CHAPTER 10

Aggregate Demand I: Building the *IS-LM* Model

MACROECONOMICS SIXTH EDITION

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PowerPoint® Slides by Ron Cronovich

In this chapter, you will learn…

- the *IS* curve, and its relation to
  - the Keynesian cross
  - the loanable funds model
- the *LM* curve, and its relation to
  - the theory of liquidity preference
- how the *IS-LM* model determines income and the interest rate in the short run when ***P*** is fixed

Context

- Chapter 9 introduced the model of aggregate demand and aggregate supply.
- Long run
  - prices flexible
  - output determined by factors of production & technology
  - unemployment equals its natural rate
- Short run
  - prices fixed
  - output determined by aggregate demand
  - unemployment negatively related to output

Context

- This chapter develops the *IS-LM* model, the basis of the aggregate demand curve.
- We focus on the short run and assume the price level is fixed (so, *SRAS* curve is horizontal).
- This chapter (and chapter 11) focus on the closed-economy case.
  - Chapter 12 presents the open-economy case.

The Keynesian Cross

- A simple closed economy model in which income is determined by expenditure.
  (due to J.M. Keynes)
- Notation:
  I = planned investment
  $E = C + I + G$ = planned expenditure
  Y = real GDP = actual expenditure
- Difference between actual & planned expenditure = unplanned inventory investment

Elements of the Keynesian Cross

consumption function: $C = C(Y - T)$

govt policy variables: $G = \bar{G}, \quad T = \bar{T}$

for now, planned investment is exogenous: $I = \bar{I}$

planned expenditure: $E = C(Y - \bar{T}) + \bar{I} + \bar{G}$

equilibrium condition:

actual expenditure = planned expenditure

$$Y = E$$

Keynesian Cross: Numerical

- C = 10 + 0.6(Y – T)
- G = 12, T = 4
- I = 8
- E = C + I + G
  = 10 + 0.6(Y – 4) + 8 + 12 = 10 + 0.6Y – (0.6   4) + 8 + 12
- Y = E
- So, Y = 10 + 0.6Y – (0.6   4) + 8 + 12.
- So, Y – 0.6Y = 10 – (0.6   4) + 8 + 12 = (1 – 0.6) Y.

$$Y = \frac{1}{1 - 0.6}[10 - (0.6 \times 4) + 8 + 12] = \frac{27.6}{0.4} = 69$$

$$Y = \frac{1}{1 - MPC}[C_A - (MPC \times T) + I + G]$$

Keynesian Cross: Algebraic

- $C = C_A + MPC \quad (Y - T)$; C_A is autonomous consumption.
- $E = C + I + G$
  $= C_A + MPC \quad (Y - T) + I + G$
  $= C_A + (MPC \quad Y) - (MPC \quad T) + I + G$
- $E = Y$
- So, $Y = C_A + (MPC \quad Y) - (MPC \quad T) + I + G$.
- So, $Y - (MPC \quad Y) = C_A - (MPC \quad T) + I + G$.
- So, $(1 - MPC) \quad Y = C_A - (MPC \quad T) + I + G$. Therefore,

$$Y = \frac{1}{1 - MPC}[C_A - (MPC \times T) + I + G]$$

Algebraic Example (contd.)

- We can now see the *quantitative* effects of shocks and policy decisions.
- From the previous slide,

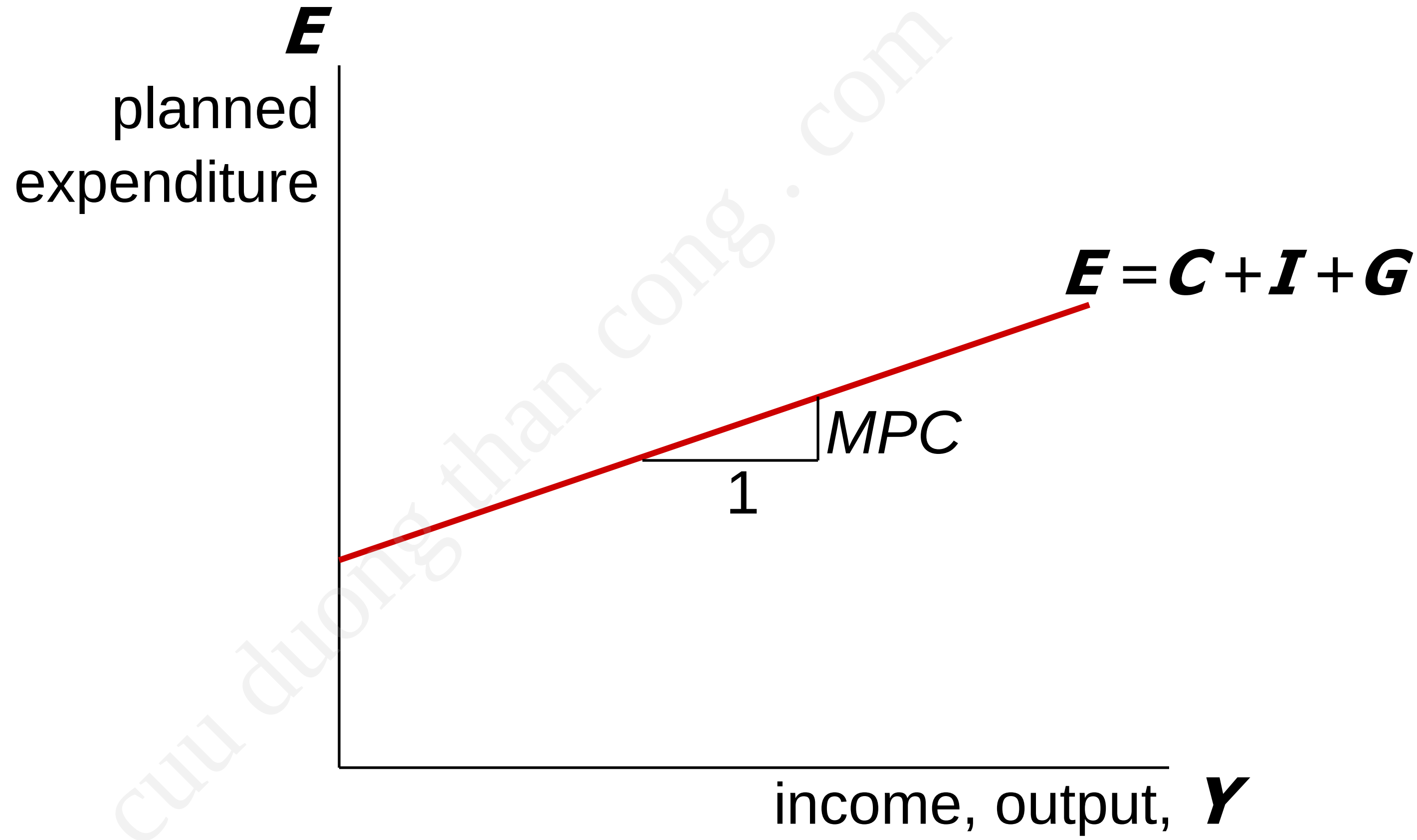
$$Y = \frac{1}{1 - MPC}[C_A - (MPC \times T) + I + G]$$

