


Chapter 3:

The National Income: Where it Comes From and Where it Goes



In this chapter you will learn:

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



Outline of a model

A closed economy, market-clearing model

Supply side

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

Demand side

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

Equilibrium

- goods market
- loanable funds (可贷资金) market



Factors of production (生产要素)


K = capital (资本),
tools, machines, and structures
used in production

L = labor (劳动),
the physical and mental efforts
of workers



The production function (生产函数)

- 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**
(规模收益不变).



Returns to scale (规模收益) *: a review*

Initially $Y_1 = F(K_1, L_1)$

Scale all inputs by the same factor z :

$$K_2 = zK_1 \text{ and } L_2 = zL_1$$

(If $z = 2$, then all inputs are increased by 100%)

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*, $Y_2 < zY_1$



Exercise: *determine returns to scale*

Determine whether each of the following production functions has constant, increasing, or decreasing returns to scale:

a) $\mathbf{F(K,L) = 2K + 15L}$

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


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



Assumptions of the model

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

$$\mathbf{K} = \overline{\mathbf{K}} \quad \text{and} \quad \mathbf{L} = \overline{\mathbf{L}}$$



Determining GDP

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

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



The distribution of national income

- determined by **factor prices** (要素物价), the prices per unit that firms pay for the factors of production.
- The **wage** (工资) is the price of L , the **rental rate** (租赁物价) is the price of K .



Notation


W = nominal wage

R = nominal rental rate

P = price of output

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

R/P = real rental rate

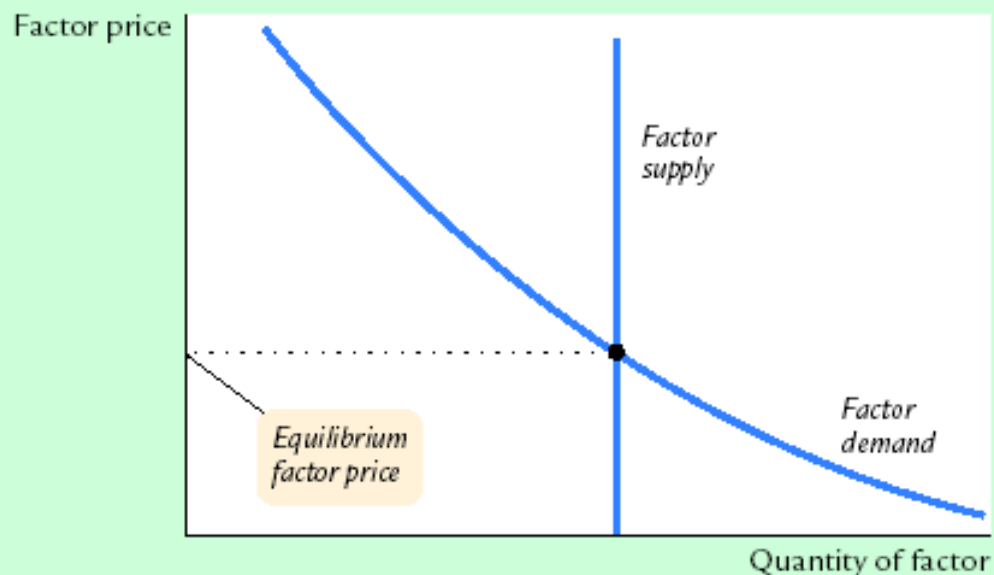


How factor prices are determined

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

How factor prices are determined

figure 3-2




How a Factor of Production Is Compensated The price paid to any factor of production depends on the supply and demand for that factor's services. Because we have assumed that supply is fixed, the supply curve is vertical. The demand curve is downward sloping. The intersection of supply and demand determines the equilibrium factor price.



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 that is paid
benefit = ***marginal product of labor***
(劳动的边际产量)



Marginal product of labor (*MPL*) (劳动的边际产量)

def:

