

PART II

CLASSICAL THEORY

Chapter 3: National Income: Where it Comes From and Where it Goes*

MACROECONOMICS

Seventh Edition

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* Slides based on Ron Cronovich's slides, adjusted for course in Macroeconomics at the Wang Yanan Institute for Studies in Economics at Xiamen University.

Learning Objectives

This chapter introduces you to understanding:

- what determines the economy's total production of goods and services ←
- how national income is distributed to the factors of production
- what determines the demand for goods and services
- how equilibrium in the market for goods and services is achieved

3.1) Economy's Production of G&S

An economy's output of goods and services depends on

- its factors of production
- its production function

3.1) Economy's Production of G&S

→ Factors of Production

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

L = Labor: the physical and mental efforts of workers

3.1) Economy's Production of G&S

→ The Production Function

- Denoted $Y = F(K, L)$
- 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

3.1) Economy's Production of G&S

→ Digression: Returns to Scale

Initially $Y_1 = F(K_1, L_1)$

Scale all inputs by the same factor z : $K_2 = zK_1$ and $L_2 = zL_1$ (for example, if $z = 1.25$, then all inputs are increased by 25%)

What happens to output, $Y_2 = F(K_2, L_2)$?

- If **constant returns to scale**, $Y_2 = zY_1$
- If **increasing returns to scale**, $Y_2 > zY_1$
- If **decreasing returns to scale**, $Y_2 < zY_1$

3.1) Economy's Production of G&S

→ Digression: Returns to Scale, Example 1

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

$$F(zK, zL) = \sqrt{(zK)(zL)}$$

$$= \sqrt{z^2 KL}$$

$$= \sqrt{z^2} \sqrt{KL}$$

$$= z\sqrt{KL}$$

$$= zF(K, L)$$

Constant returns to scale

3.1) Economy's Production of G&S

→ Digression: Returns to Scale, Example 2

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

$$F(zK, zL) = \sqrt{zK} + \sqrt{zL}$$

$$= \sqrt{z}\sqrt{K} + \sqrt{z}\sqrt{L}$$

$$= \sqrt{z}(\sqrt{K} + \sqrt{L})$$

$$= \sqrt{z} F(K, L) \quad \text{Decreasing returns to scale}$$

3.1) Economy's Production of G&S

→ Digression: Returns to Scale, Example 3

$$F(K, L) = K^2 + L^2$$

$$F(zK, zL) = (zK)^2 + (zL)^2$$

$$= z^2 (K^2 + L^2)$$

$$= z^2 F(K, L)$$

Increasing returns to scale

3.1) Economy's Production of G&S

→ Digression:该你们了

Determine whether the following production functions feature constant, decreasing, or increasing returns to scale:

(a) $F(K, L) = \frac{K^2}{L}$

(b) $F(K, L) = K + L$

3.1) Economy's Production of G&S

→ Digression: Answers to Part (a)

$$F(K, L) = \frac{K^2}{L}$$

$$F(zK, zL) = \frac{(zK)^2}{zL}$$

$$= \frac{z^2 K^2}{zL}$$

$$= z \frac{K^2}{L}$$

$$= zF(K, L) \quad \text{Constant returns to scale}$$

3.1) Economy's Production of G&S

→ Digression: Answers to Part (b)

$$F(K, L) = K + L$$

$$F(zK, zL) = zK + zL$$

$$= z(K + L)$$

$$= zF(K, L)$$

Constant returns to scale

3.1) Economy's Production of G&S

→ Supply of Goods & Services: Model Assumptions

- Technology is fixed
- The economy's supplies of capital and labor are fixed at:

$$K = \bar{K} \quad \text{and} \quad L = \bar{L}$$

3.1) Economy's Production of G&S

→ Determining GDP

Output is determined by the fixed factor supplies and the fixed state of technology:

$$\bar{Y} = F(\bar{K}, \bar{L})$$

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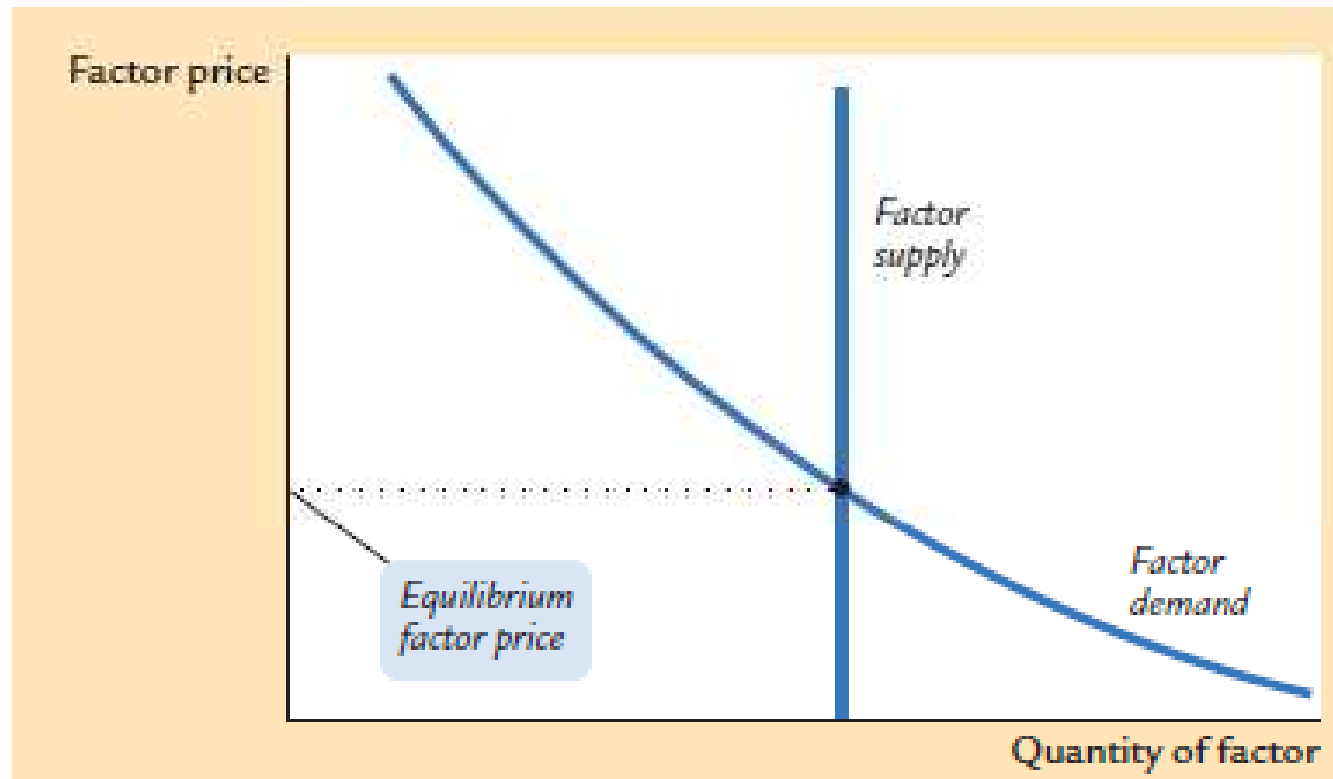
3.2) Distribution of National Income

- Remember from chapter 2: Total output = total income
- Since factors of production determine total output, they also determine total income.
- *Distribution* of national income determined by **factor prices**, that is, the prices firms pay per unit for factors of production:
 - Wage = price of **L**
 - Rental rate = price of **K**

3.2) Distribution of National Income

→ How Factor Prices are Determined

- Factor prices are determined by supply and demand in factor markets.



- Since supply is fixed we need to determine demand

3.2) Distribution of National Income

→ Notation used to Obtain Factor Demand

W = Nominal wage

R = Nominal rental rate

P = Price of output

R/P = Real rental rate

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

3.2) Distribution of National Income

→ Demand for Labor

- Assume markets are competitive: each firm takes W , R , and P as given.
- Firms choose L and K to maximize profit:
Profit = $PF(K,L) - WL - RK$
- Basic idea: A firm hires additional units of labor if the cost does not exceed the benefit.