$$Y = \frac{1}{1 - MPC}[C_A + I + G] - \frac{MPC}{1 - MPC}T$$

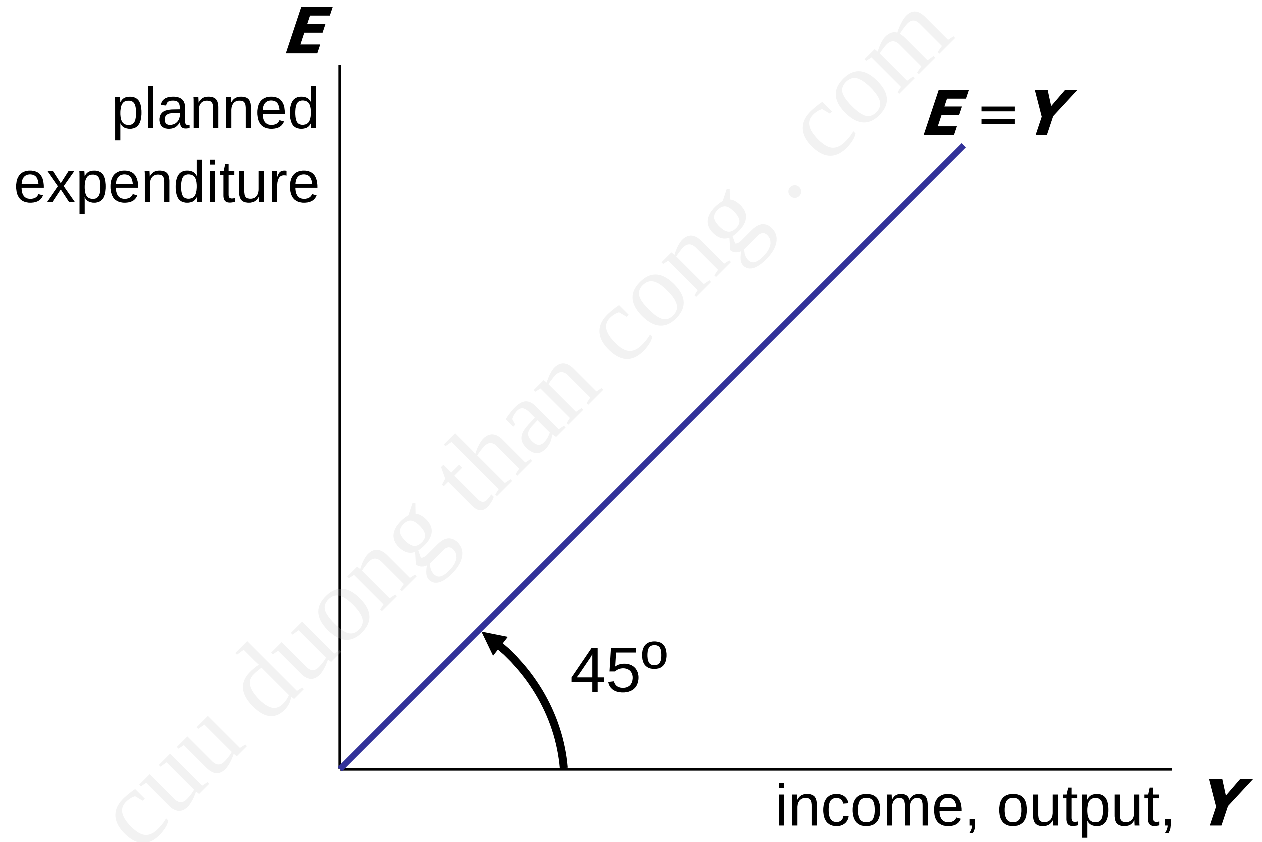
Spending Multiplier

Tax Multiplier

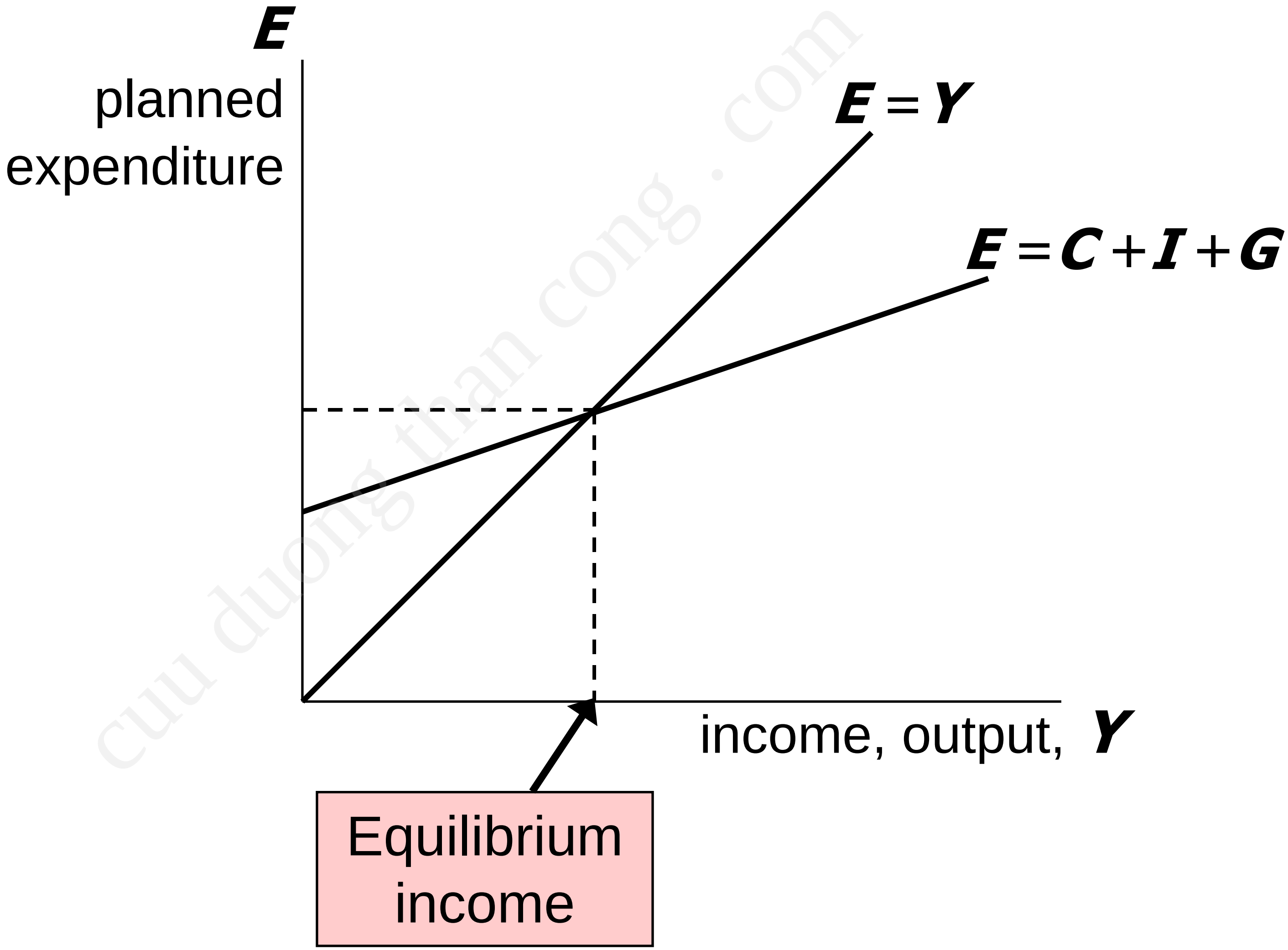
Graphing planned expenditure



Graphing the equilibrium condition

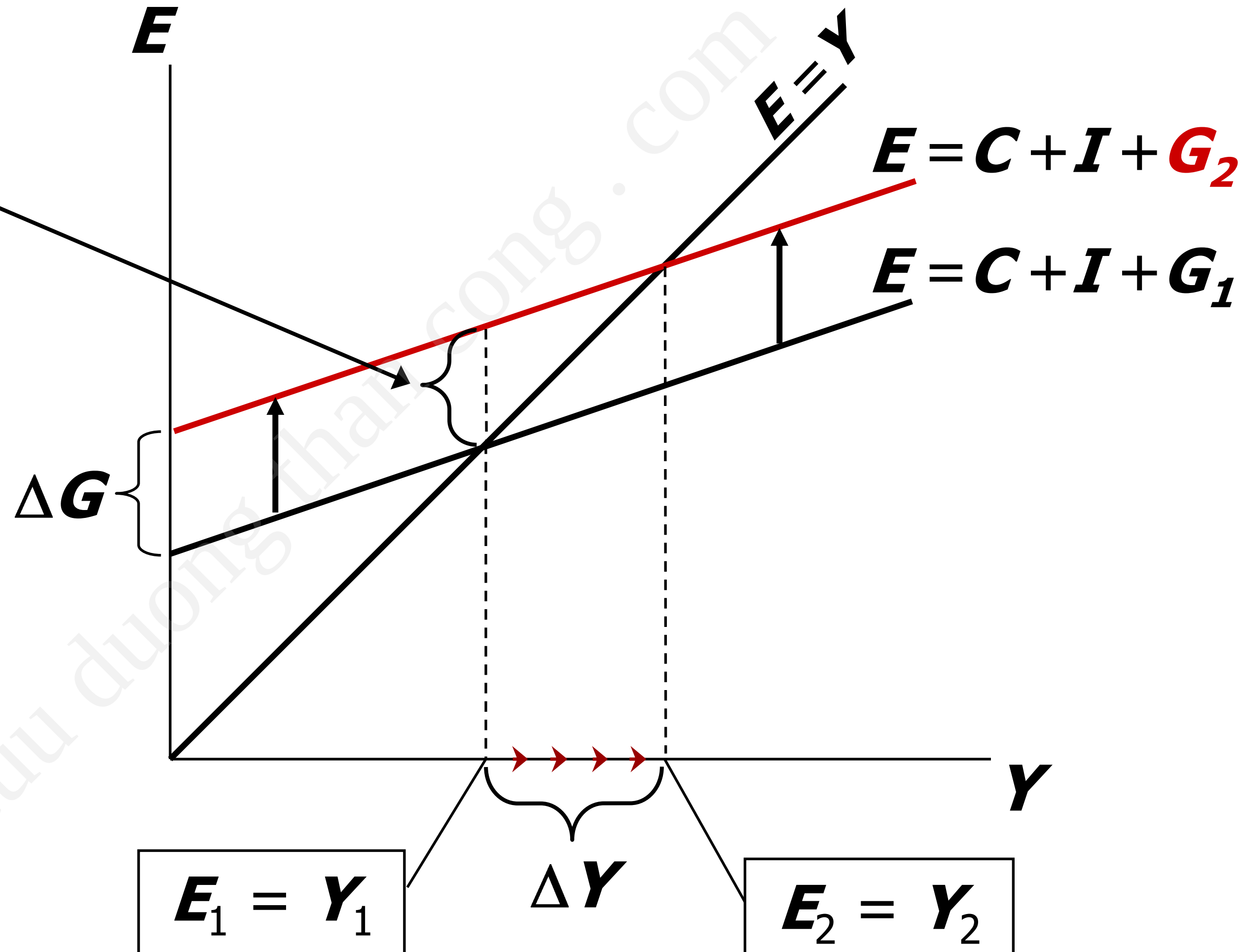


Keynesian Cross: Graphical



An increase in government purchases

At Y_1,
there is now an unplanned drop in inventory…



…so firms increase output, and income rises toward a new equilibrium.

Solving for ΔY

$$Y = C + I + G$$ equilibrium condition

$$\Delta Y = \Delta C + \Delta I + \Delta G$$ in changes

$$= \Delta C + \Delta G$$ because I exogenous

$$= MPC \times \Delta Y + \Delta G$$ because $\Delta C = MPC\, \Delta Y$

Collect terms with ΔY on the left side of the equals sign:

$$(1 - MPC) \times \Delta Y = \Delta G$$

Solve for ΔY:

