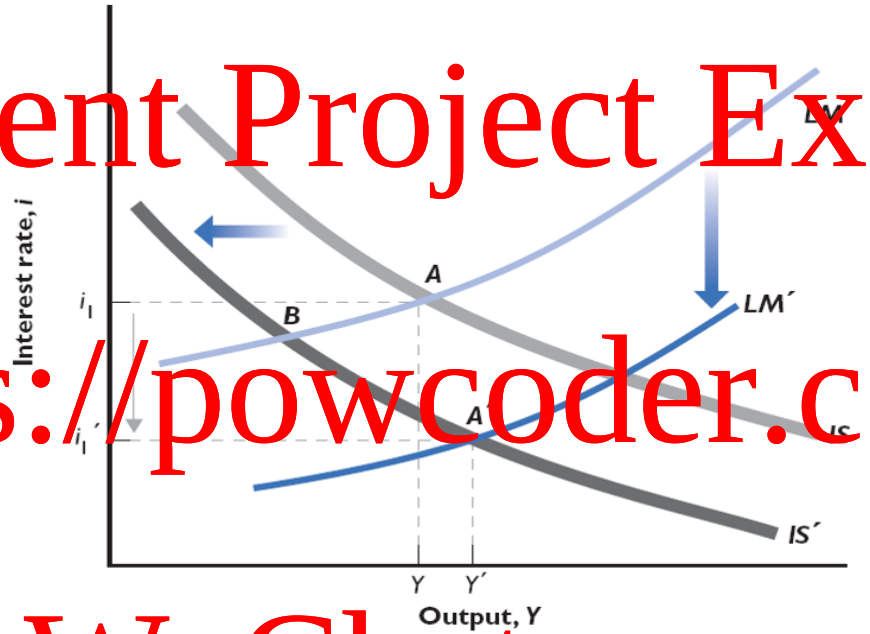
- The fiscal policy contraction leads to a much lower level of output if the central bank keeps the interest rate constant.
- The reason is that investment would have been stimulated by the falling interest rate, thus partly compensating for the reduction in aggregate demand from the fiscal contraction.

Fiscal and Monetary Policy in Same Direction



- Deficit Reduction and Monetary Contraction
- Tight fiscal and tight monetary policy has severe adverse effects on output.

Fiscal and Monetary Policy in Opposite Direction



- Fiscal Contraction and Monetary Expansion
- Tight fiscal and easy monetary policy allows output to continue to grow modestly

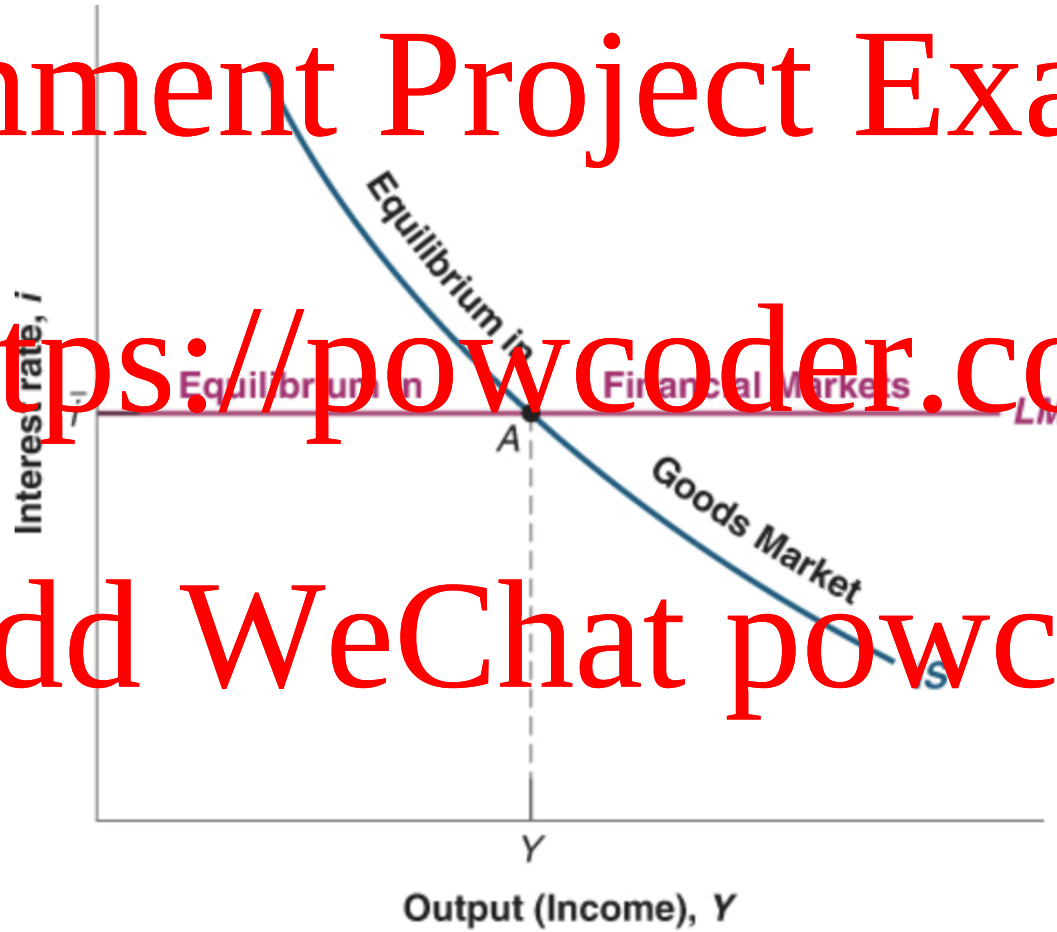
Extension I: Endogeneity of Money

- So far we were assuming the central bank chooses the money stock and then just lets the interest rate adjust
- This is not how modern monetary policy is conducted