Cost = Real wage

Benefit = Marginal product of labor

3.2) Distribution of National Income

→ Demand for Labor: Marginal Product of Labor

- To determine demand for labor we introduce the concept of **marginal product of labor** (MPL).
- Definition:
MPL is the extra output a firm can produce using an additional unit of labor (holding other inputs fixed):

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

3.2) Distribution of National Income

→ 该你们了: Compute and Graph MPL

a. Determine **MPL** at each value of **L**.

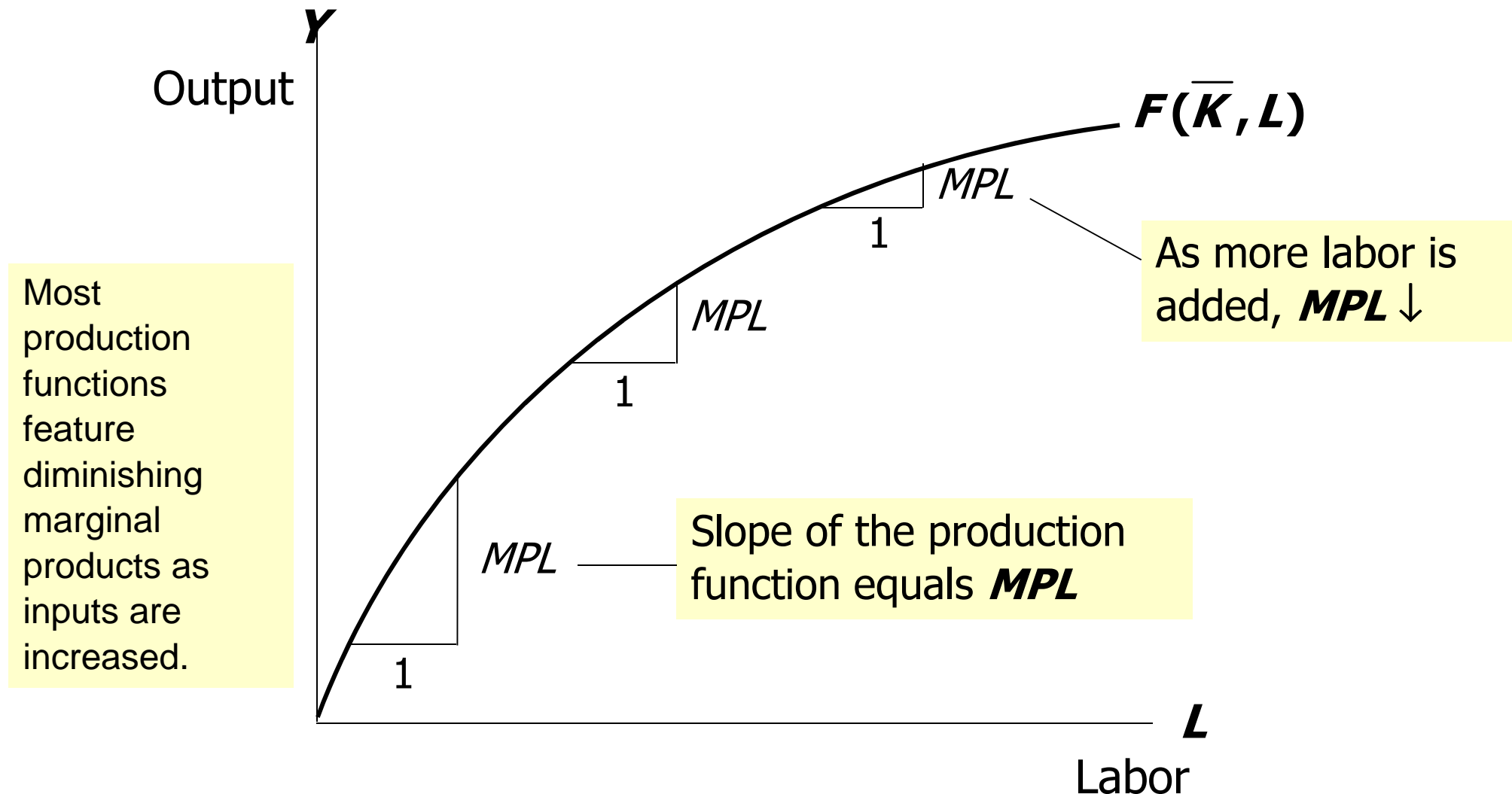
b. Graph the production function (That is, **Y** as a function of **L**)

c. Graph the **MPL** curve (that is, **MPL** as a function of **L**).

L	Y	MPL
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	?

3.2) Distribution of National Income

→ MPL and the Production Function



3.2) Distribution of National Income

→ 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

3.2) Distribution of National Income

→ MPL and the Demand for Labor

- A firm's change in profit from hiring an additional unit of labor equals

$$\begin{aligned}\Delta\text{Profit} &= \Delta\text{Revenue} - \Delta\text{Cost} \\ &= P \cdot \text{MPL} - W\end{aligned}$$

- A manager will increase labor until $\Delta\text{Profit}=0$
- To maximize profit, a competitive firm hires labor up to the point where the marginal product of labor equals the real wage:
 $\text{MPL}=W/P$

3.2) Distribution of National Income

→ 该你们了: MPL and the Demand for Labor

Suppose $W/P = 6$.

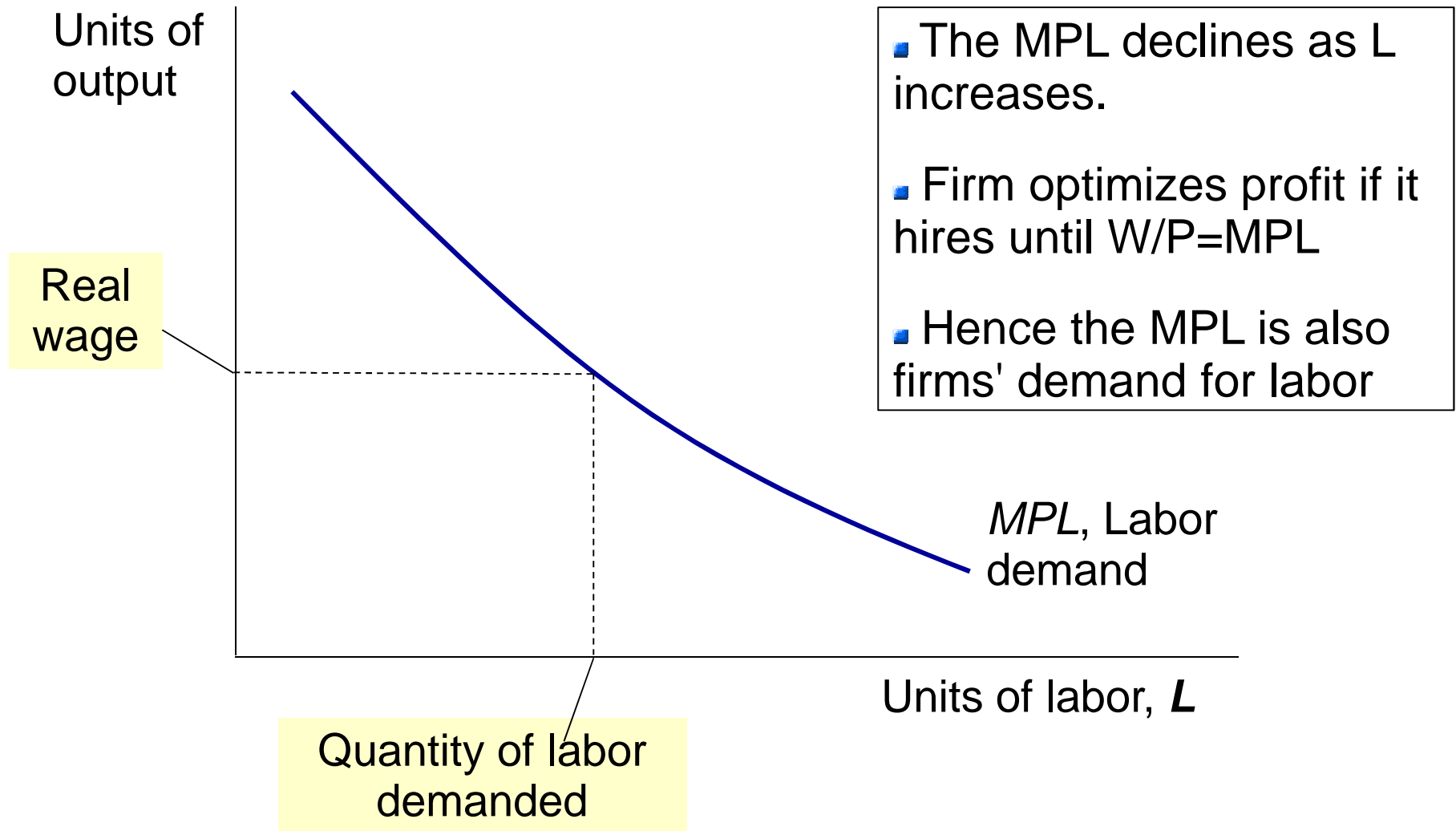
a) If $L = 3$, should firm hire more or less labor? Why?

