

CHAPTER 3

National Income: Where it Comes From and Where it Goes

MACROECONOMICS SIXTH EDITION

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In this chapter, you will learn...

- what determines the economy's total output/income
- how the prices of the factors of production are determined
- how total income is distributed
- what determines the demand for goods and services
- how equilibrium in the goods market is achieved



Classical Theory, Long Run

- This chapter is in **Part II Classical Theory: The Economy in the Long Run**
- This theory assumes that the economy automatically ensures that supply equals demand for every commodity
- Supply and demand are made equal by fast-acting prices that quickly close the gap between supply and demand whenever there is one



Outline of model

A closed economy, market-clearing model

Supply side

- factor markets (supply, demand, price)
- determination of output/income

Demand side

- determinants of ***C***, ***I***, and ***G***

Equilibrium

- goods market
- loanable funds market



Factors of production

K = capital:
tools, machines, and structures used in
production

L = labor:
the physical and mental efforts of
workers

These are exogenous variables.



The production function

- $Y = F(K, L)$
- shows how much output (Y) the economy can produce from K units of capital and L units of labor
- reflects the economy's level of technology
- exhibits constant returns to scale



Production Function: Example

- $Y = K^\alpha L^{1-\alpha}$
 - This often-used production function is called the **Cobb-Douglas** production function.
 - α is any positive fraction. For example, $\alpha = 0.3$.
- $Y = K^{0.3} L^{0.7}$
 - If K and L are known, then Y can be calculated.



The distribution of national income

- determined by **factor prices**, which are the prices per unit that firms pay for the factors of production
 - **wage** = price of L
 - **rental rate** = price of K



Notation

W = nominal wage of labor

R = nominal rental rate of capital

P = price of output (Y)

W/P = real wage
(measured in units of output)

R/P = real rental rate



How factor prices are determined

- Factor prices are determined by supply and demand in factor markets.
- Recall: Supply of each factor is fixed.
- What about demand?



Demand for labor

- Assume markets are competitive:
each firm takes W , R , and P as given.
- Basic idea:
A firm hires each unit of labor
if the cost does not exceed the benefit.
 - cost = real wage
 - benefit = marginal product of labor



Marginal product of labor (*MPL*)

- definition:

The extra output the firm can produce using an additional unit of labor (holding other inputs fixed):

$$MPL = F(K, L+1) - F(K, L)$$



Marginal Product of Labor

- $MPL = F(K, L+1) - F(K, L)$
- If $F(K, L) = K^{0.3} L^{0.7}$, and if K and L are known, then MPL can be calculated by substitution.
- For the Cobb-Douglas production function $F(K, L) = K^\alpha L^{1-\alpha}$, it can be shown that:
 - $MPL = (1 - \alpha) K^\alpha L^{-\alpha}$.
 - Once again, if α , K and L are known, then MPL can be calculated.



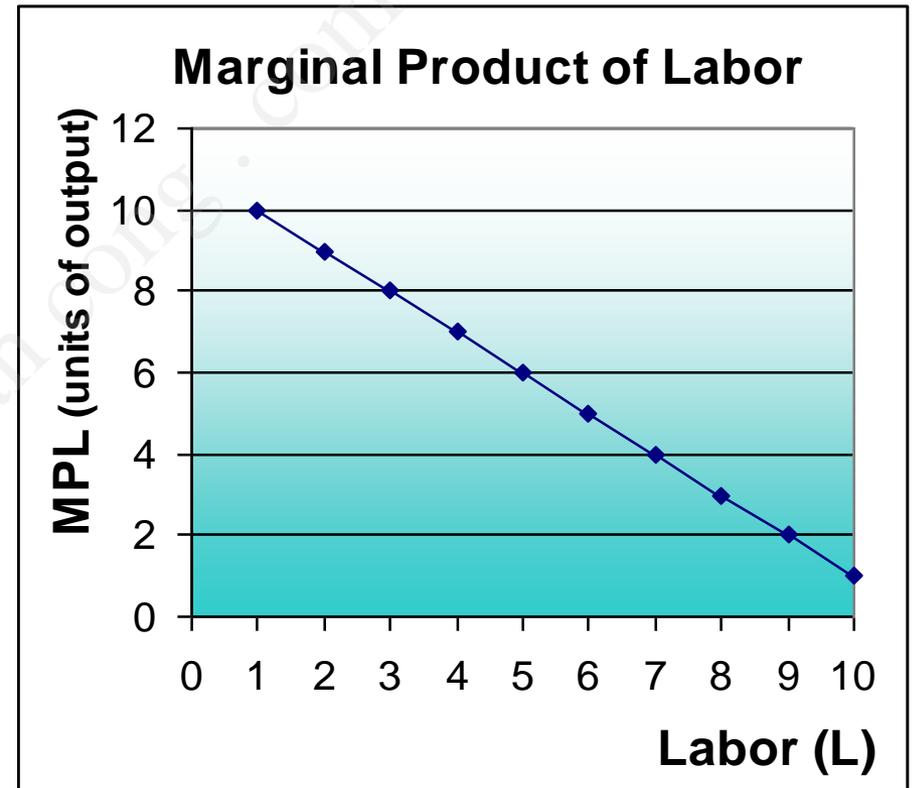
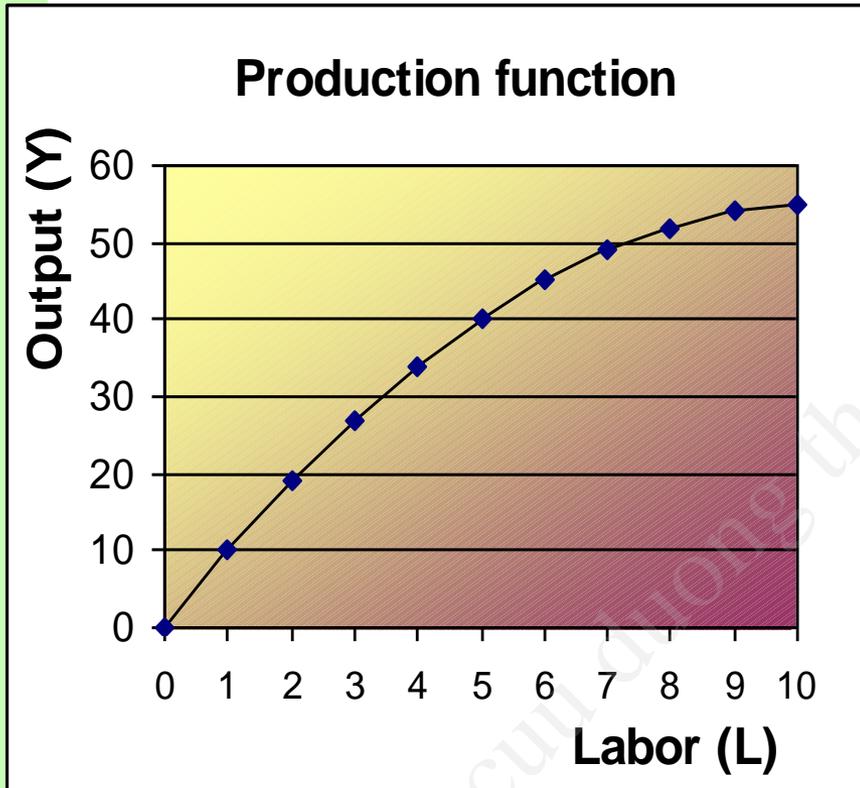
Exercise: *Compute & graph MPL*

- a. Determine ***MPL*** at each value of ***L***.
- b. Graph the production function.
- c. Graph the ***MPL*** curve with ***MPL*** on the vertical axis and ***L*** on the horizontal axis.

<i>L</i>	<i>Y</i>	<i>MPL</i>
0	0	n.a.
1	10	?
2	19	?
3	27	8
4	34	?
5	40	?
6	45	?
7	49	?
8	52	?
9	54	?
10	55	?