$$\Delta Y = \left(\frac{1}{1 - MPC}\right) \times \Delta G$$

The government purchases multiplier

Definition: the increase in income resulting from a \$1 increase in ***G***.

In this model, the govt purchases multiplier equals

$$\frac{\Delta \boldsymbol{Y}}{\Delta \boldsymbol{G}} = \frac{1}{1 - MPC}$$

Example: If *MPC* = 0.8, then

$$\frac{\Delta \boldsymbol{Y}}{\Delta \boldsymbol{G}} = \frac{1}{1 - 0.8} = 5$$

An increase in ***G*** causes income to increase 5 times as much!

Why the multiplier is greater than 1

- Initially, the increase in ***G*** causes an equal increase in ***Y*:** $\Delta Y = \Delta G$.
- But $\uparrow Y \Rightarrow \uparrow C$

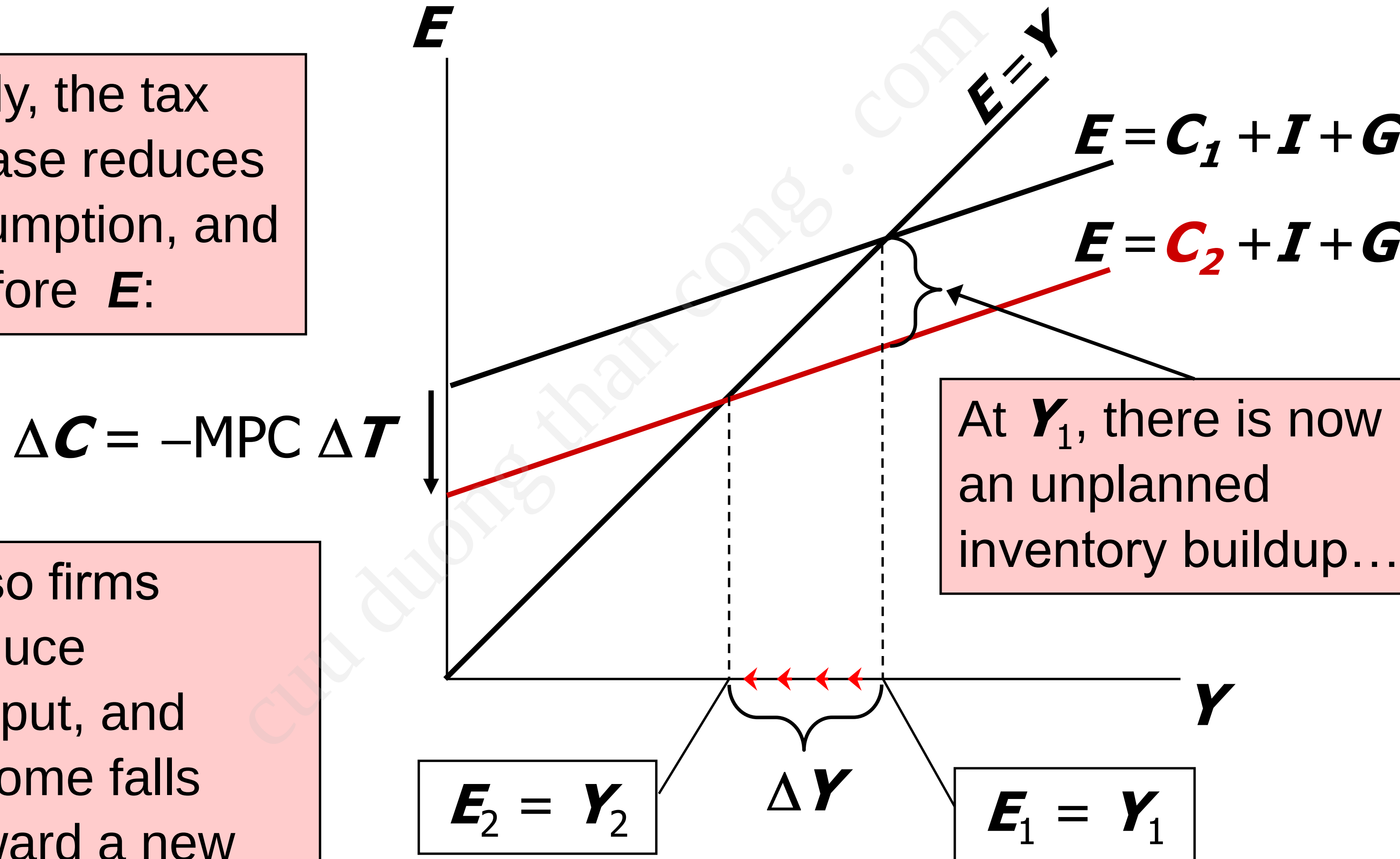
  $\Rightarrow$ further $\uparrow Y$

  $\Rightarrow$ further $\uparrow C$

  $\Rightarrow$ further $\uparrow Y$
- So the final impact on income is much bigger than the initial ΔG.