b) 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

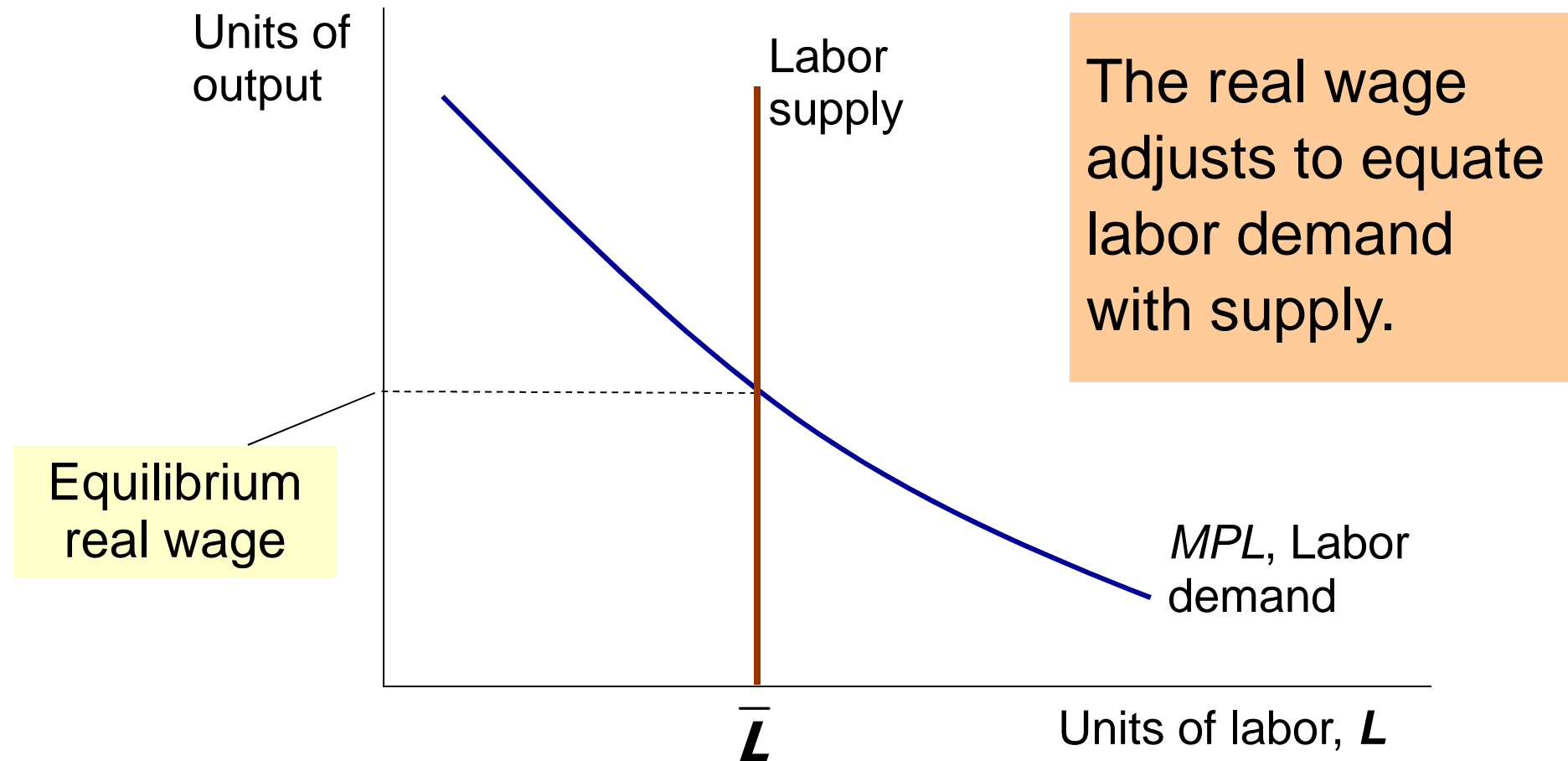
3.2) Distribution of National Income

→ MPL and the Demand for Labor



3.2) Distribution of National Income

→ The Equilibrium Real Wage



3.2) Distribution of National Income

→ Determining the Demand for Capital

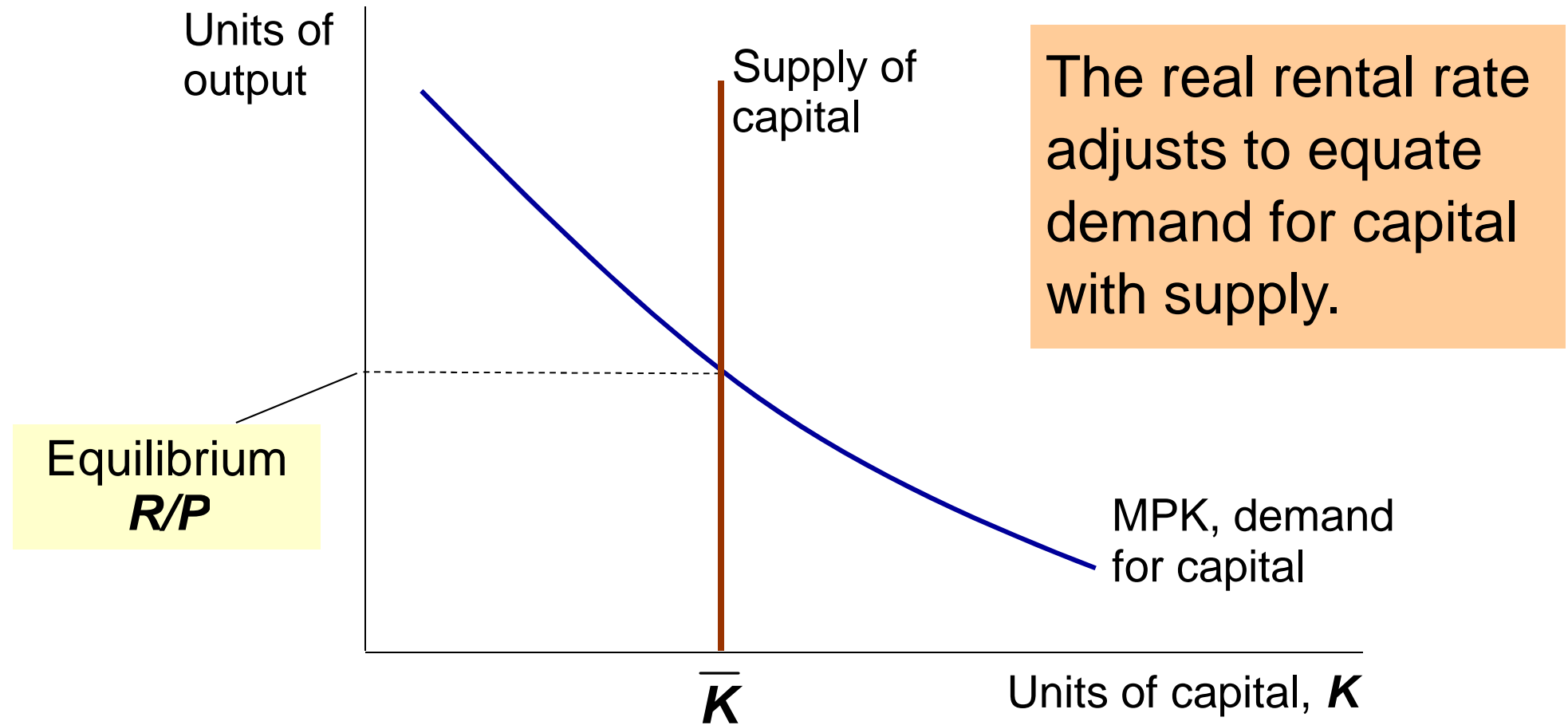
We have just seen that $MPL = W/P$.