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

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

Or,

$$MPL = F_2(K, L) = \frac{\partial F(K, L)}{\partial L}$$

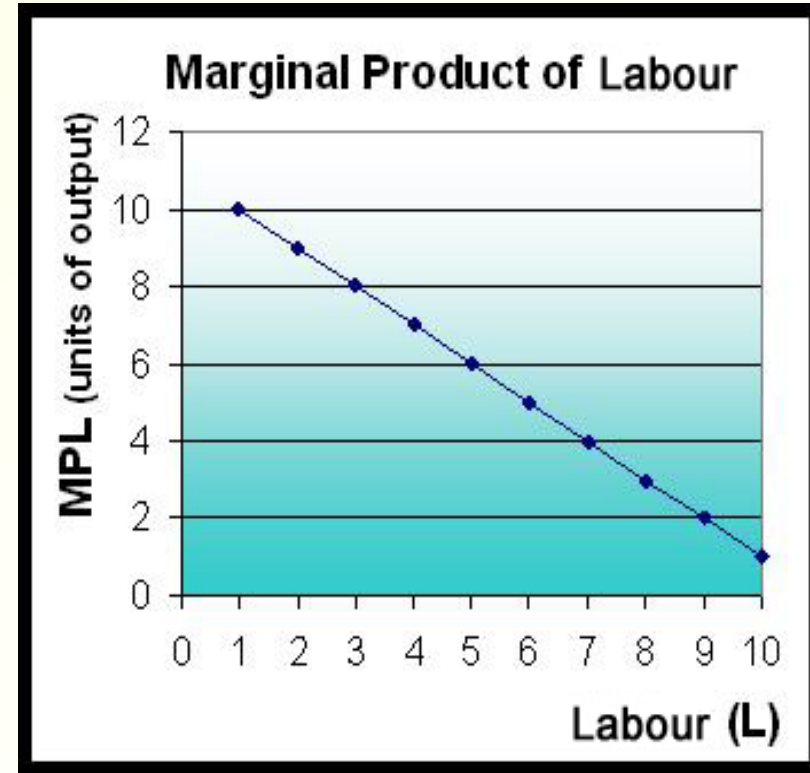
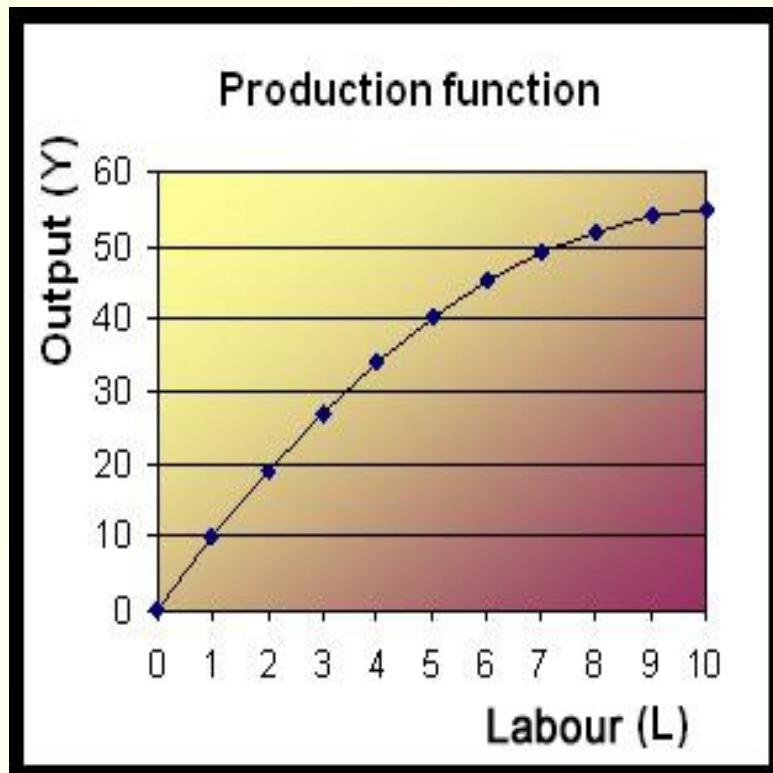


Exercise: *compute & graph MPL*

- Determine ***MPL*** at each value of ***L***
- Graph the production function
- 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:





Diminishing marginal returns (边际产量递减)

- As a factor input is increased, its marginal product falls (other things equal).
- Intuition:
 - ↑ **L** while holding **K** fixed
 - ⇒ fewer machines per worker
 - ⇒ lower productivity