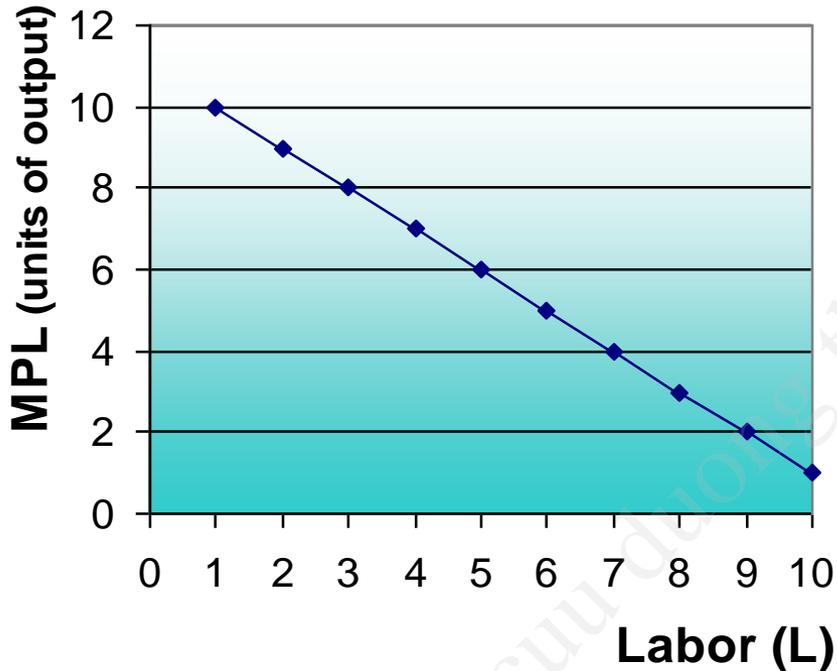
Answers:



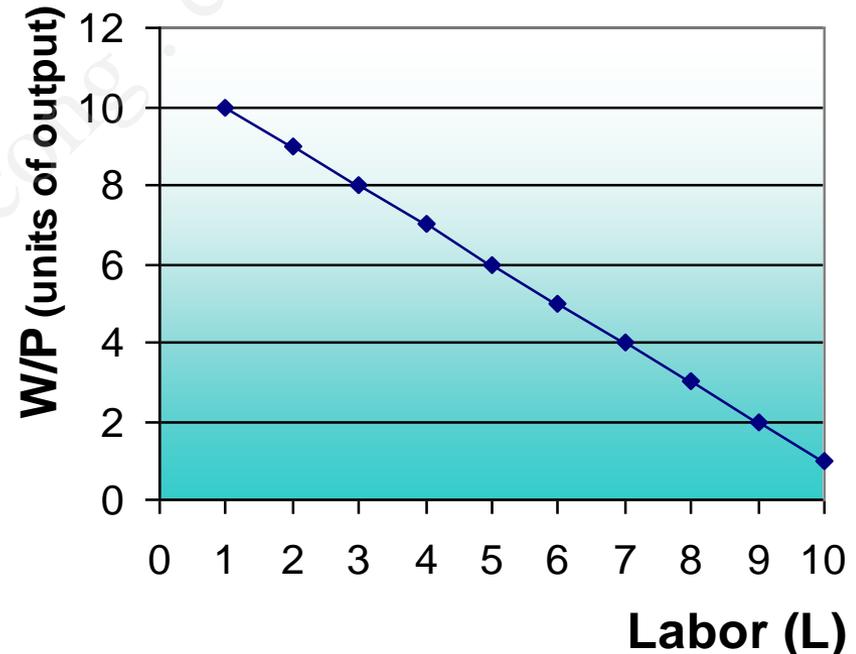


The MPL Curve is also the Labor Demand Curve

Marginal Product of Labor



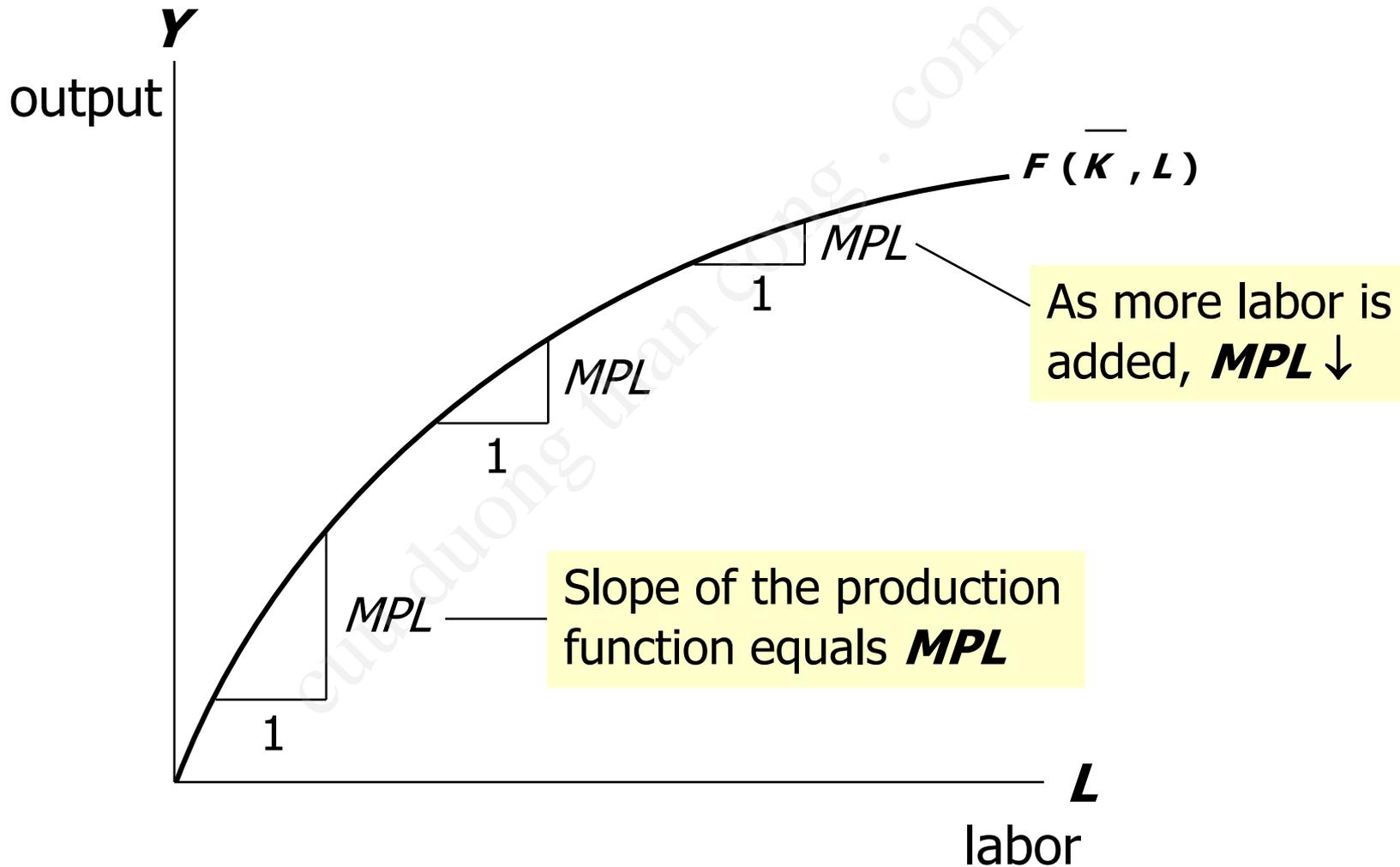
Demand for Labor



...will be shown soon!



Fig 3-3: *MPL* and the production function





Diminishing marginal returns

- As a factor input is increased, its marginal product falls (other things equal).
- Intuition:
Suppose $\uparrow L$ while holding K fixed
 - \Rightarrow fewer machines per worker
 - \Rightarrow lower worker productivity



Check your understanding:

- Which of these production functions have diminishing marginal returns to labor?

a) $F(K, L) = 2K + 15L$

b) $F(K, L) = \sqrt{KL}$

c) $F(K, L) = 2\sqrt{K} + 15\sqrt{L}$



Exercise (part 2)

Suppose $W/P = 6$.

- d. If $L = 3$, should firm hire more or less labor? Why?
- e. If $L = 7$, should firm hire more or less labor? Why?

L	Y	MPL
0	0	n.a.
1	10	10
2	19	9
3	27	8
4	34	7
5	40	6
6	45	5
7	49	4
8	52	3
9	54	2
10	55	1