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 $MPK = R/P$.

3.2) Distribution of National Income

→ The Equilibrium Real Rental Rate



3.2) Distribution of National Income

→ How Income is Distributed

- Each factor input is paid its marginal product ($W/P=MPL$ and $R/P=MPK$)

- Total labor income = $\frac{W}{P}\bar{L} = MPL \times \bar{L}$

- Total capital income = $\frac{R}{P}\bar{K} = MPK \times \bar{K}$

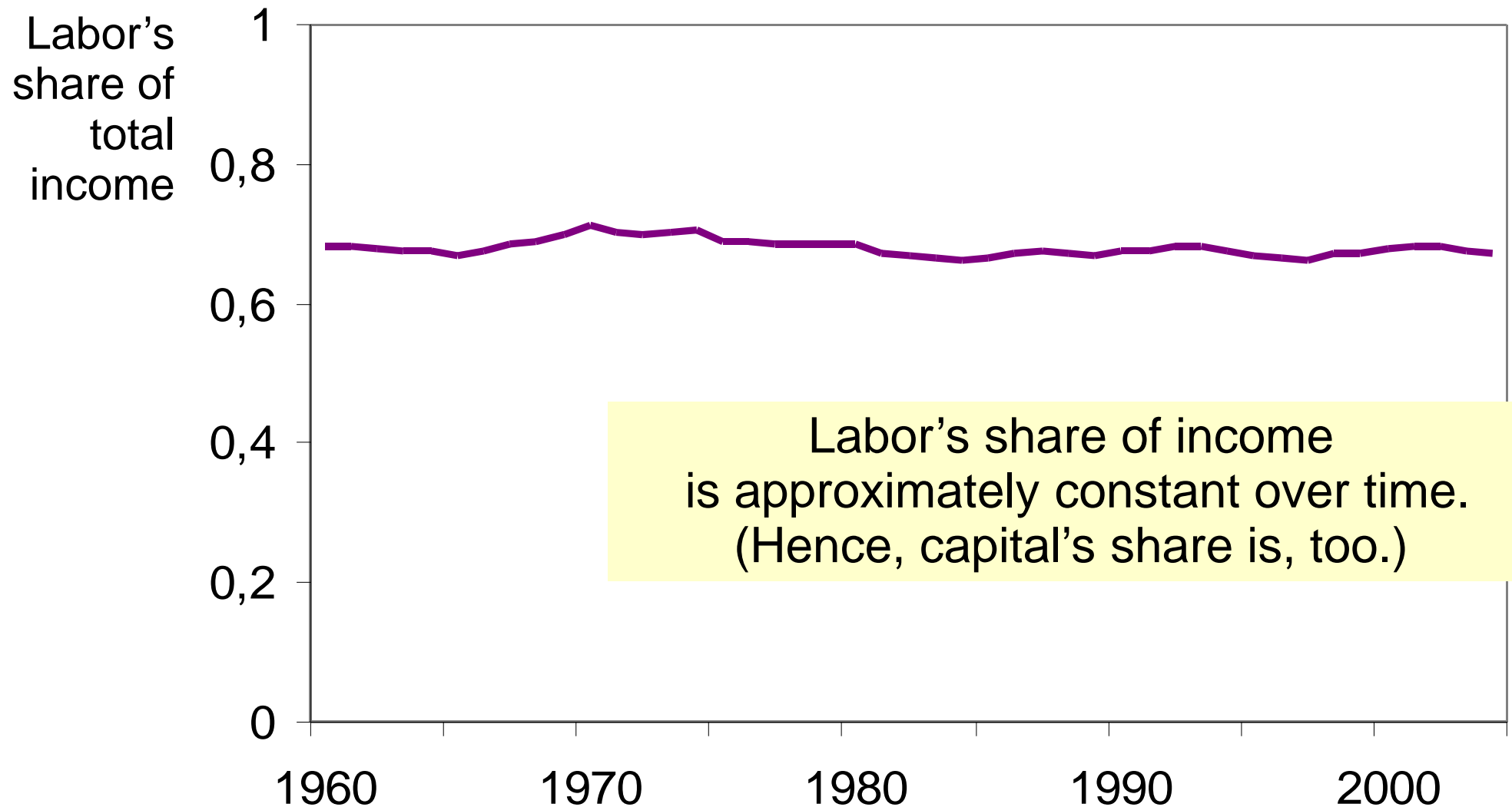
- If production function has constant returns to scale, then

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

National income

3.2) Distribution of National Income

→ Ratio of Labor Income to Total Income in the U.S.



3.2) Distribution of National Income

→Cobb-Douglas Production Function

The Cobb-Douglas production function features the empirically observed constant factor shares:

α = capital's constant share of total income:

- capital income = $MPK \times K = \alpha Y$
- labor income = $MPL \times L = (1 - \alpha) Y$

The Cobb-Douglas production function is:

$$Y = AK^\alpha L^{1-\alpha}$$

where A represents the level of technology.

3.2) Distribution of National Income

→Cobb-Douglas Production Function

- Each factor's marginal product is proportional to its average product
- The MPK is proportional to output per unit of Capital

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

- The MPL is proportional to output per worker:

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

3.2) Distribution of National Income

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

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- what determines the demand for goods and services ←

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3.3) Demand for Goods & Services

→ Components of Aggregate Demand

C = Consumer demand for goods & services

I = Demand for investment goods

G = Government demand for goods & services

(Closed economy: no **NX**)