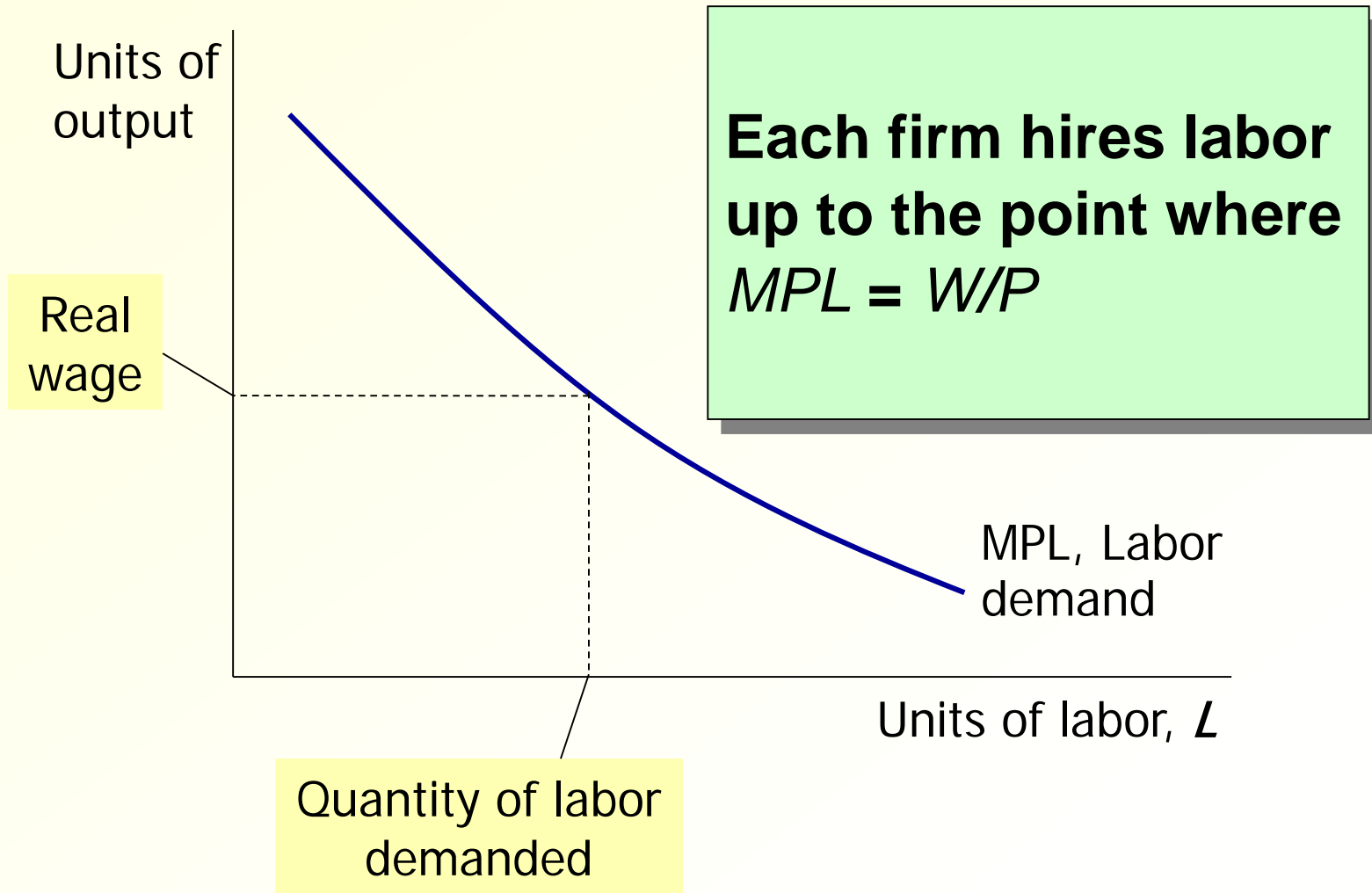
Exercise (part 2)

Suppose $W/P = 6$.

- If $L = 3$, should a firm hire more or less labor? Why?
- What if $L = 7$?

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

MPL and the demand for labor





Determining the rental rate

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

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

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



The Neoclassical (新古典主义) Theory of Distribution

- *states that each factor input is paid its marginal product, i.e.*

$$MPL = W/P, MPK = R/P$$

How income is distributed:

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

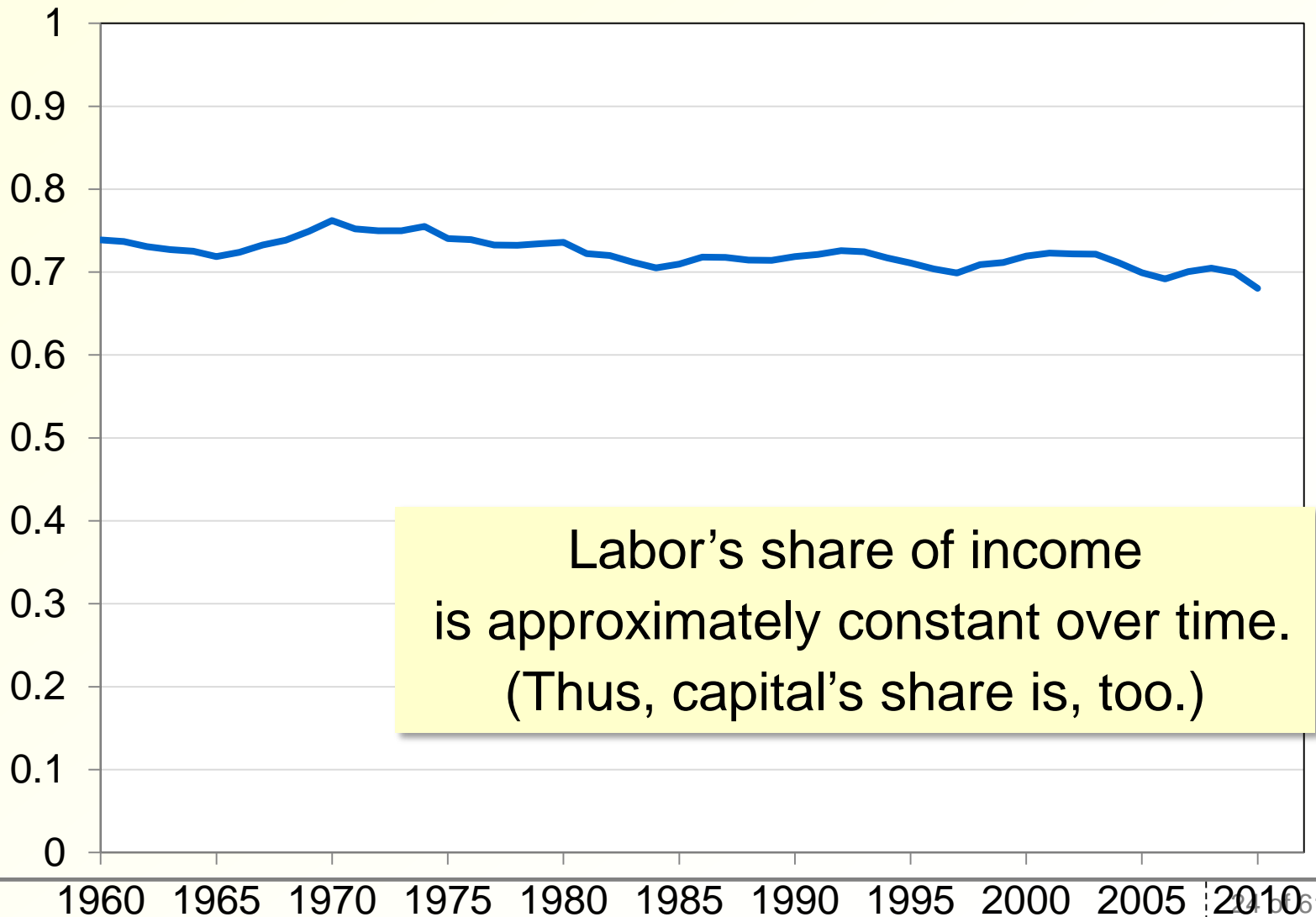
$$\text{total capital income} = \frac{R}{P} \bar{K} = \mathbf{MPK} \times \bar{K}$$

If production function has constant returns to scale, then

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

The ratio of labor income to total income in the U.S., 1960-2010

Labor's
share of
total
income



Labor's share of income
is approximately constant over time.
(Thus, capital's share is, too.)