Figure 3-4: *MPL* and the demand for labor

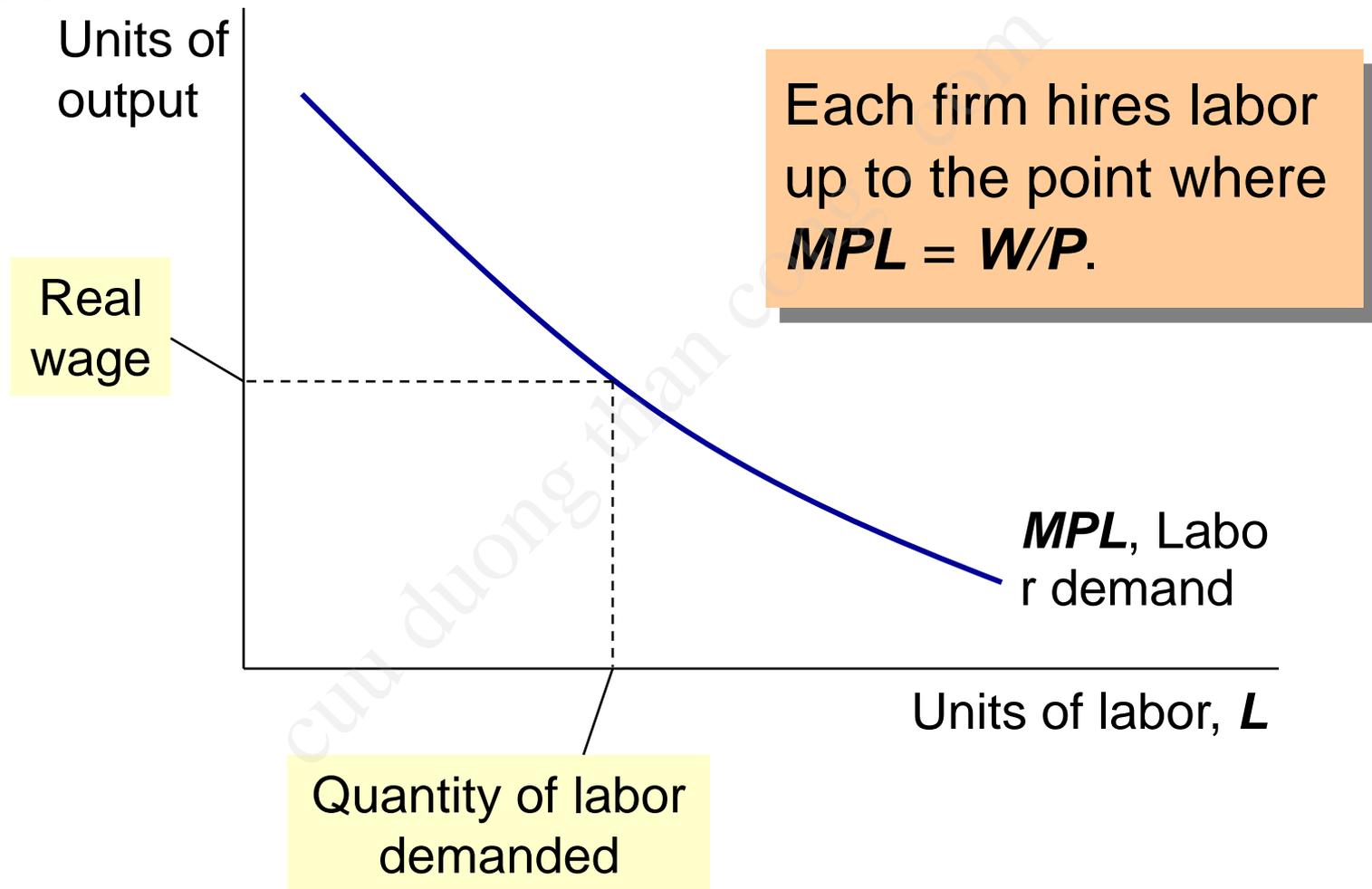
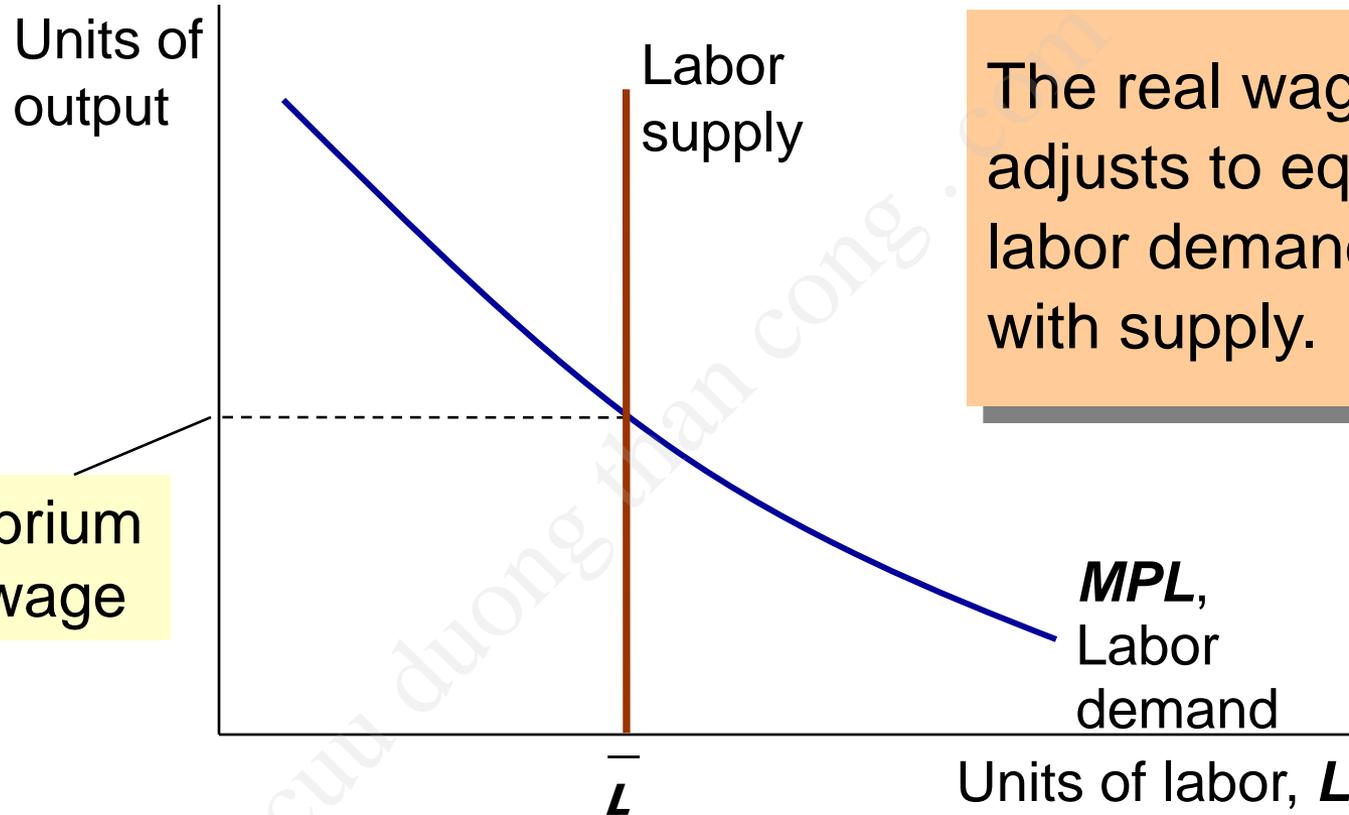




Fig 3-2: The equilibrium real wage



The real wage adjusts to equate labor demand with supply.



Calculating the Real Wage

- We saw earlier, that if the production function is known, and if K and L are known, then MPL can be calculated.
- As $W/P = MPL$, the real wage can also be calculated.
- The total real income of labor is $W/P \cdot L$, this can also be calculated.



Calculating the Real Wage

- For the Cobb-Douglas production function $F(K, L) = K^\alpha L^{1-\alpha}$,
- $MPL = (1 - \alpha) K^\alpha L^{-\alpha}$. Once again, if α , K and L are known, then MPL can be calculated.
- So, labor's real income = $W/P \quad L = (1 - \alpha) K^\alpha L^{1-\alpha} = (1 - \alpha) Y$.
- So, labor's share of total real income is $(W/P \quad L)/Y = 1 - \alpha$.
- In US data, labor's share has been approximately 0.7 for a long time; see Fig. 3-5. So, a Cobb-Douglas production function with $\alpha = 0.3$ is a good approximation of the US economy.