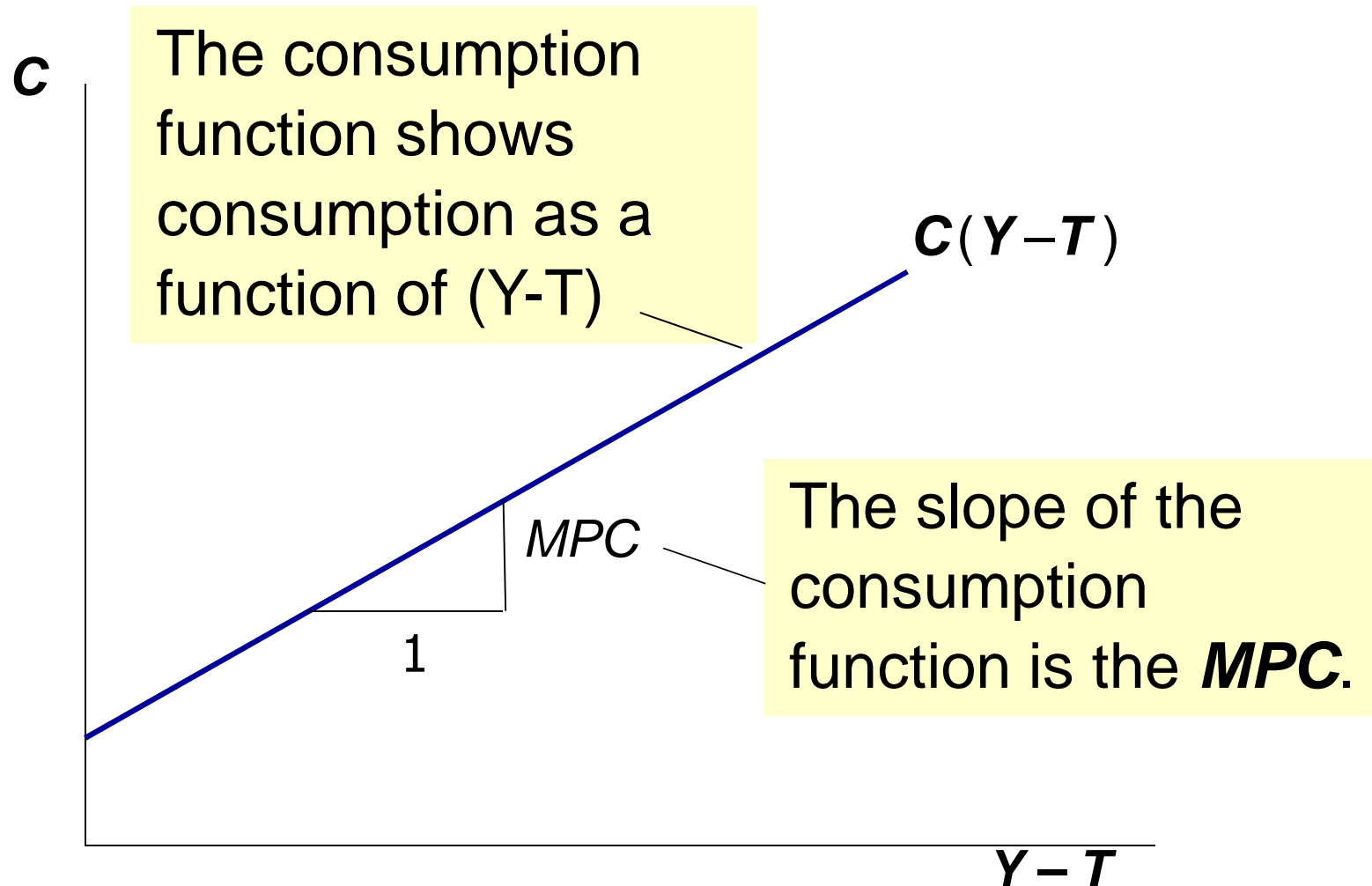
3.3) Demand for G&S

→ Components of Aggregate Demand: **C**

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

3.3) Demand for G&S

→ Components of Aggregate Demand: **C**



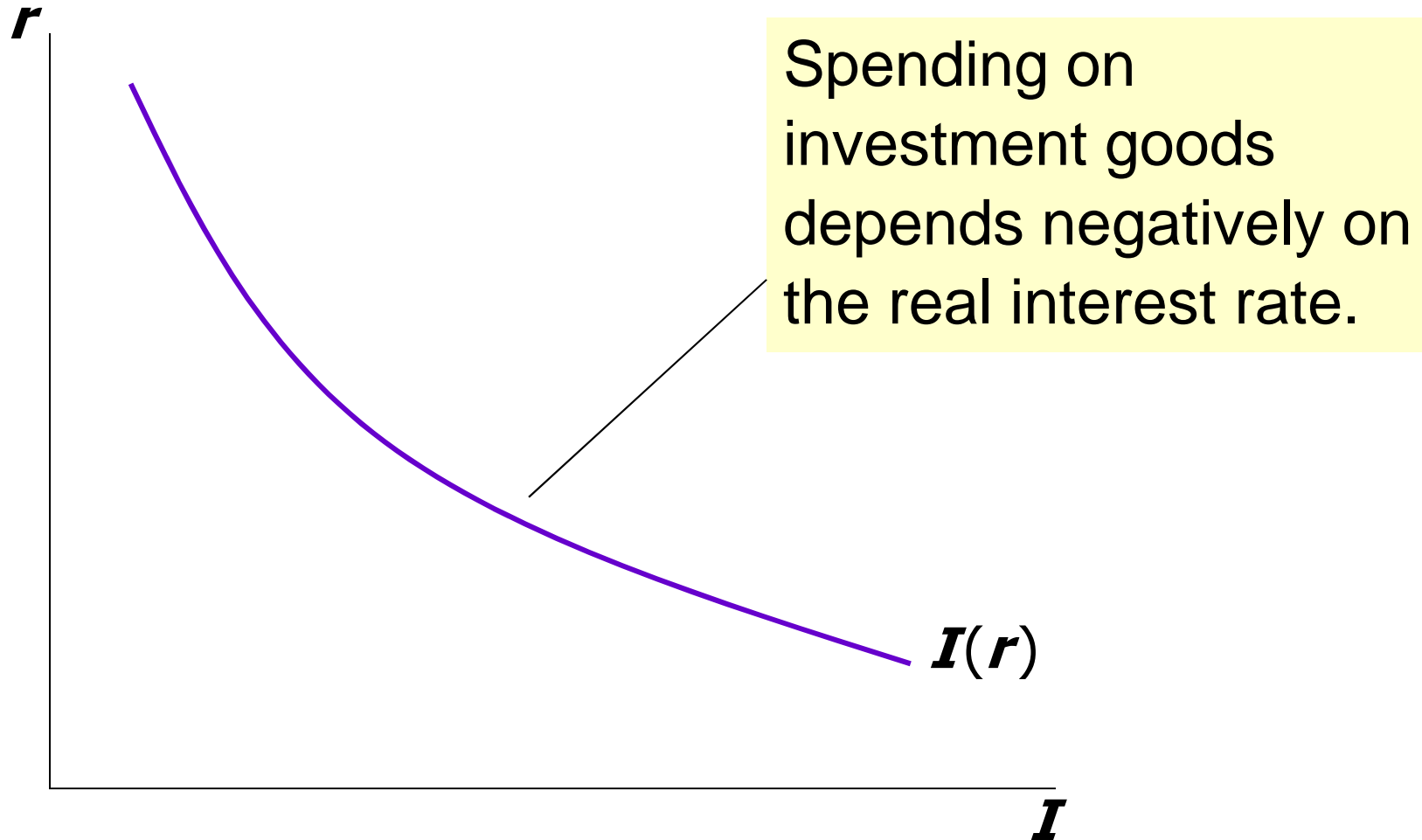
3.3) Demand for G&S

→ Components of Aggregate Demand: **I**

- The investment function is $\mathbf{I} = \mathbf{I}(r)$, where r denotes the **real interest rate**, that is, 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, if $\uparrow r \Rightarrow \downarrow \mathbf{I}$

3.3) Demand for G&S

→ Components of Aggregate Demand: **I**



3.3) Demand for G&S

→ Components of Aggregate Demand: **G**

G = Government spending on goods and services.

G excludes transfer payments (*for example*, social security benefits, unemployment insurance benefits).

Assume government spending and total taxes are exogenous: $\mathbf{G} = \bar{\mathbf{G}}$ and $\mathbf{T} = \bar{\mathbf{T}}$

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3.4) Equilibrium on the Market for G&S

- Aggregate demand: $\mathbf{C(\bar{Y} - \bar{T}) + I(r) + \bar{G}}$
- Aggregate supply: $\mathbf{\bar{Y} = F(\bar{K}, \bar{L})}$
- Equilibrium: $\mathbf{\bar{Y} = C(\bar{Y} - \bar{T}) + I(r) + \bar{G}}$
- The real interest rate (r) adjusts to equate demand with supply.
- How does the adjustment take place? → Loanable Funds Market