An increase in taxes

Initially, the tax increase reduces consumption, and therefore E:



At Y_1, there is now an unplanned inventory buildup…

…so firms reduce output, and income falls toward a new equilibrium

Solving for ΔY

$$\Delta Y = \Delta C + \Delta I + \Delta G$$ eq'm condition in changes

$$= \Delta C$$ I and G exogenous

$$= MPC \times \Delta Y - \Delta T$$

Solving for ΔY: $(1 - MPC) \times \Delta Y = - MPC \times \Delta T$

Final result:

$$\boxed{\Delta Y = \left(\frac{- MPC}{1 - MPC}\right) \times \Delta T}$$

The tax multiplier

def: the change in income resulting from a $1 increase in *T* :

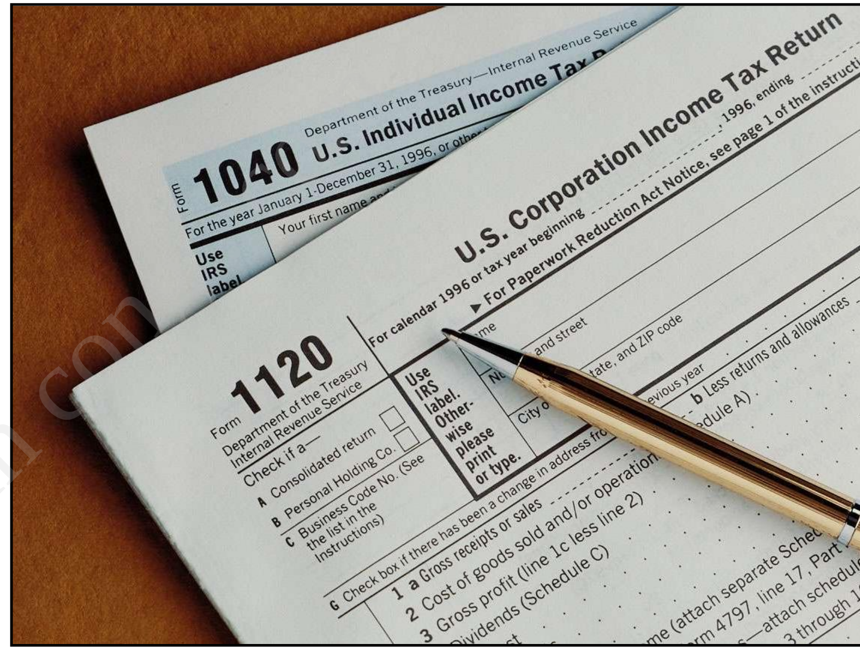
$$\frac{\Delta Y}{\Delta T} = \frac{-MPC}{1 - MPC}$$

If *MPC* = 0.8, then the tax multiplier equals

$$\frac{\Delta Y}{\Delta T} = \frac{-0.8}{1 - 0.8} = \frac{-0.8}{0.2} = -4$$

The tax multiplier

…is *negative:*
A tax increase reduces ***C***, which reduces income.



…is *greater than one*
(*in absolute value*):
A change in taxes has a multiplier effect on income.

…is *smaller than the govt spending multiplier:*
Consumers save the fraction (1 – *MPC*) of a tax cut, so the initial boost in spending from a tax cut is smaller than from an equal increase in ***G***.

Exercise:

- Use a graph of the Keynesian cross to show the effects of an increase in planned investment on the equilibrium level of income/output.

The *IS* Curve

def: a graph of all combinations of ***r*** and ***Y*** that result in goods market equilibrium

i.e. actual expenditure (output)
= planned expenditure

The equation for the *IS* curve is:

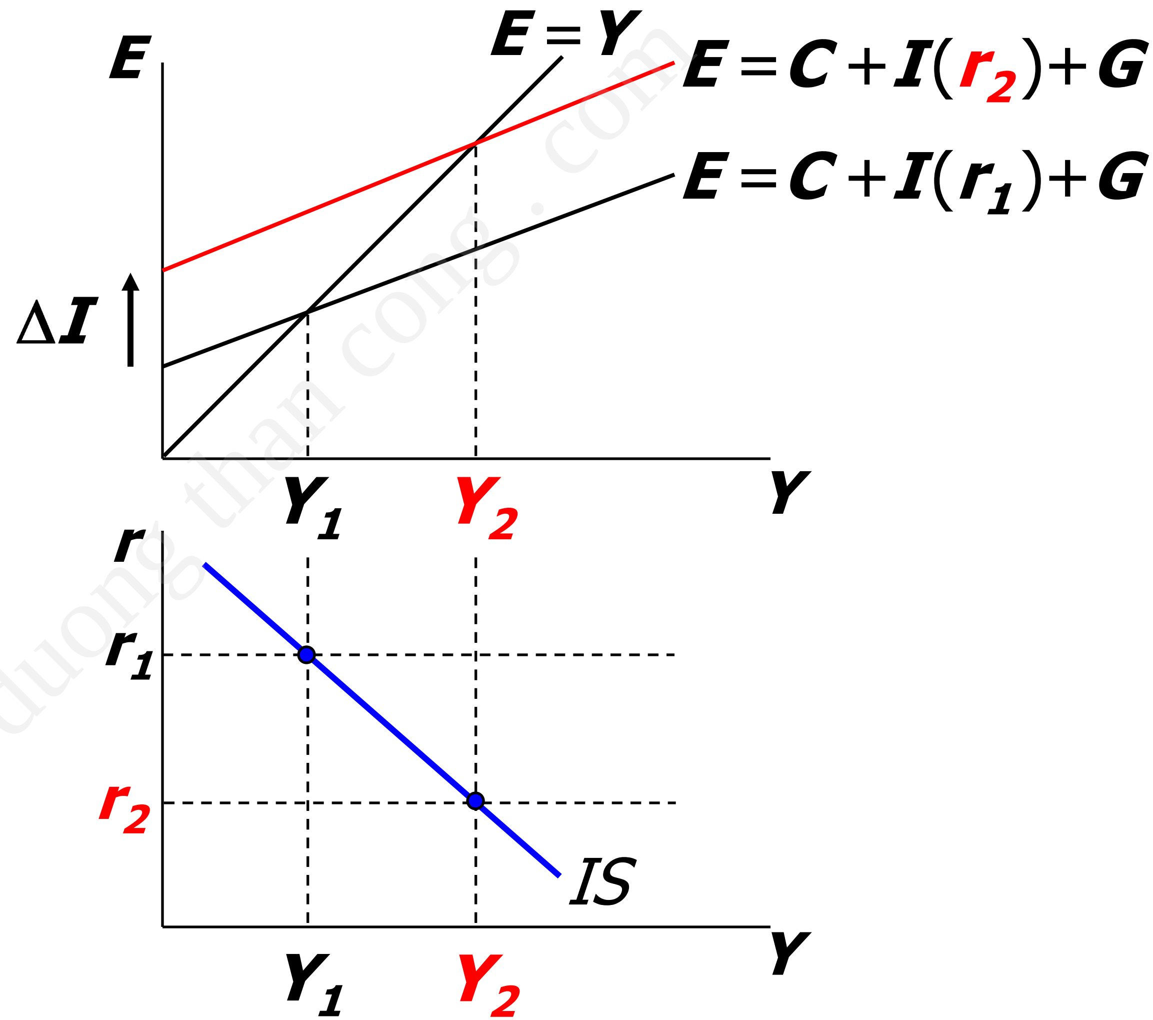
$$Y = C(Y - \bar{T}) + I(r) + \bar{G}$$

IS Curve: Graphical

$\downarrow r \quad \Rightarrow \uparrow I$

$\Rightarrow \uparrow E$

$\Rightarrow \uparrow Y$



Why the *IS* curve is negatively sloped

- A fall in the interest rate motivates firms to increase investment spending, which drives up total planned spending (***E***).
- To restore equilibrium in the goods market, output (*a.k.a.* actual expenditure, ***Y***) must increase.

IS Curve: Algebraic

- We saw earlier that

$$Y = \frac{1}{1 - MPC}[C_A + I + G] - \frac{MPC}{1 - MPC}T$$

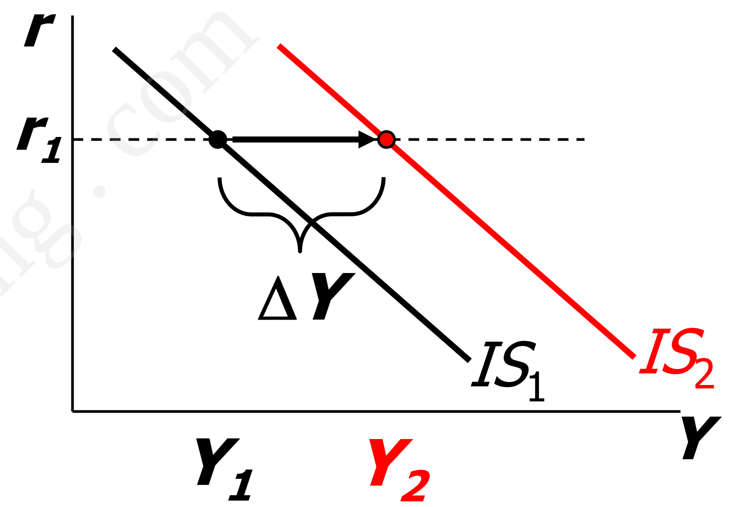
- As *I* = *I*(r), we get:

$$Y = \frac{1}{1 - MPC}[C_A + I(r) + G] - \frac{MPC}{1 - MPC}T$$

When *r* increases, *I* decreases. And so, *Y* decreases. This inverse relation between *r* and *Y* is called the ***IS Curve***.