- Let's think of the central bank as choosing the interest rate and doing what it needs to do with money supply to achieve it

- In this scenario the LM curve becomes a horizontal line
- LM relation: $i = \bar{i}$

Extension I: Endogeneity of Money



Extension II: The ZLB

Liquidity trap

"After the rate of interest has fallen to a certain level, liquidity preference may become virtually absolute in the sense that almost everyone prefers holding cash rather than holding a debt which yields so low a rate of interest." (Keynes, 1936 *General Theory*)

- After the financial crisis and especially during Covid many central banks around the world have moved interest rate to the Zero-Lower bound (ZLB)
- This is essentially the liquidity trap John Maynard Keynes was talking about
- Let's adjust our model so that it can capture the ZLB

Pingo Question

What do you think happens to the curves in the IS-LM model if the economy is at the ZLB?

a The IS curve is horizontal and the LM curve is unchanged.

b The LM curve is horizontal and the IS curve is unchanged.

c The LM curve and the IS curve are unchanged.

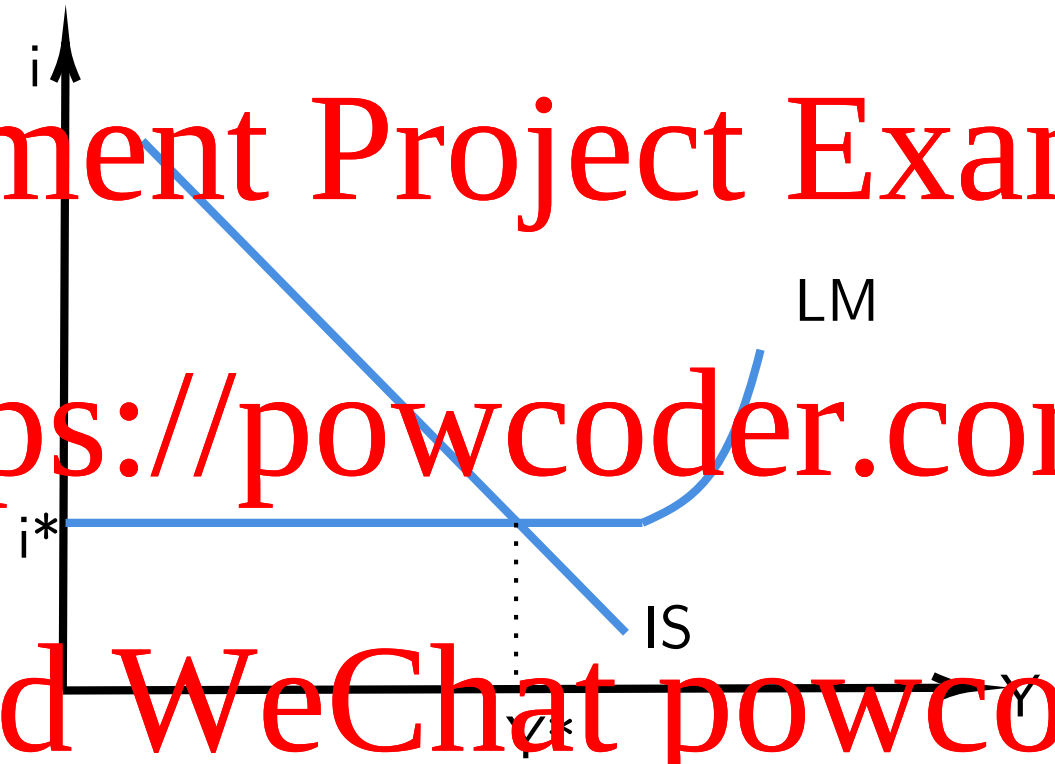
d The LM curve is vertical and the IS curve is unchanged.

Extension II: The ZLB

- When interest rates are close or equal to zero, the central bank cannot push interest rates further down. Why?
  - Outside option to hold cash if rates go negative
  - Financial assets are not as desirable because their liquidity is lower and the return is close to zero

- In this scenario the LM curve becomes horizontal as well even when we assume quantity-setting monetary policy:
  - Agents are indifferent between holding money or other assets
  - Demand for money becomes infinitely elastic

Extension II: The ZLB



- What happens if the government decides to conduct expansionary fiscal policy?

Summary

- The IS-LM model combines the implications of equilibria in both the goods and the financial market
- The IS curve shows combinations of interest rate and output consistent with the equilibrium in the goods market

- The LM curve shows combinations of interest rate and output consistent with the equilibrium in the financial market

- Fiscal policy leads to crowding out if the LM curve is upward sloping
- Assumptions matter! Change the assumption and you will see different results

Outlook

- The model captures aggregate demand for goods and services
- However, we also need think about the supply side of the economy
- This means we have to look at employment and prices

Outlook

- Expand the model to the AS-AD model
- Bringing prices and employment into the model
- Next week: The Labour Market