3.4) Equilibrium on the Market for G&S

→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

3.4) Equilibrium on the Market for G&S

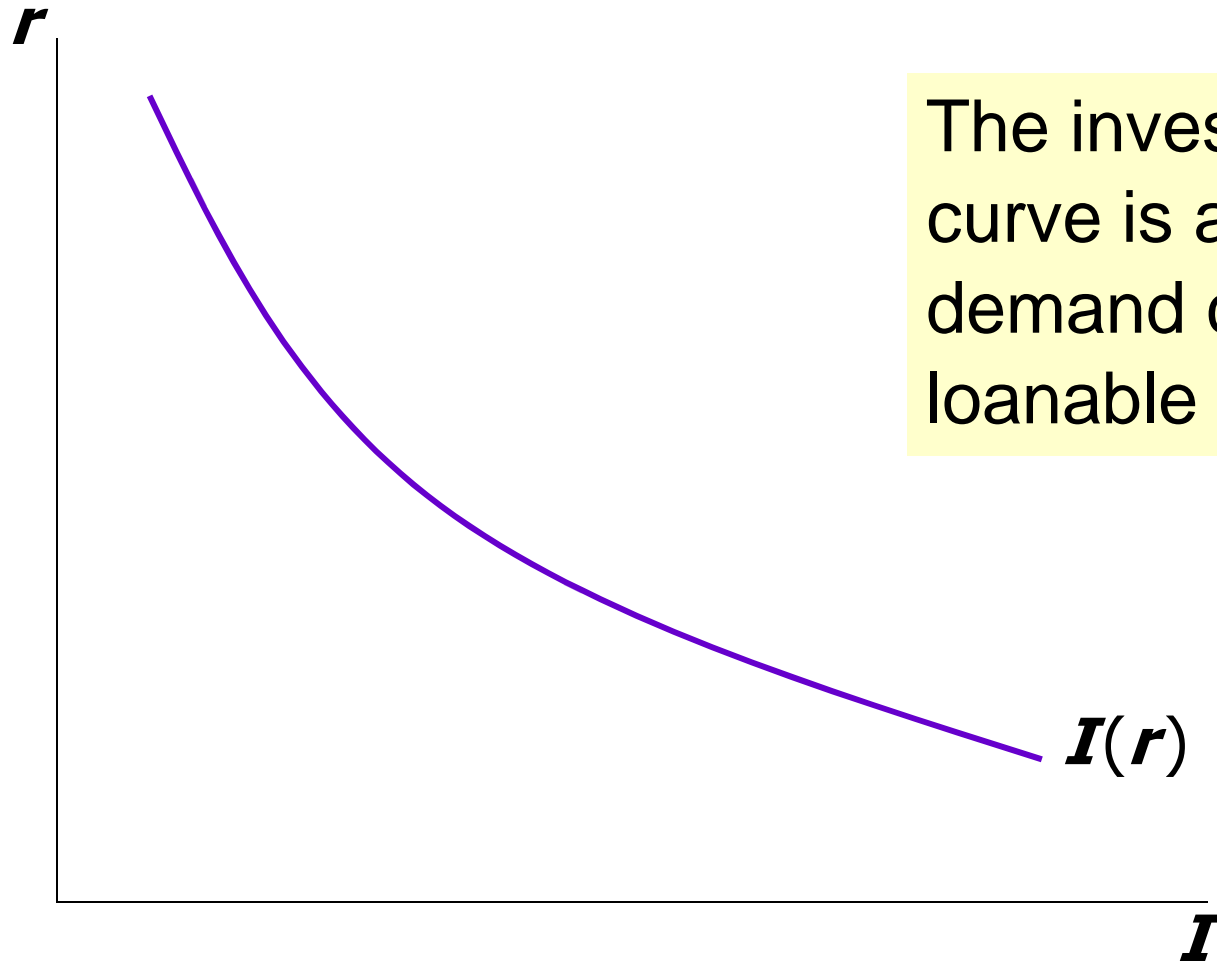
→ Demand for Funds: Investment

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).

3.4) Equilibrium on the Market for G&S

→ Loanable Funds Demand Curve



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

3.4) Equilibrium on the Market for G&S

→ 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.

3.4) Equilibrium on the Market for G&S

→Types of Savings

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

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

$$\text{National saving, } S = \text{private saving} + \text{public saving}$$

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

$$= Y - C - G$$

$$= I \quad (\text{using national accounts identity})$$

3.4) Equilibrium on the Market for G&S

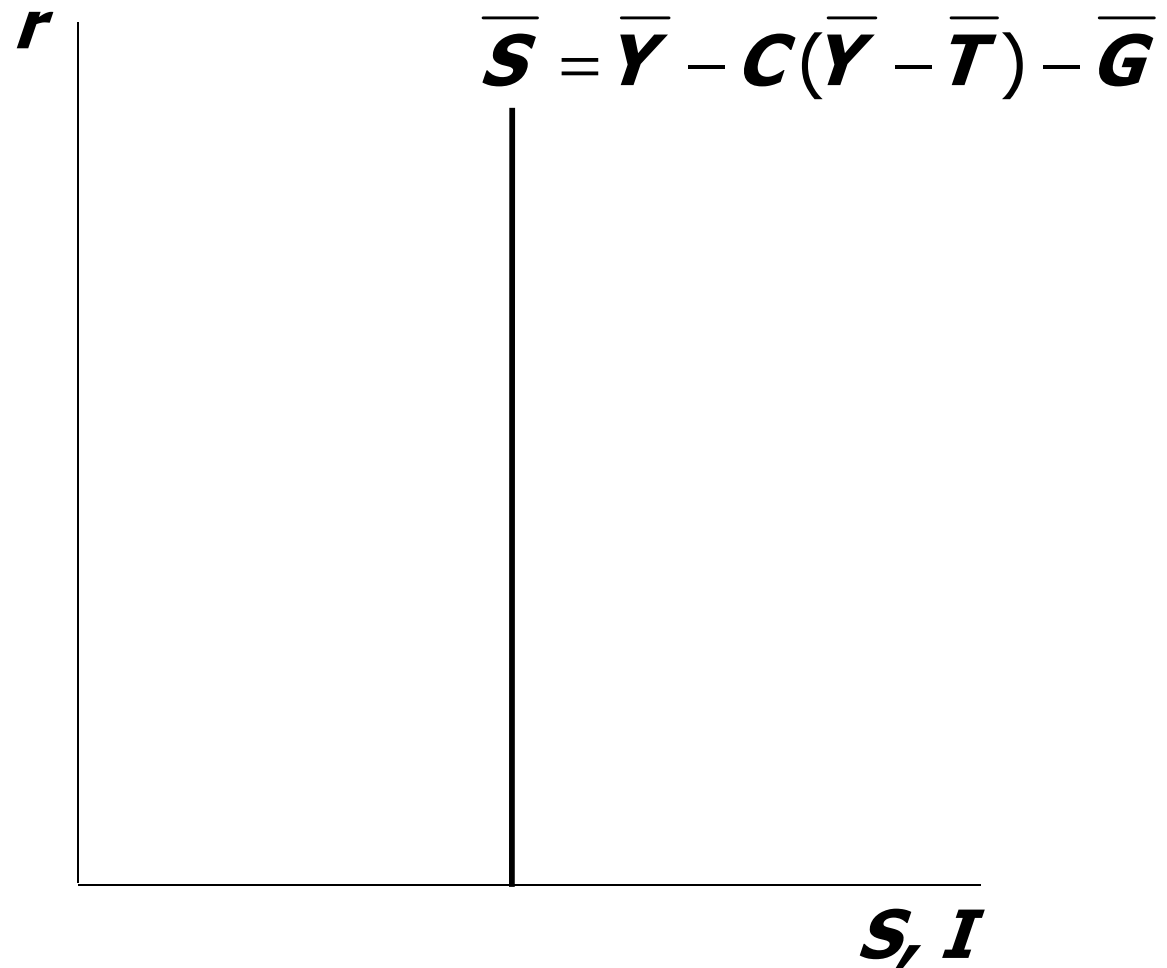
→ Digression: Budget Surpluses and Deficits

- If $T > G$, **budget surplus** = $(T - G)$
= public saving.
- If $T < G$, **budget deficit** = $(G - T)$
and public saving is negative.
- If $T = G$, “balanced budget,” public saving = 0.
- The U.S. government finances its deficit by issuing Treasury bonds – *i.e.*, borrowing.