Determining the rental rate

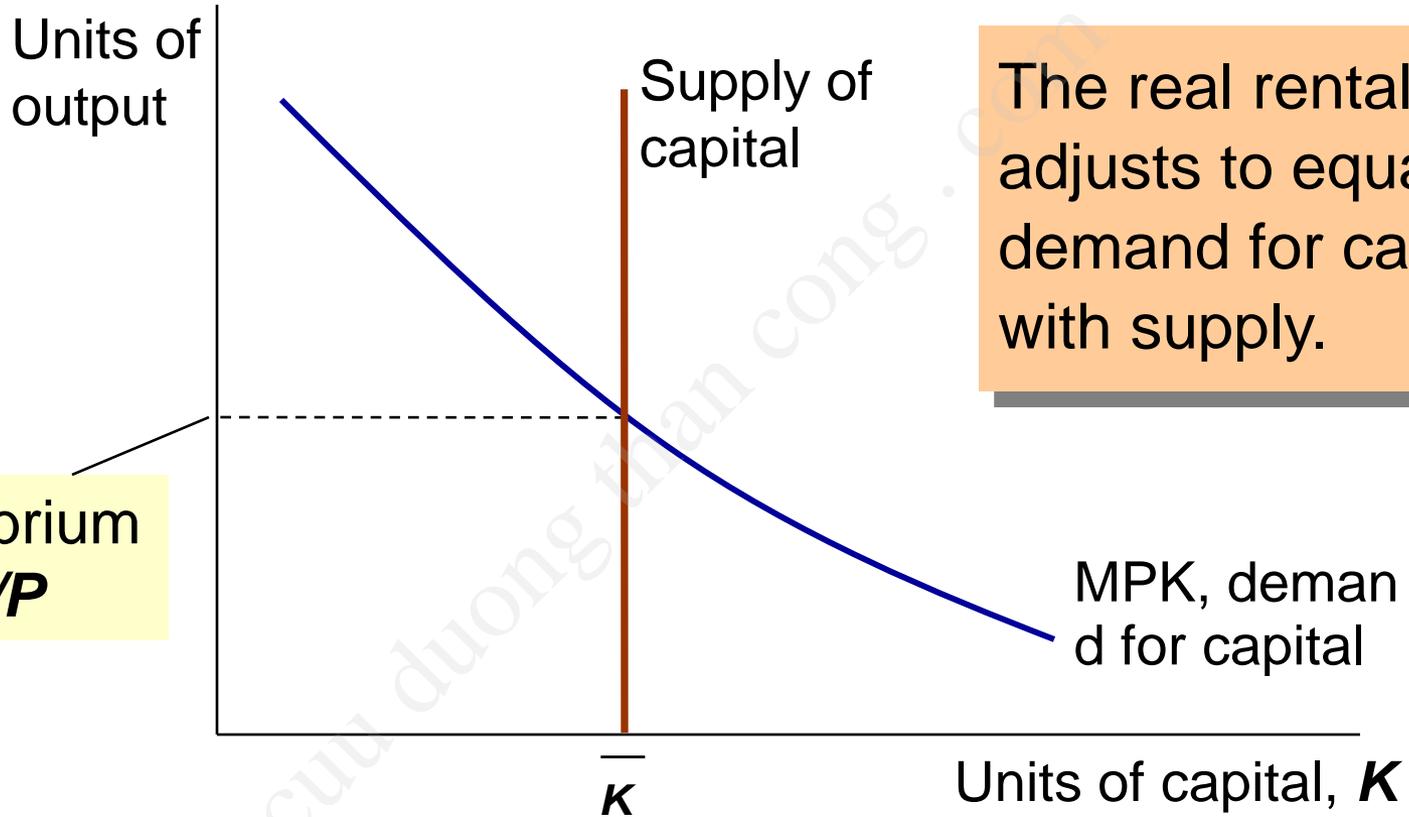
We have just seen that $MPL = W/P$.

The same logic shows that $MPK = R/P$:

- diminishing returns to capital: $MPK \downarrow$ as $K \uparrow$
- The MPK curve is the firm's demand curve for renting capital.
- Firms maximize profits by choosing K such that $MPK = R/P$.



The equilibrium real rental rate



The real rental rate adjusts to equate demand for capital with supply.



Calculating the Real Rental

- If the production function is known, and if K and L are known, then MPK can be calculated.
- As $R/P = MPK$, the real rental rate can also be calculated.
- As the total real income of capital is $R/P \quad K$, this can also be calculated.



Calculating the Real Rental

- For the Cobb-Douglas production function $F(K, L) = K^\alpha L^{1-\alpha}$,
- $MPK = \alpha K^{\alpha-1} L^{1-\alpha}$. Once again, if α , K and L are known, then MPK can be calculated.
- So, capital's real income = $R/P \quad K = \alpha K^\alpha L^{1-\alpha} = \alpha Y$.
- So, capital's share of total real income is $(R/P \quad K)/Y = \alpha$.
- Note that the total share of labor *and* capital is $1 - \alpha + \alpha = 1$.



The Neoclassical Theory of Distribution

- Our theory of the distribution of total income between labor and capital is called the neoclassical theory of distribution
- It states that each factor input is paid its marginal product



How income is distributed:

$$\text{total labor income} = \frac{W}{P} \bar{L} = MPL \times \bar{L}$$

$$\text{total capital income} = \frac{R}{P} \bar{K} = MPK \times \bar{K}$$

If production function has constant returns to scale, then

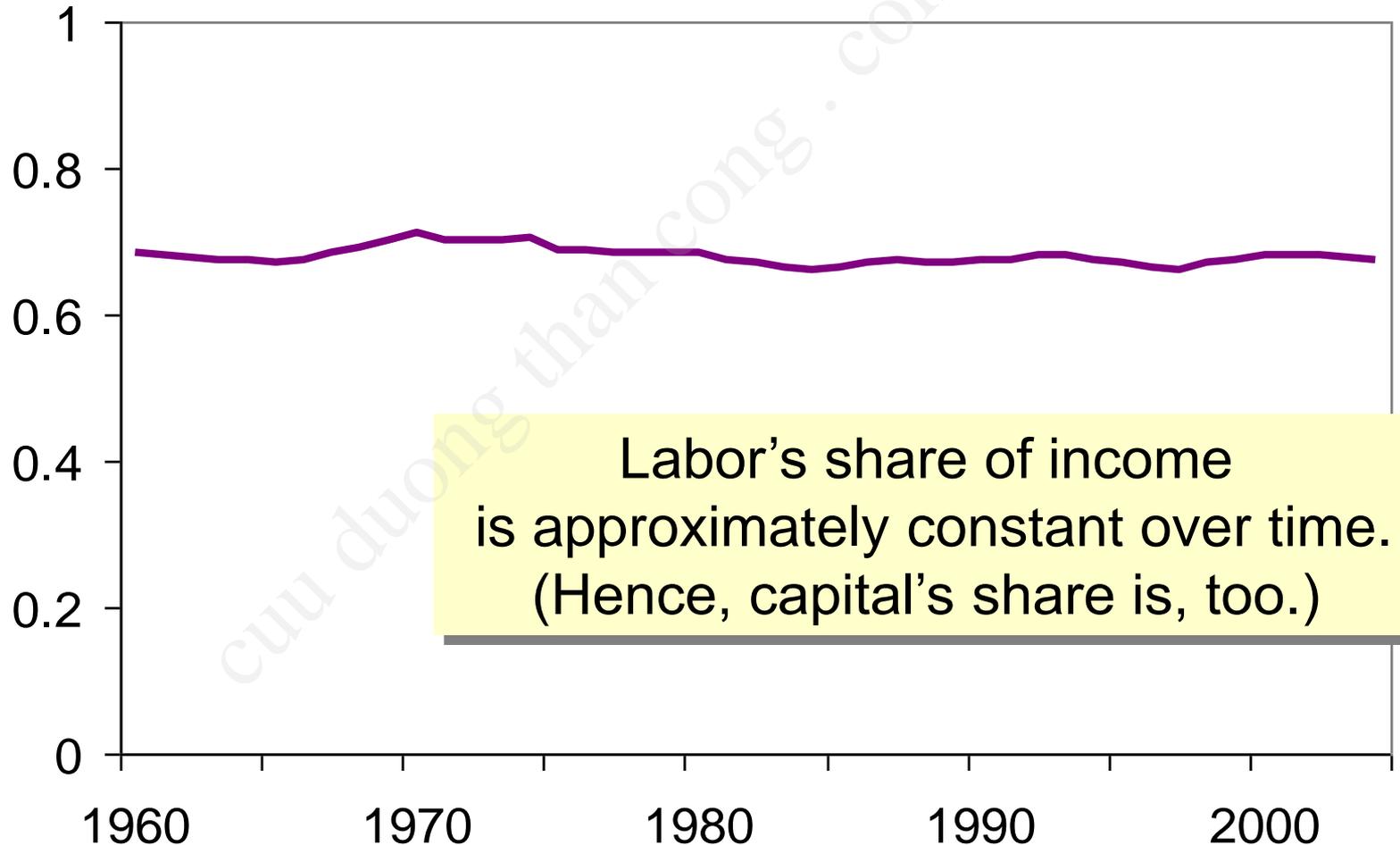
$$\bar{Y} = \underbrace{MPL \times \bar{L}}_{\text{labor income}} + \underbrace{MPK \times \bar{K}}_{\text{capital income}}$$

national income



The ratio of labor income to total income in the U.S.

Labor's share of total income





The Cobb-Douglas Production Function

- The Cobb-Douglas production function has constant factor shares:

α = capital's share of total income:

$$\text{capital income} = MPK \times K = \alpha Y$$

$$\text{labor income} = MPL \times L = (1 - \alpha) Y$$

- The Cobb-Douglas production function is:

$$Y = A K^{\alpha} L^{1-\alpha}$$

where A represents the level of technology.