Shifts of the *IS* Curve

- The inverse relation between *r* and *Y* is the *IS* curve
- For any particular value of *r*, such as r_1, *Y* increases if
  - There is an increase in *G* or in autonomous *C* or *I*, or if
  - There is a decrease in *T*
- Therefore, these changes shift the *IS* curve to the right.



$$Y = \frac{1}{1 - MPC}[C_A + I(r) + G] - \frac{MPC}{1 - MPC}T$$

Fiscal Policy and the *IS* curve

- We can use the *IS*-*LM* model to see how fiscal policy (***G*** and ***T***) affects aggregate demand and output.
- Let's start by using the Keynesian cross to see how fiscal policy shifts the *IS* curve…

Shifting the *IS* curve: ΔG

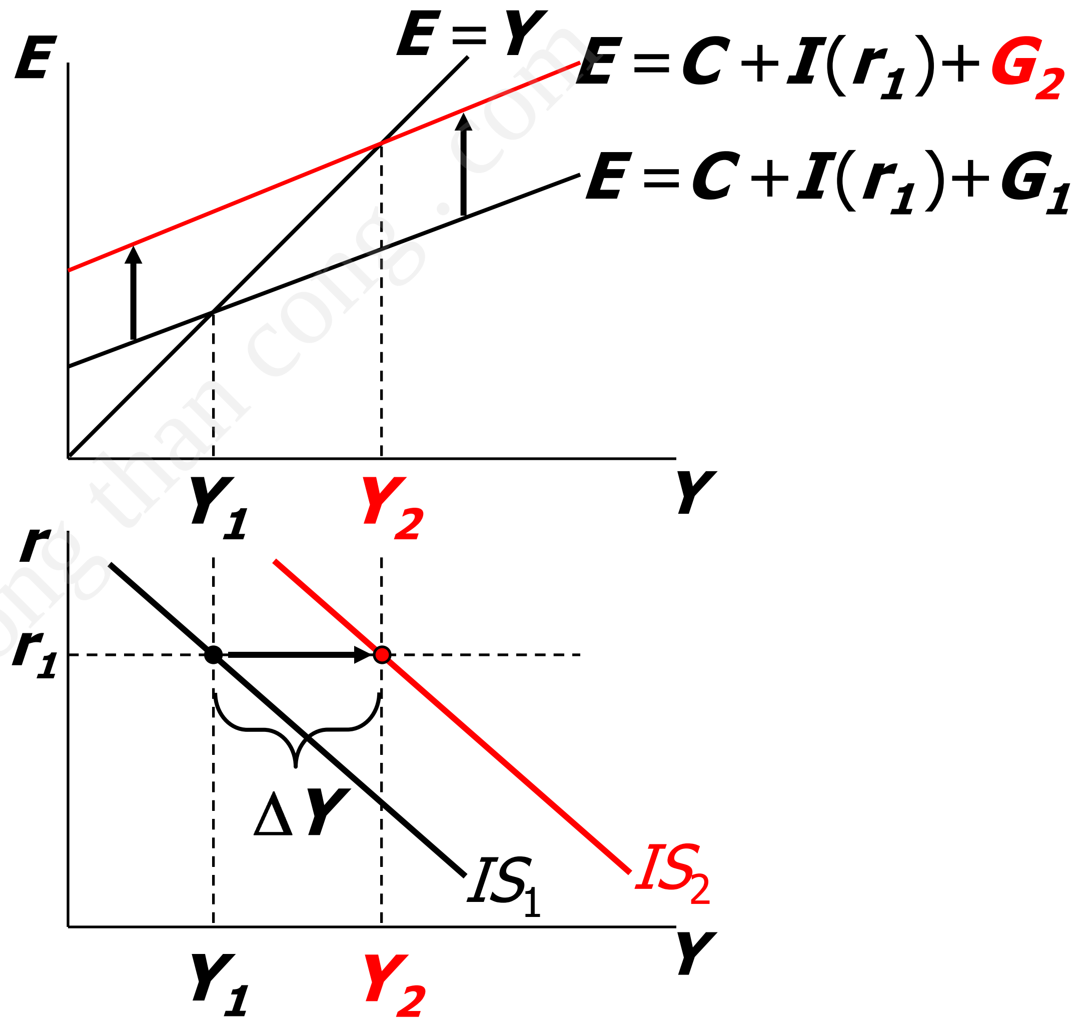
At any value of ***r***,

$\uparrow G \Rightarrow \uparrow E \Rightarrow \uparrow Y$

…so the *IS* curve shifts to the right.

The horizontal distance of the *IS* shift equals

$$\Delta Y = \frac{1}{1 - MPC} \Delta G$$



Exercise: Shifting the IS curve

- Use the diagram of the Keynesian cross or loanable funds model to show how an increase in taxes shifts the *IS* curve.

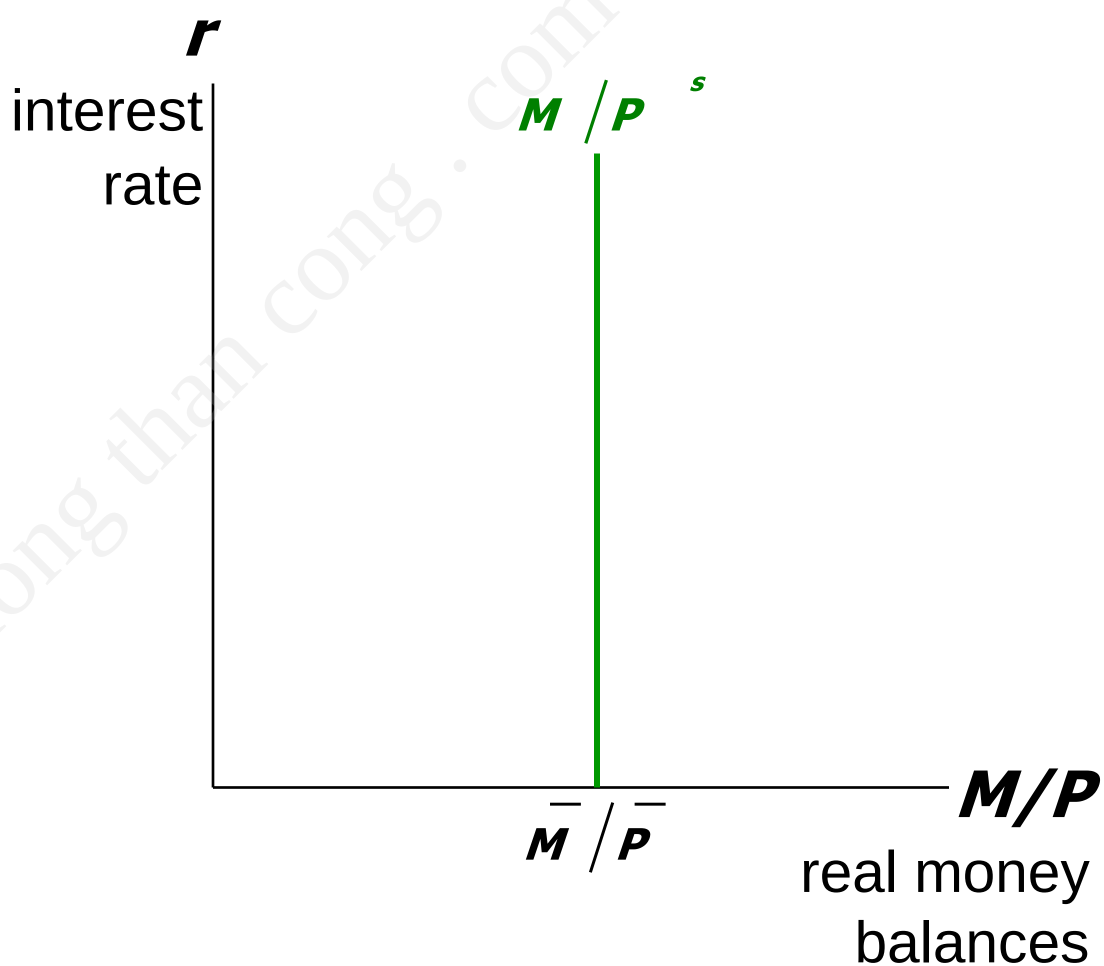
The Theory of Liquidity Preference

- Due to John Maynard Keynes.
- A simple theory in which the interest rate is determined by money supply and money demand.