3.4) Equilibrium on the Market for G&S

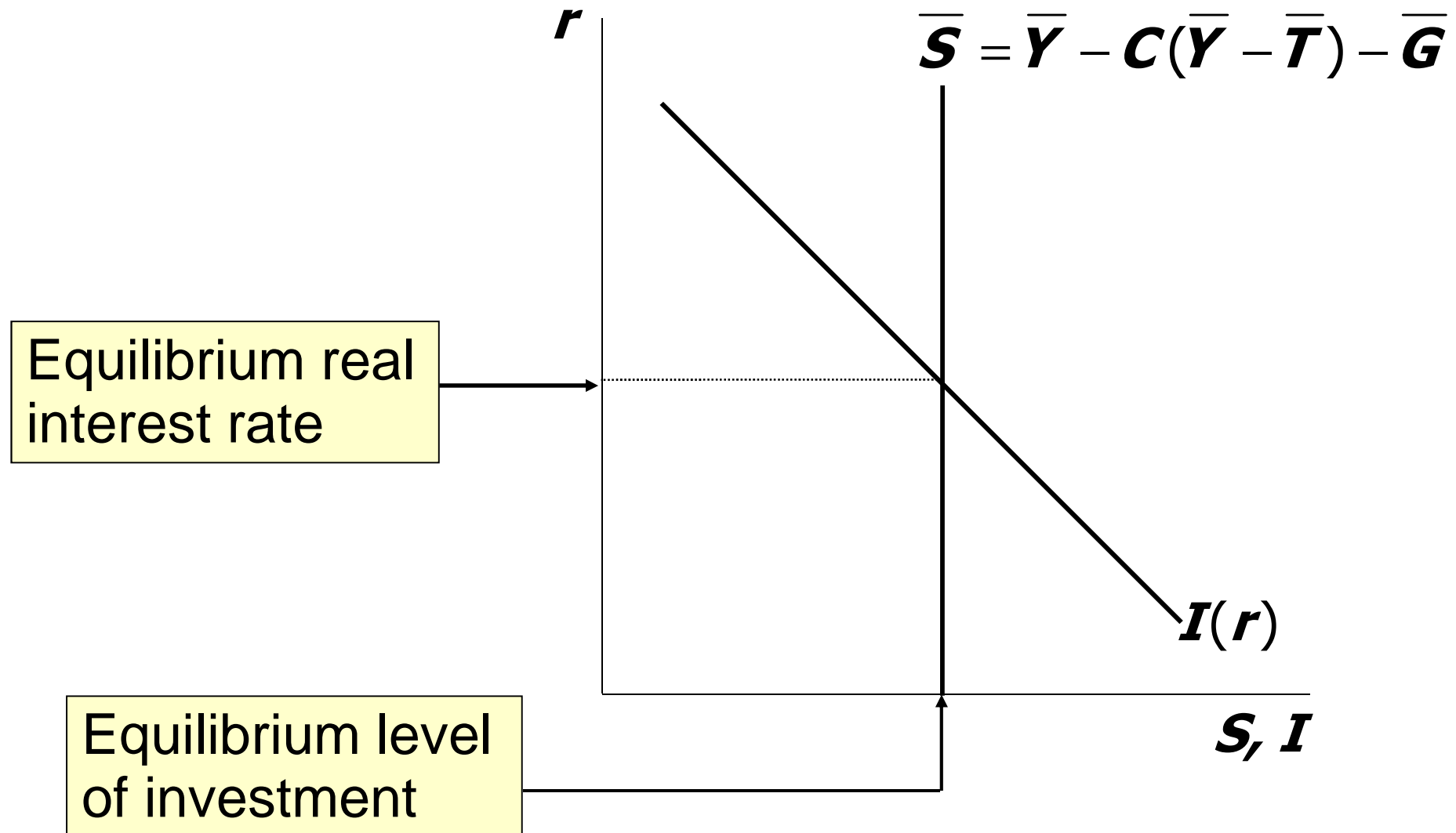
→ Loanable Funds Supply Curve

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



3.4) Equilibrium on the Market for G&S

→ Loanable Funds Market Equilibrium



3.4) Equilibrium on the Market for G&S

→The Special Role of r

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

- If L.F. market 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

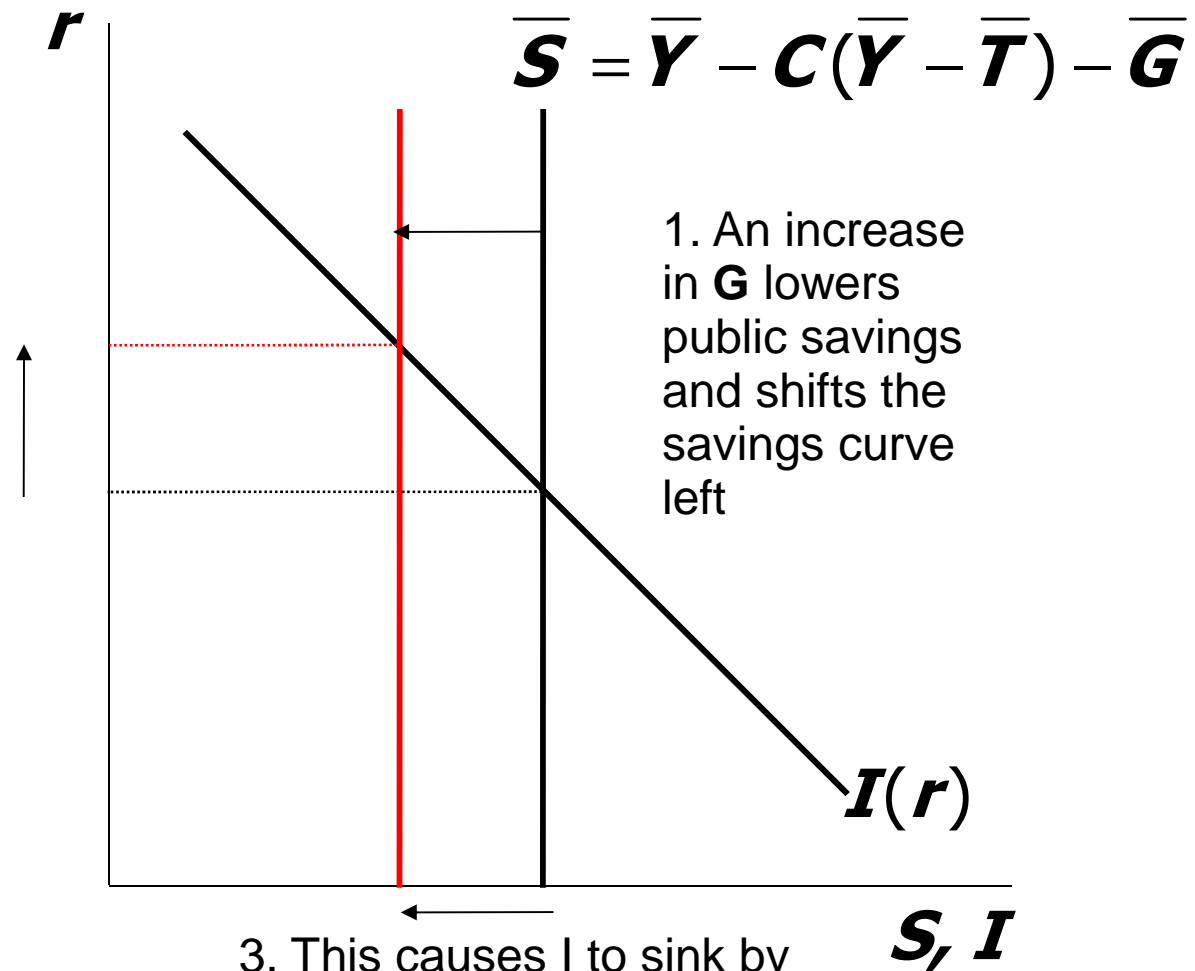


Eq'm in goods
market

3.4) Equilibrium on the Market for G&S

→ Using the Model to Analyze Fiscal Policy Effects

2. Lower supply of loanable funds to the market cause the real interest rate to increase to equilibrate demand and supply on the LF market



1. An increase in G lowers public savings and shifts the savings curve left

3. This causes I to sink by the same amount G increased ('crowding out')

3.4) Equilibrium on the Market for G&S

→该你们了

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?