The Cobb-Douglas Production Function

- Each factor's marginal product is proportional to its average product:

$$MPK = \alpha A K^{\alpha-1} L^{1-\alpha} = \frac{\alpha Y}{K}$$

$$MPL = (1 - \alpha) A K^{\alpha} L^{-\alpha} = \frac{(1 - \alpha) Y}{L}$$



Outline of model

A closed economy, market-clearing model

Supply side

- DONE** ✓ factor markets (supply, demand, price)
- DONE** ✓ determination of output/income

Demand side

- Next** → determinants of **C**, **I**, and **G**

Equilibrium

- goods market
- loanable funds market



Demand for goods & services

Components of aggregate demand:

C = consumer demand for g & s

I = demand for investment g & s

G = government demand for g & s

(closed economy: no **NX**)



Consumption, C

- def: **Disposable income** is total income minus total taxes: $Y - T$.
- **Consumption function**: $C = C(Y - T)$
Shows that $\uparrow(Y - T) \Rightarrow \uparrow C$
- def: **Marginal propensity to consume (MPC)** is the increase in C caused by a one-unit increase in disposable income.



Consumption Function: Example

- Assume $C(Y - T) = 10 + 0.8(Y - T)$
- We saw earlier that if K , L , and the production function are known, then Y can be calculated. Therefore,
- If T , which is an exogenous variable, is known and if the consumption function is known, then C can be calculated.

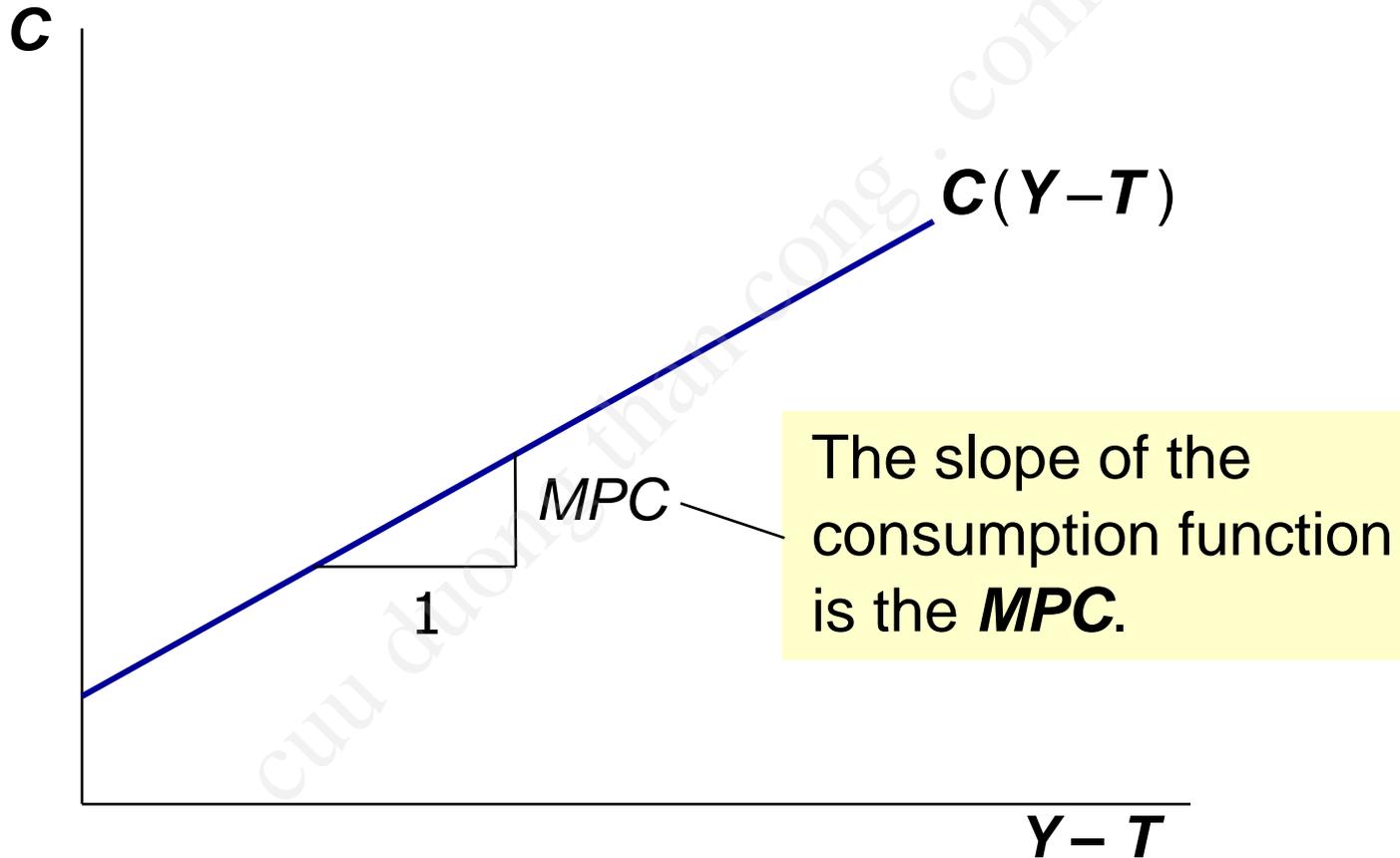


Consumption Function: Example

- $C(Y - T) = 10 + 0.8(Y - T)$
- Marginal Propensity to Consume = 0.8
- $\uparrow Y \Rightarrow \uparrow C$
- $\downarrow T \Rightarrow \uparrow C$
- All other factors that can boost C are hidden in the number 10. When there is such a boost, 10 will increase to, say, 12.



Figure 3-6: The consumption function





Investment, I

- The **investment function** is $I = I(r)$, where r denotes the **real interest rate**, the nominal interest rate corrected for inflation.
- The real interest rate is
 - the cost of borrowing
 - the opportunity cost of using one's own funds to finance investment spending.

So, $\uparrow r \Rightarrow \downarrow I$

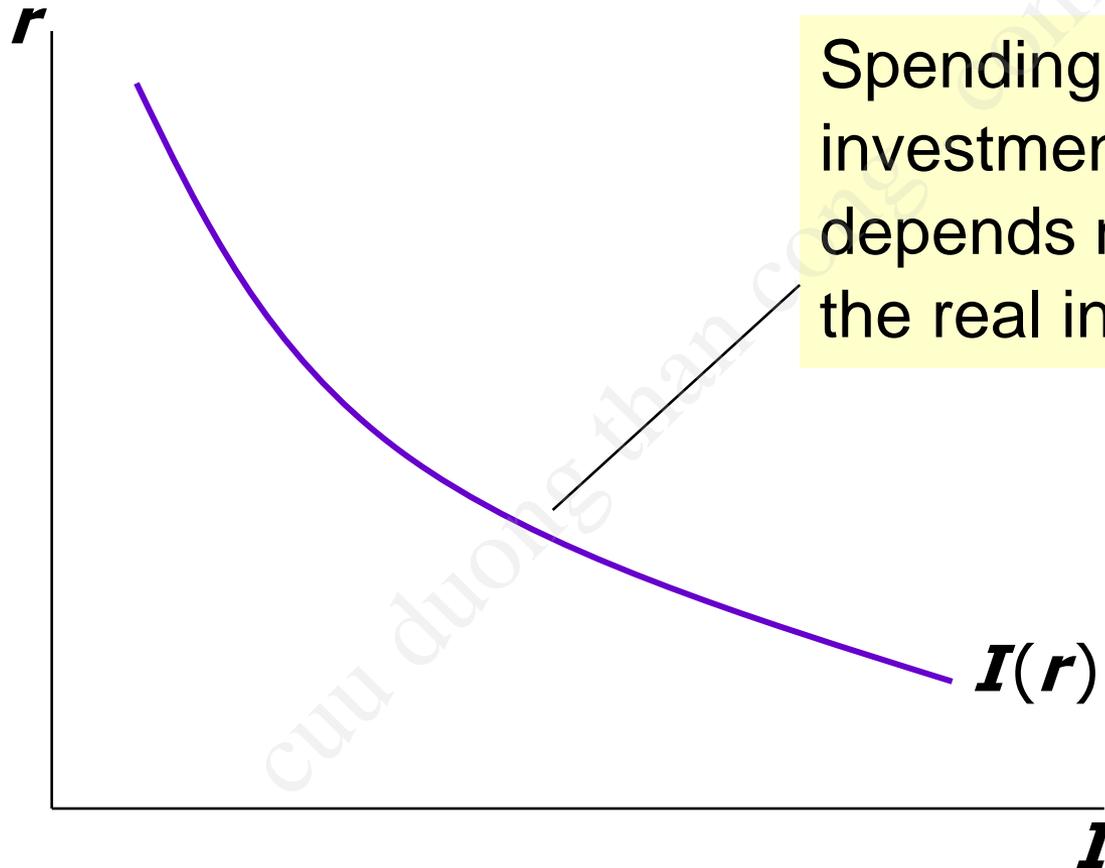


Investment

- $I = 100 - 8r$ is a simple investment function.
- Note that $\uparrow r \Rightarrow \downarrow I$
- **All other factors that can boost I** are hidden in the number 100. When there is such a boost, 100 will increase to, say, 120.