Money supply

The supply of real money balances is fixed:

$$\left(M/P\right)^s = \overline{M}/\overline{P}$$



The *LM* curve

The money demand function is:

$$\left(M/P\right)^d = L(r, Y)$$

The ***LM* curve** is a graph of all combinations of ***r*** and ***Y*** that equate the supply and demand for real money balances, when *M* and *P* are known.

The equation for the *LM* curve is:

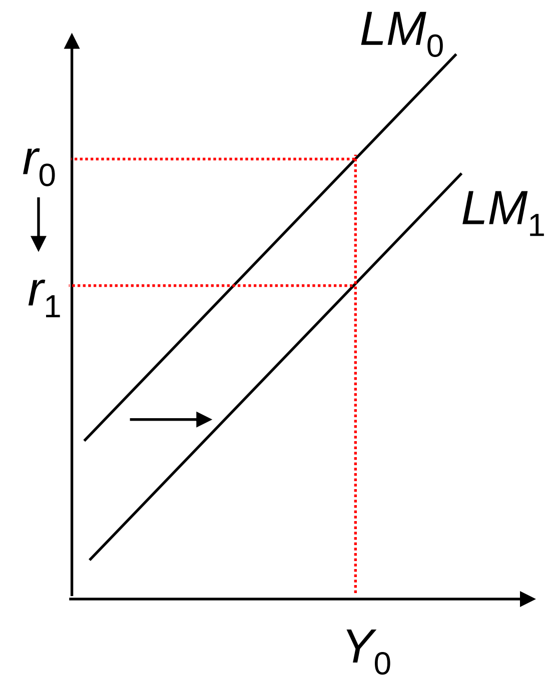
$$\overline{M}/\overline{P} = L(r, Y)$$

The *LM* Curve: Numerical

- Recall the Quantity Equation from Chapter 9: $M \quad V = P \quad Y$.
- Assume $V = 1/L(r)$.
- Assume $L(r) = 10/r$. Therefore, $V = r/10$.
- $M \quad (r/10) = P \quad Y$.
- $r = 10 \quad P \quad Y\ /\ M$.
- This *direct* relation between r and Y is the ***LM Curve***.

Shifts of the *LM* Curve: Numerical

- As r = 10 P Y / M,
- We see that r decreases when either
  - P or Y decreases, or
  - M increases, or
  - Autonomous money demand—represented here by the number 10—decreases.

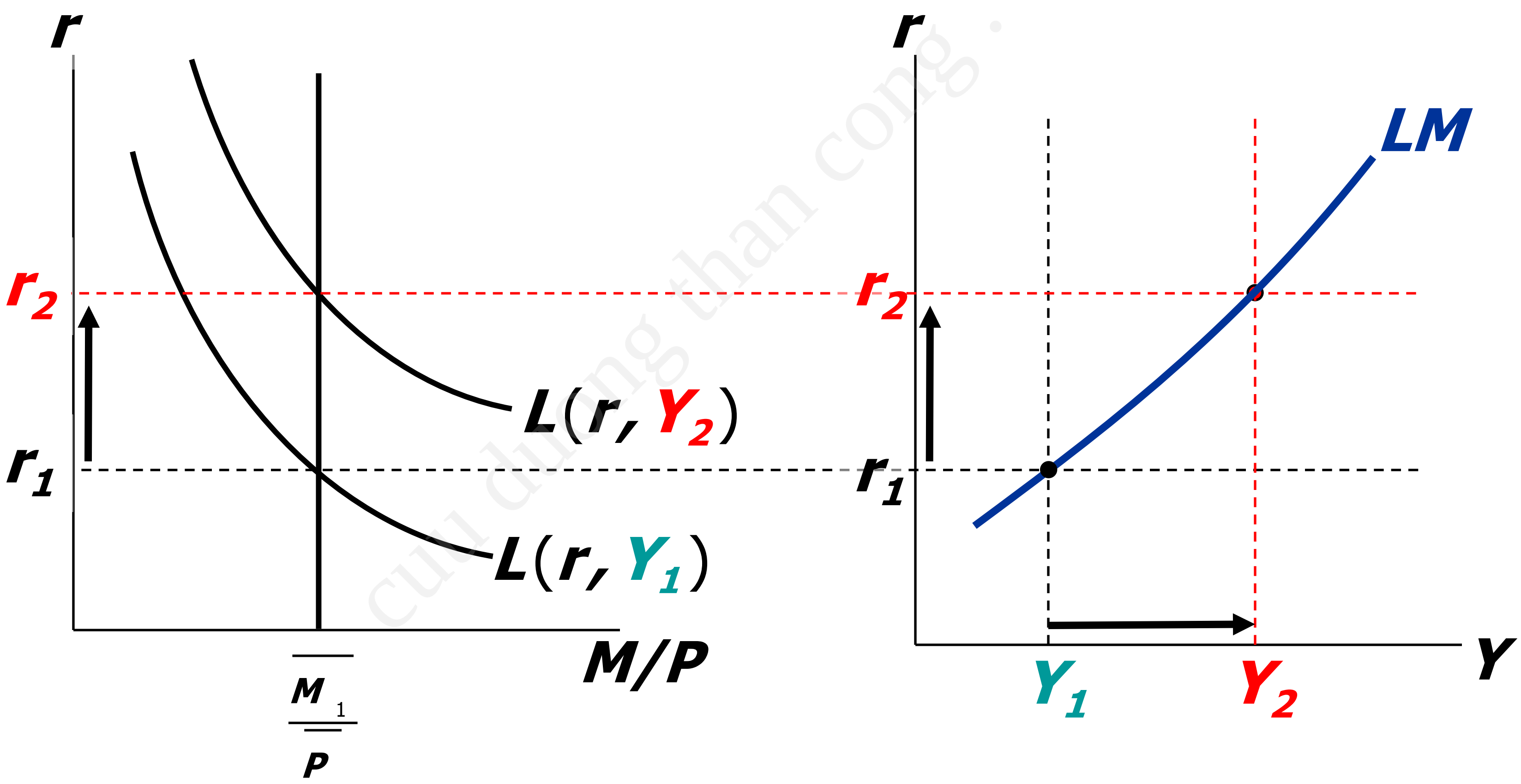


Therefore, the *LM* curve shifts right if there is an increase in M or a decrease in either P or autonomous money demand.