The Cobb-Douglas production function

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

α = capital's share of total income:

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

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

- The Cobb-Douglas production function is:

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

where \mathbf{A} represents the level of technology



The Cobb-Douglas production function

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

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

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

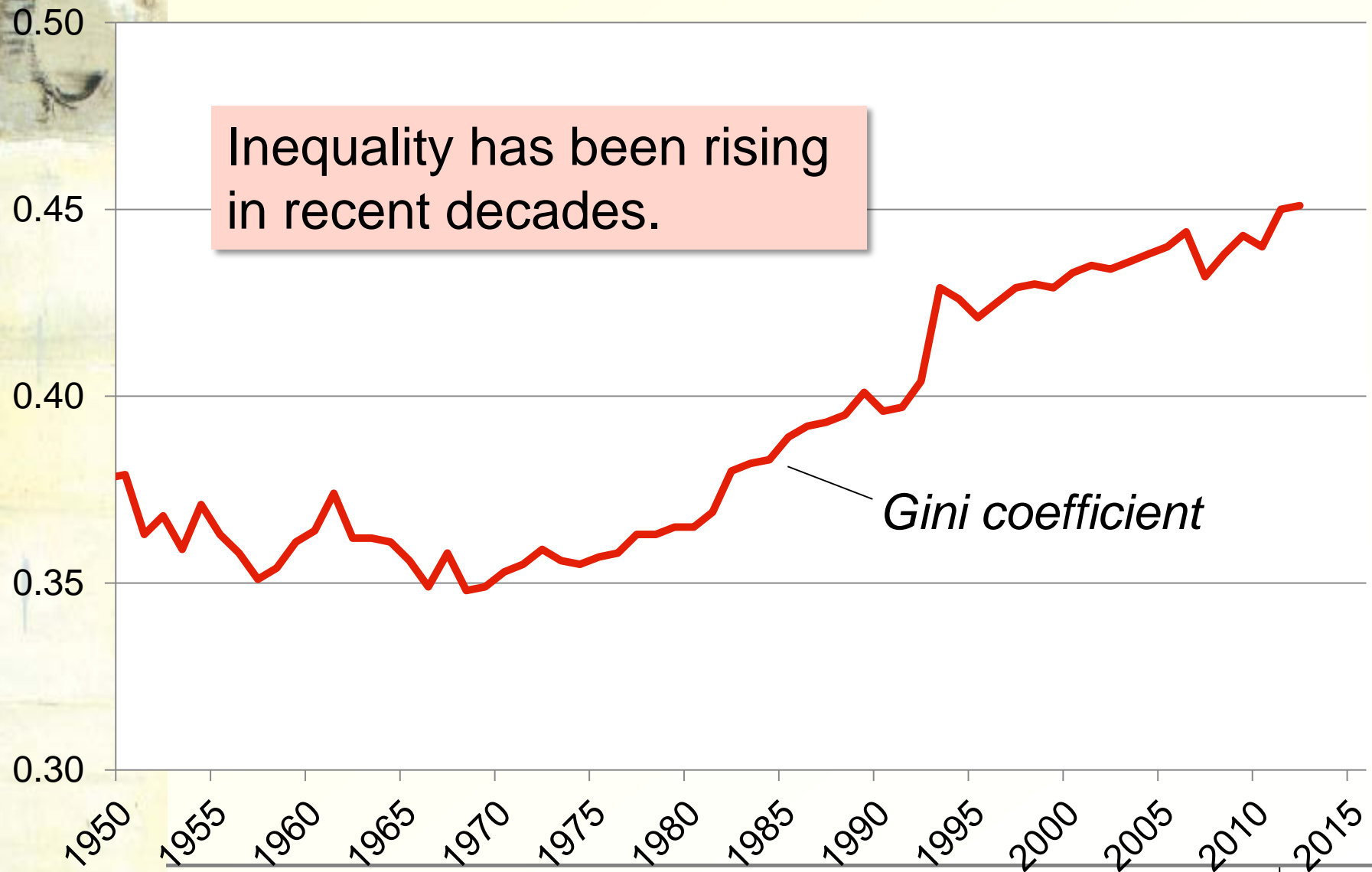


Labor productivity and wages

- Theory: wages depend on labor productivity
- U.S. data:

<i>period</i>	<i>productivity growth</i>	<i>real wage growth</i>
1960-2013	2.1%	1.8%
1960-1973	2.9%	2.7%
1973-1995	1.5%	1.2%
1995-2013	2.3%	2.0%


The growing gap between rich & poor





Explanations for rising inequality

1. Rise in capital's share of income, since capital income is more concentrated than labor income
2. From *The Race Between Education and Technology* by Goldin & Katz
 - Technological progress has increased the demand for skilled relative to unskilled workers.
 - Due to a slowdown in expansion of education, the supply of skilled workers has not kept up.