The investment function





Government spending, G

- G = govt spending on goods and services.
- G excludes transfer payments (e.g., social security benefits, unemployment insurance benefits).
- Assume government spending and total taxes are exogenous:

$$G = \bar{G} \quad \text{and} \quad T = \bar{T}$$



The market for goods & services

- Aggregate demand: $C(\bar{Y} - \bar{T}) + I(r) + \bar{G}$
- Aggregate supply: $\bar{Y} = F(\bar{K}, \bar{L})$
- Equilibrium: $\bar{Y} = C(\bar{Y} - \bar{T}) + I(r) + \bar{G}$

- The real interest rate adjusts to equate demand with supply.



The loanable funds market

- A simple supply-demand model of the financial system.
- One asset: “loanable funds”
 - demand for funds: investment
 - supply of funds: saving
 - “price” of funds: real interest rate



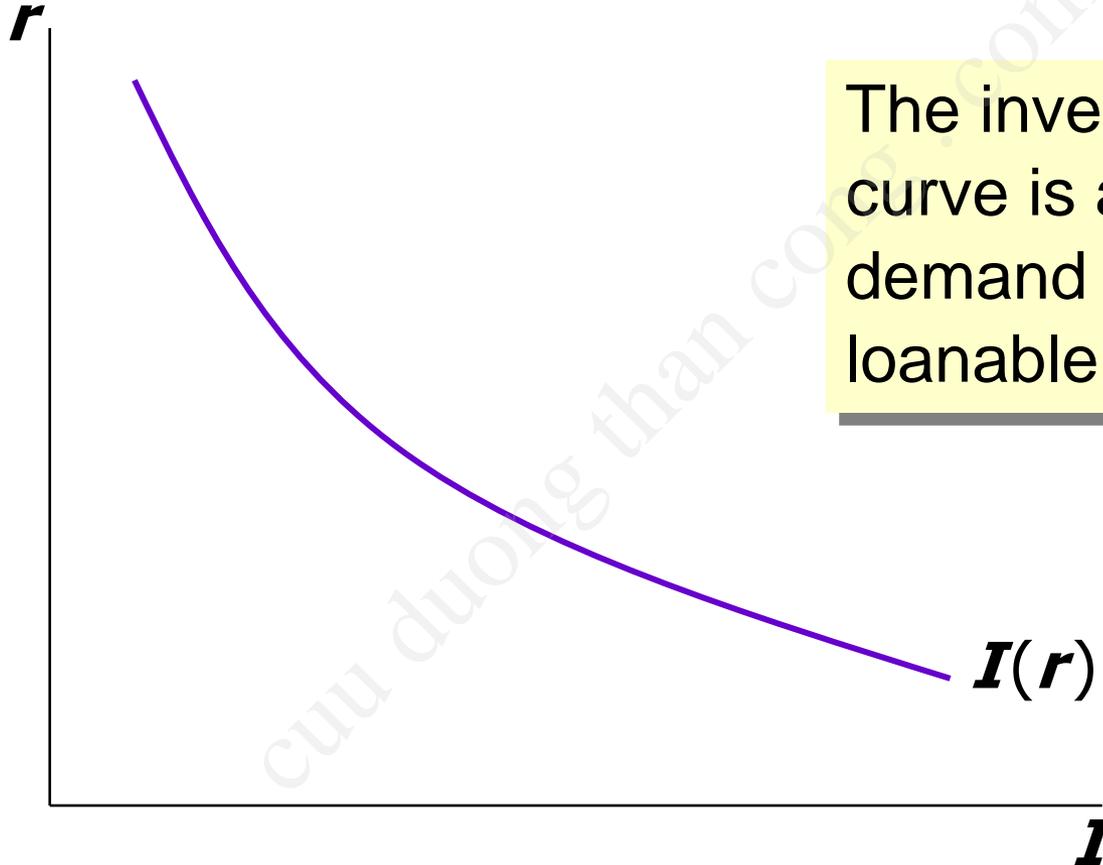
Demand for funds: Investment

The demand for loanable funds...

- comes from investment:
Firms borrow to finance spending on plant & equipment, new office buildings, etc.
Consumers borrow to buy new houses.
- depends negatively on r ,
the “price” of loanable funds
(cost of borrowing).



Loanable funds demand curve



The investment curve is also the demand curve for loanable funds.



Supply of funds: Saving

- The supply of loanable funds comes from saving:
 - Households use their saving to make bank deposits, purchase bonds and other assets. These funds become available to firms to borrow to finance investment spending.
 - The government may also contribute to saving if it does not spend all the tax revenue it receives.



Types of saving

$$\text{private saving} = (Y - T) - C$$

$$\text{public saving} = T - G$$

$$\text{national saving, } S$$

$$= \text{private saving} + \text{public saving}$$

$$= (Y - T) - C + T - G$$

$$= Y - C - G$$



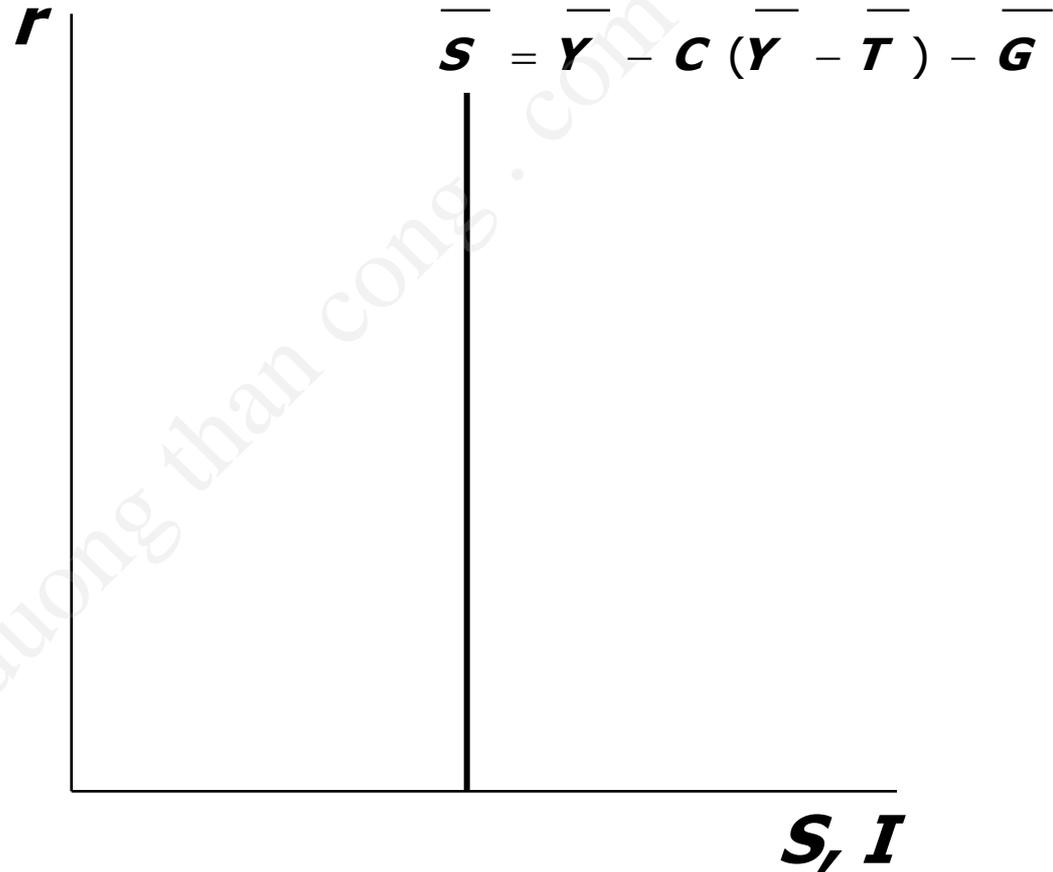
Saving

- If K , L , and the production function are known, then Y can be calculated.
- If T and the consumption function are also known, then C can be calculated.
- Finally, if G , which is exogenous, is known, then $S = Y - C - G$ can be calculated.