Deriving the *LM* curve

(a) The market for real money balances

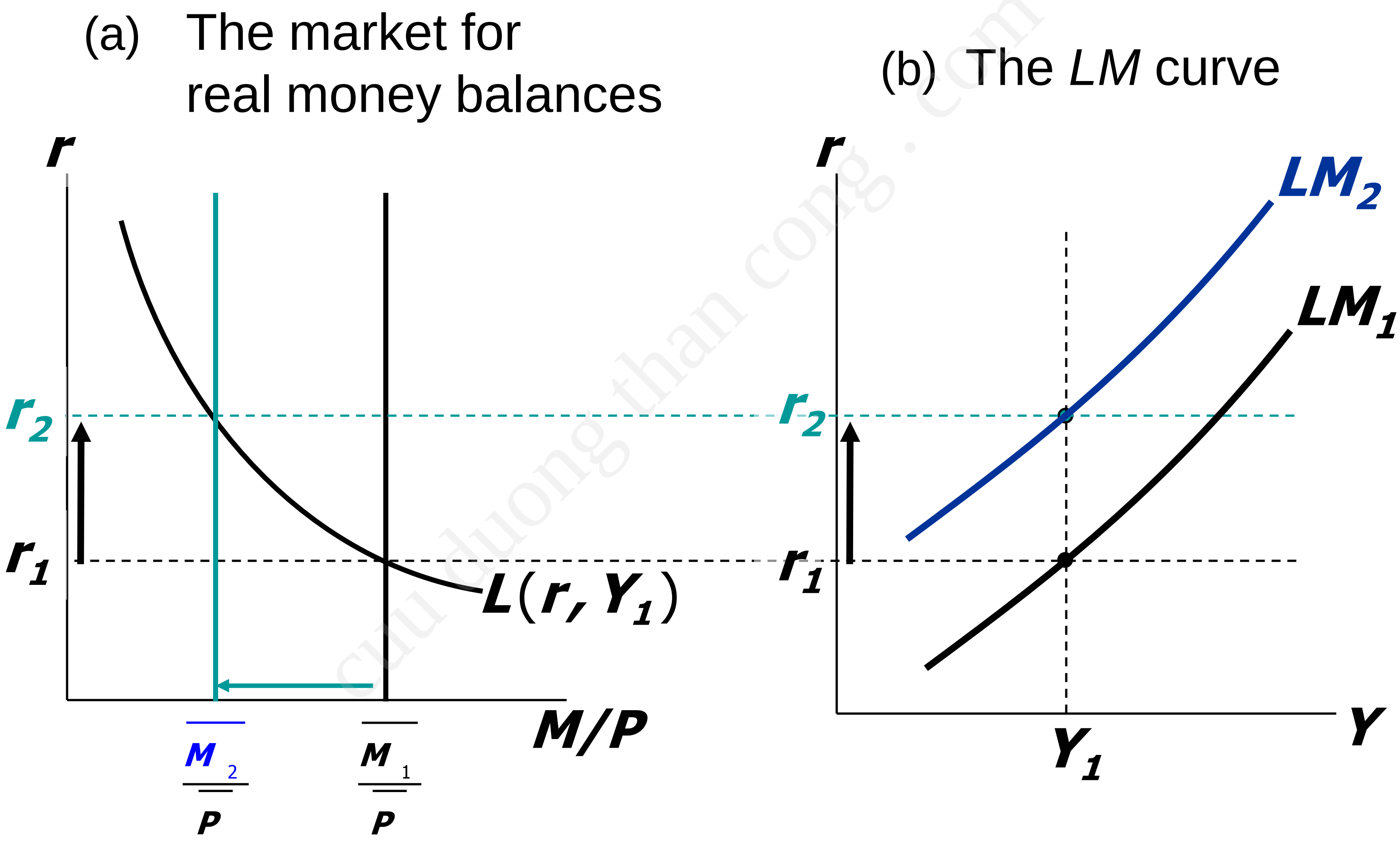
(b) The *LM* curve



Why the *LM* curve is upward sloping

- An increase in income raises money demand.
- Since the supply of real balances is fixed, there is now excess demand in the money market at the initial interest rate.
- The interest rate must rise to restore equilibrium in the money market.

How ΔM shifts the LM curve



Exercise: Shifting the LM curve

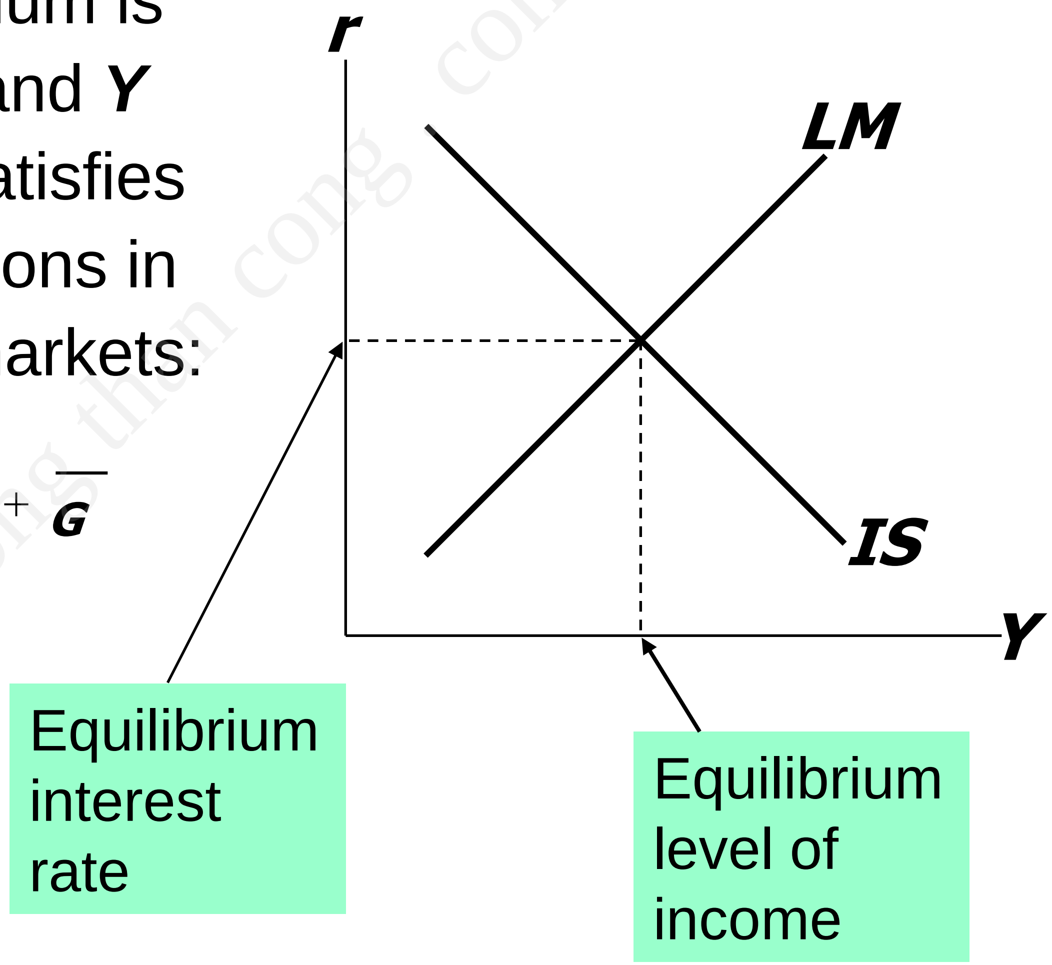
- Suppose a wave of credit card fraud causes consumers to use cash more frequently in transactions.
- Use the liquidity preference model to show how these events shift the *LM* curve.

The short-run equilibrium

The short-run equilibrium is the combination of ***r*** and ***Y*** that simultaneously satisfies the equilibrium conditions in the goods & money markets:

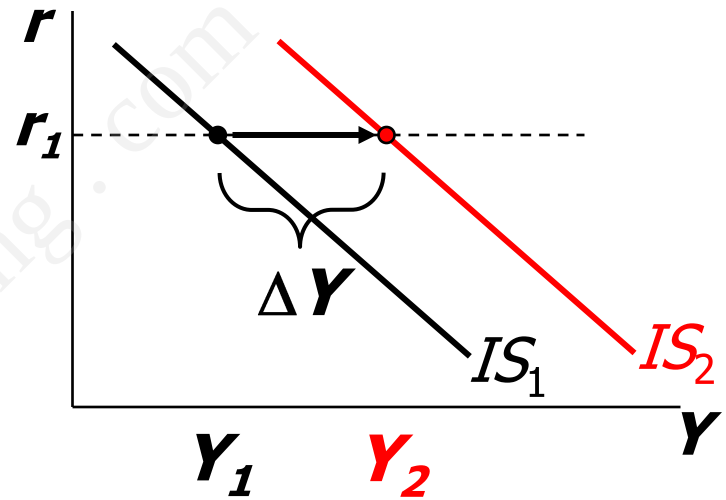
$$Y = C(Y - \overline{T}) + I(r) + \overline{G}$$

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



Recap: Shifts of the *IS* Curve

- The *IS* curve shifts right if
  - *G* increases, or
  - autonomous *C* or *I* increases, or
  - *T* decreases