3.4) Equilibrium on the Market for G&S

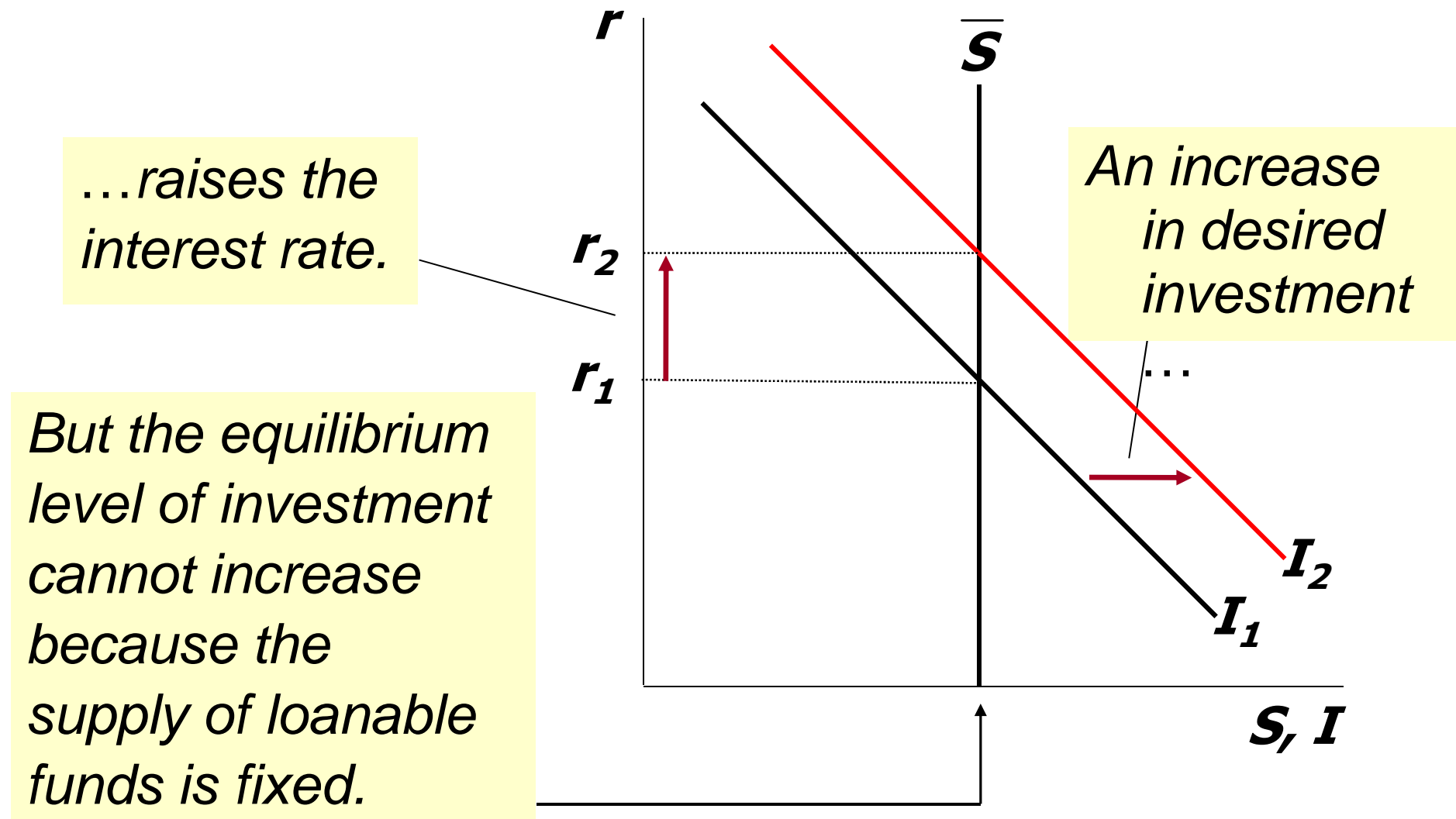
→ Using the Model to Analyze Investment

Things that shift the investment curve:

- Technical innovation can increase investment demand (e.g. invention of railroads required huge infrastructure investments)
- Tax laws can incentivize investment

3.4) Equilibrium on the Market for G&S

→ Using the Model to Analyze Investment



3.4) Equilibrium on the Market for G&S

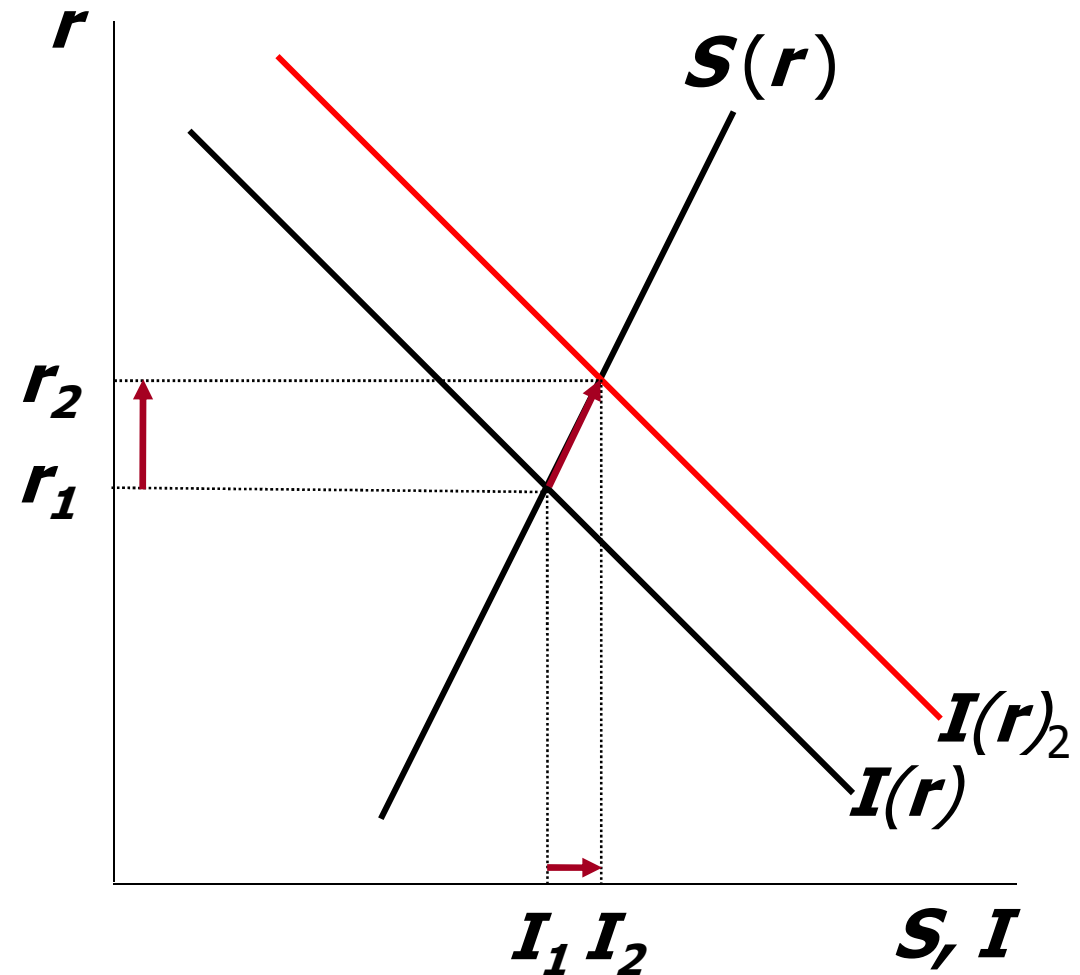
→ Modifying the Model to make S depend on r

- 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?

3.4) Equilibrium on the Market for G&S

→ Modifying the Model to make S depend 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.