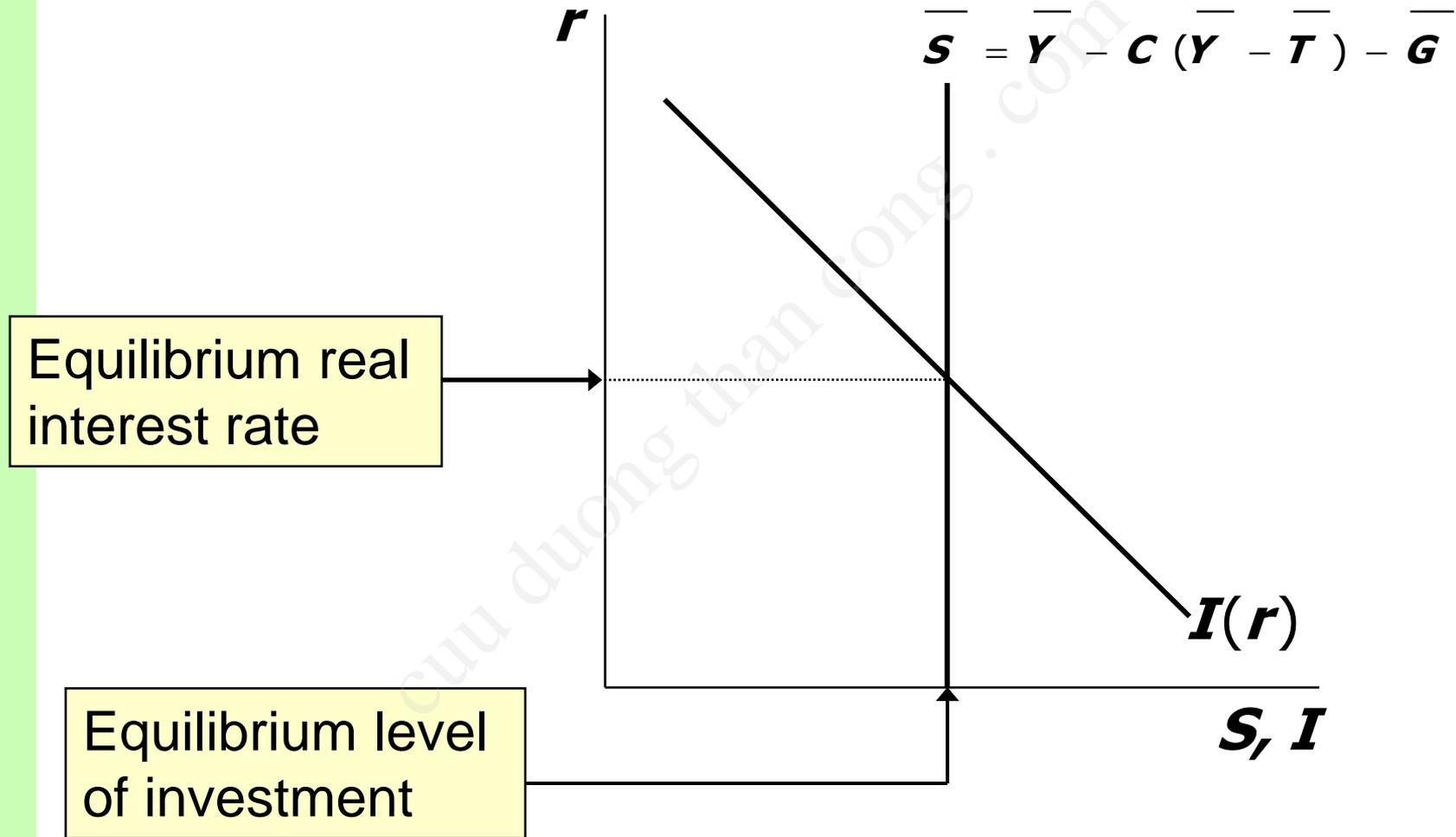
Loanable funds supply curve

National saving does not depend on r , so the supply curve is vertical.





Loanable funds market equilibrium





Equilibrium in the Loanable Funds Market

- Recall: Equilibrium in the goods market requires $Y = C + I + G$. Therefore,
- $Y - C - G = I$. Therefore,
- $S = I$.
- This condition determines the real interest rate.



Investment and Interest Rate

- We saw earlier how S can be calculated.
- $S = I$ means that investment can be calculated.
- If, further, the investment function is known to be, say, $I = 100 - 8r$, then $I = 100 - 8r$ can be used to calculate r .



The special role of r

r adjusts to equilibrate the goods market and the loanable funds market simultaneously:

If L.F. market is in equilibrium, then

$$Y - C - G = I$$

Add ($C + G$) to both sides to get

$$Y = C + I + G \quad (\text{goods market eq'm})$$

Thus,

Eq'm in L.F.
market



Eq'm in goods
market



Digression: Mastering models

To master a model, be sure to know:

1. Which of its variables are endogenous and which are exogenous.
2. For each curve in the diagram, know
 - a. definition
 - b. intuition for slope
 - c. all the things that can shift the curve
3. Use the model to analyze the effects of each item in 2c.



Mastering the loanable funds model

Things that shift the saving curve

- public saving
 - fiscal policy: changes in **G** or **T**
- private saving
 - preferences
 - tax laws that affect saving
 - 401(k)
 - IRA
 - replace income tax with consumption tax



CASE STUDY: The Reagan deficits

- Reagan policies during early 1980s:
 - increases in defense spending: $\Delta \mathbf{G} > 0$
 - big tax cuts: $\Delta \mathbf{T} < 0$
- Both policies reduce national saving:

$$\bar{S} = \bar{Y} - C(\bar{Y} - \bar{T}) - \bar{G}$$

$$\uparrow \bar{G} \Rightarrow \downarrow \bar{S}$$

$$\downarrow \bar{T} \Rightarrow \uparrow C \Rightarrow \downarrow \bar{S}$$

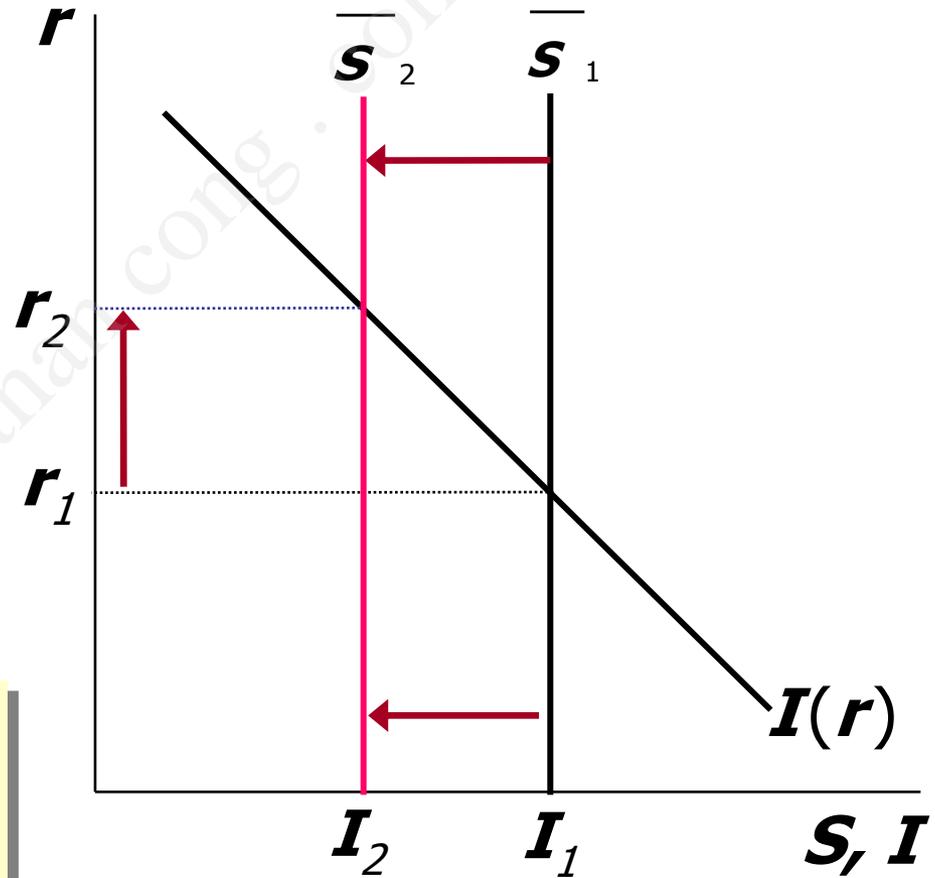


CASE STUDY: The Reagan deficits

1. The increase in the deficit reduces saving...

2. ...which causes the real interest rate to rise...

3. ...which reduces the level of investment.





Are the data consistent with these results?

<i>variable</i>	<i>1970s</i>	<i>1980s</i>
<i>T – G</i>	<i>–2.2</i>	<i>–3.9</i>
<i>S</i>	<i>19.6</i>	<i>17.4</i>
<i>r</i>	<i>1.1</i>	<i>6.3</i>
<i>I</i>	<i>19.9</i>	<i>19.4</i>

*T–G, S, and I are expressed as a percent of GDP
All figures are averages over the decade shown.*



Now you try...

- Draw the diagram for the loanable funds model.
- Suppose the tax laws are altered to provide more incentives for private saving.
(Assume that total tax revenue T does not change)
- What happens to the interest rate and investment?