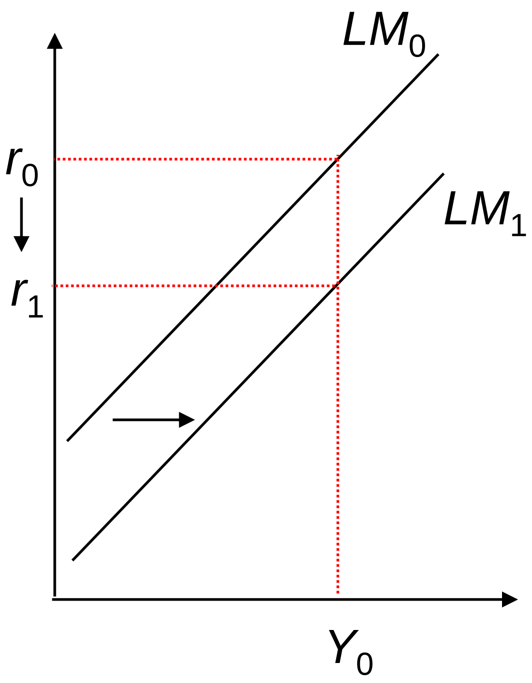


$$Y = \frac{1}{1 - MPC}[C_A + I(r) + G] - \frac{MPC}{1 - MPC}T$$

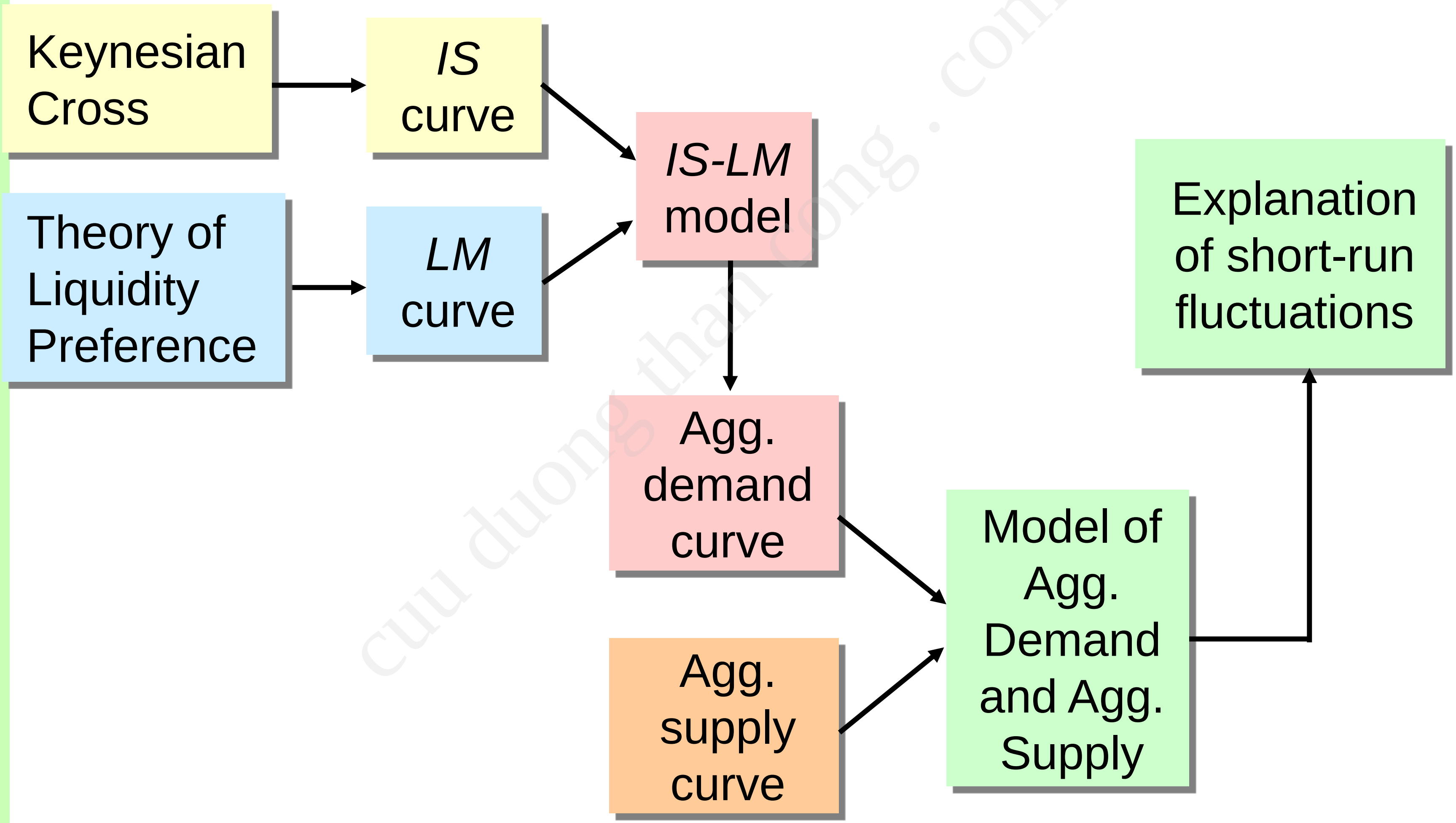
Recap: Shifts of the *LM* Curve

- The *LM* curve shifts right if
  - *M* increases, or
  - *P* decreases, or
  - Autonomous money demand decreases.

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

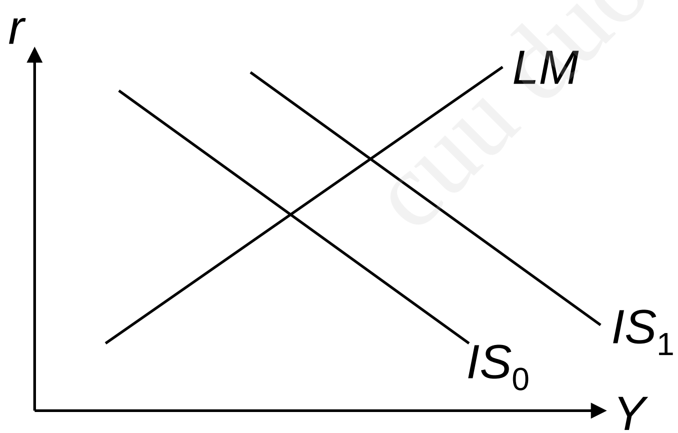


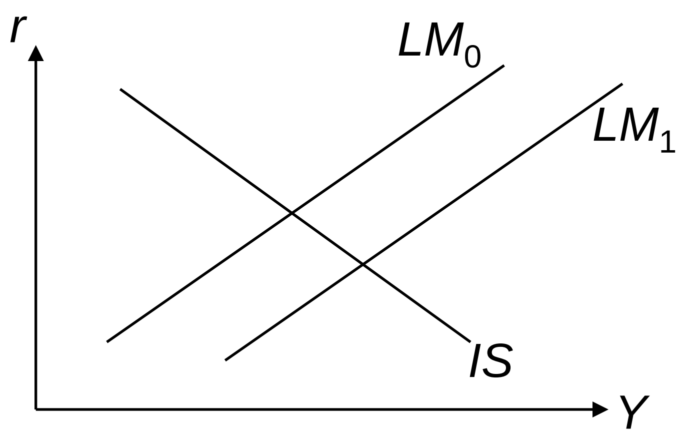
The Big Picture



Recap: Shifts of *IS* and *LM* Curves

- The *IS* curve shifts right if
  - *G* increases, or
  - autonomous *C* or *I* increases, or
  - *T* decreases
- The *LM* curve shifts right if
  - *M* increases, or
  - *P* decreases, or
  - Autonomous money demand decreases.





Preview of Chapter 11

In Chapter 11, we will

- use the *IS-LM* model to analyze the impact of policies and shocks.
- learn how the aggregate demand curve comes from *IS-LM.*
- use the *IS-LM* and *AD-AS* models together to analyze the short-run and long-run effects of shocks.
- use our models to learn about the Great Depression.

Chapter Summary

1. Keynesian cross
   - basic model of income determination
   - takes fiscal policy & investment as exogenous
   - fiscal policy has a multiplier effect on income.
2. *IS* curve
   - comes from Keynesian cross when planned investment depends negatively on interest rate
   - shows all combinations of ***r*** and ***Y*** that equate planned expenditure with actual expenditure on goods & services

Chapter Summary

3. Theory of Liquidity Preference
   - basic model of interest rate determination
   - takes money supply & price level as exogenous
   - an increase in the money supply lowers the interest rate

4. *LM* curve
   - comes from liquidity preference theory when money demand depends positively on income
   - shows all combinations of ***r*** and ***Y*** that equate demand for real money balances with supply

Chapter Summary

5. *IS*-*LM* model
   - Intersection of *IS* and *LM* curves shows the unique point (***Y***, ***r***) that satisfies equilibrium in both the goods and money markets.