Mastering the loanable funds model, *continued*

Things that shift the investment curve

- some technological innovations
 - to take advantage of the innovation, firms must buy new investment goods
- tax laws that affect investment
 - investment tax credit

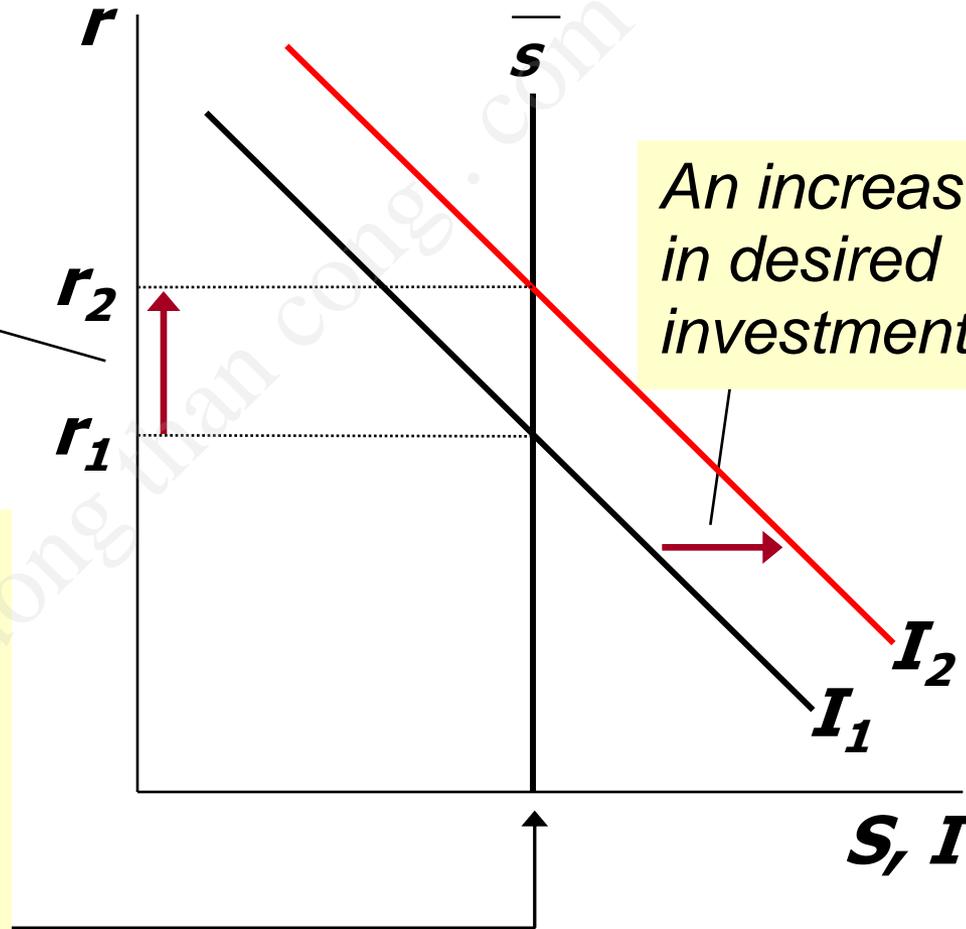


An increase in investment demand

...raises the interest rate.

An increase in desired investment...

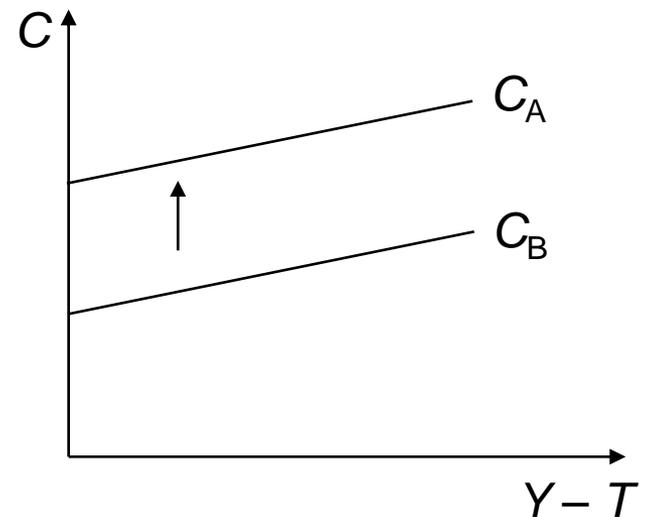
But the equilibrium level of investment cannot increase because the supply of loanable funds is fixed.





A Jump in Consumption

- If there is a boom in real-estate prices or in the stock market, people feel wealthier. They feel a reduced need to save. Therefore,
- There is a jump in consumption
- How will this affect the market for loanable funds?





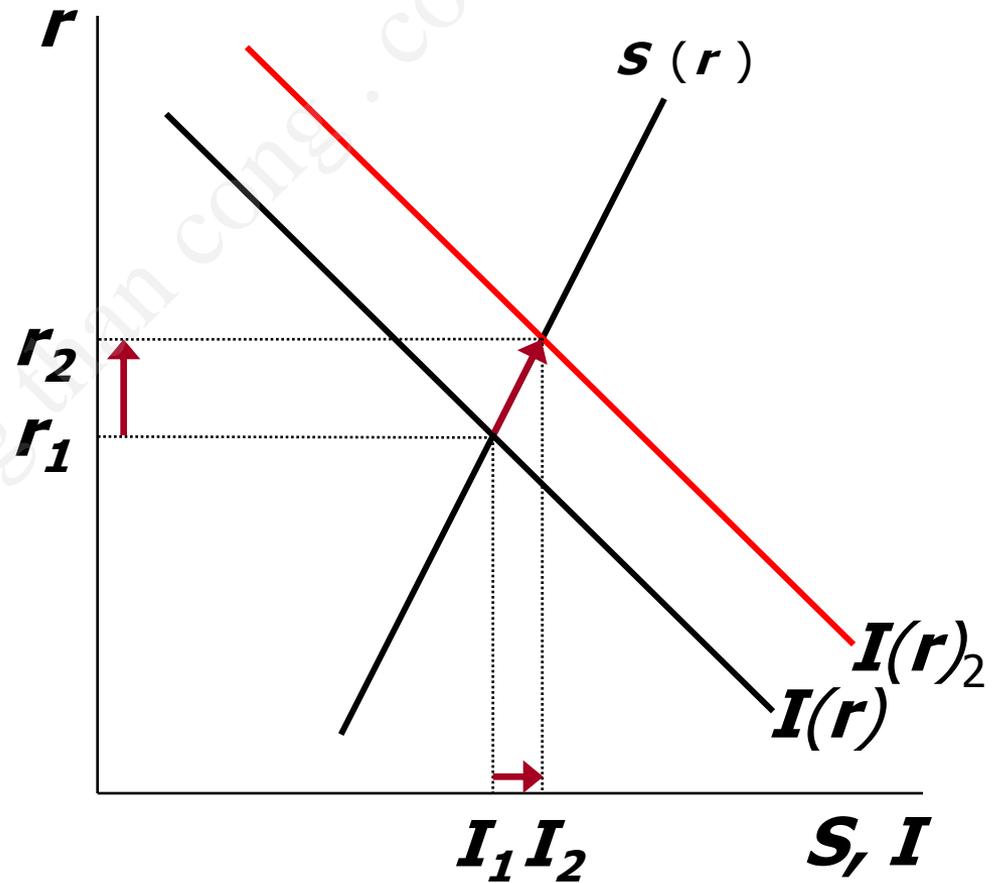
Saving and the interest rate

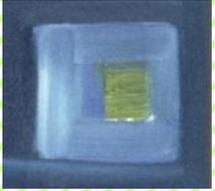
- Why might saving depend on r ?
- How would the results of an increase in investment demand be different?
 - Would r rise as much?
 - Would the equilibrium value of I change?



An increase in investment demand when saving depends on r

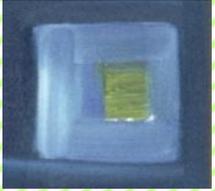
An increase in investment demand raises r , which induces an increase in the quantity of saving, which allows I to increase.





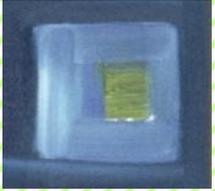
Chapter Summary

- Total output is determined by
 - the economy's quantities of capital and labor
 - the level of technology
- Competitive firms hire each factor until its marginal product equals its price.
- If the production function has constant returns to scale, then labor income plus capital income equals total income (output).



Chapter Summary

- A closed economy's output is used for
 - consumption
 - investment
 - government spending
- The real interest rate adjusts to equate the demand for and supply of
 - goods and services
 - loanable funds



Chapter Summary

- A decrease in national saving causes the interest rate to rise and investment to fall.
- An increase in investment demand causes the interest rate to rise, but does not affect the equilibrium level of investment if the supply of loanable funds is fixed.