Demand for goods & services

Components of aggregate demand:

C = consumer demand for g & s

I = demand for investment goods

G = government demand for g & s

(closed economy: no **NX**)



Consumption, C

- def: **disposable income** (可支配收入) is total income minus total taxes:

$$Y - T$$

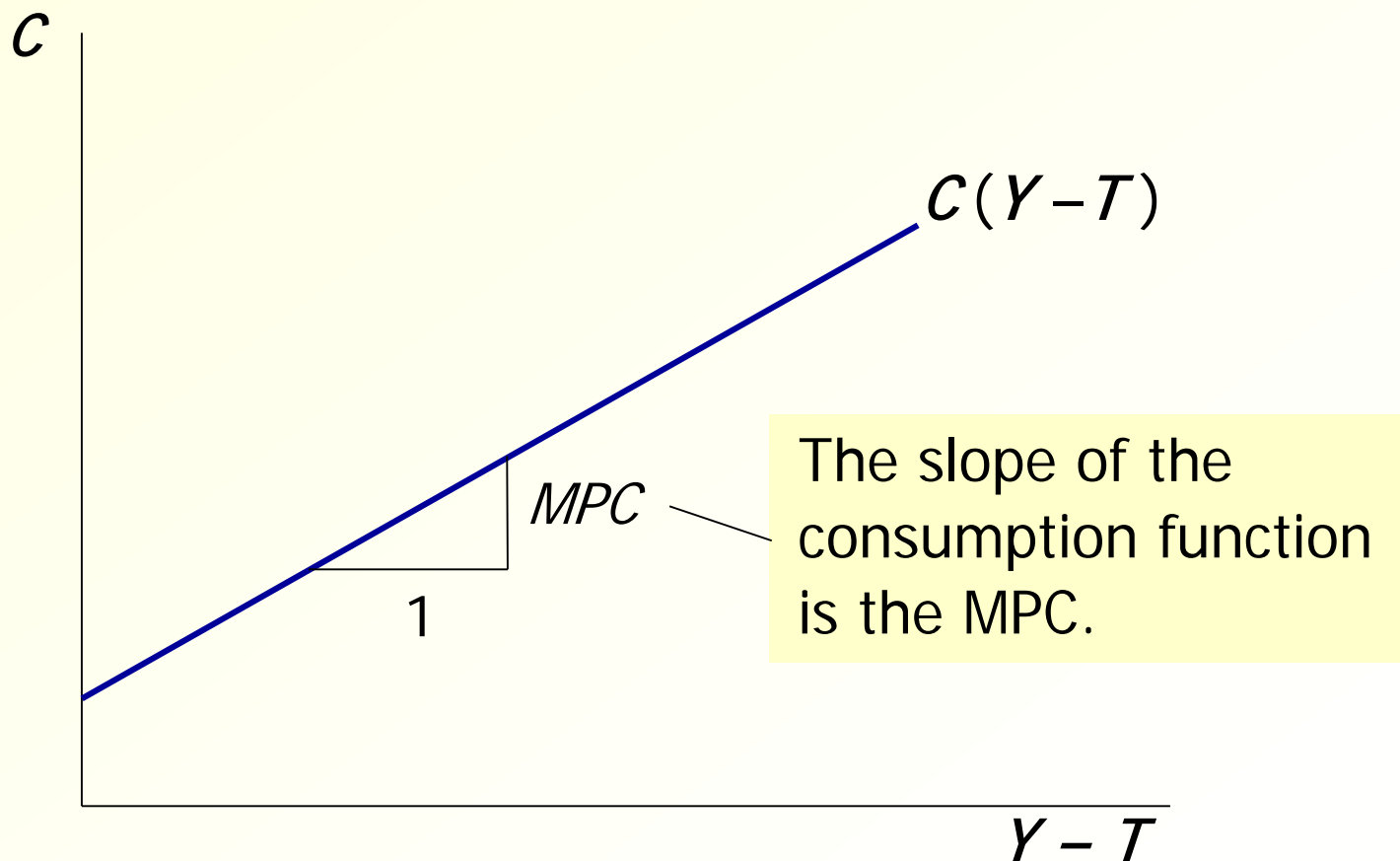
- Consumption function (消费函数)

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

Shows that $\uparrow(Y - T) \Rightarrow \uparrow C$

- def: The **marginal propensity to consume (MPC: 边际消费倾向)** is the increase in C caused by a one-unit increase in disposable income.
- marginal propensity to save $MPS = 1 - MPC$

The consumption function



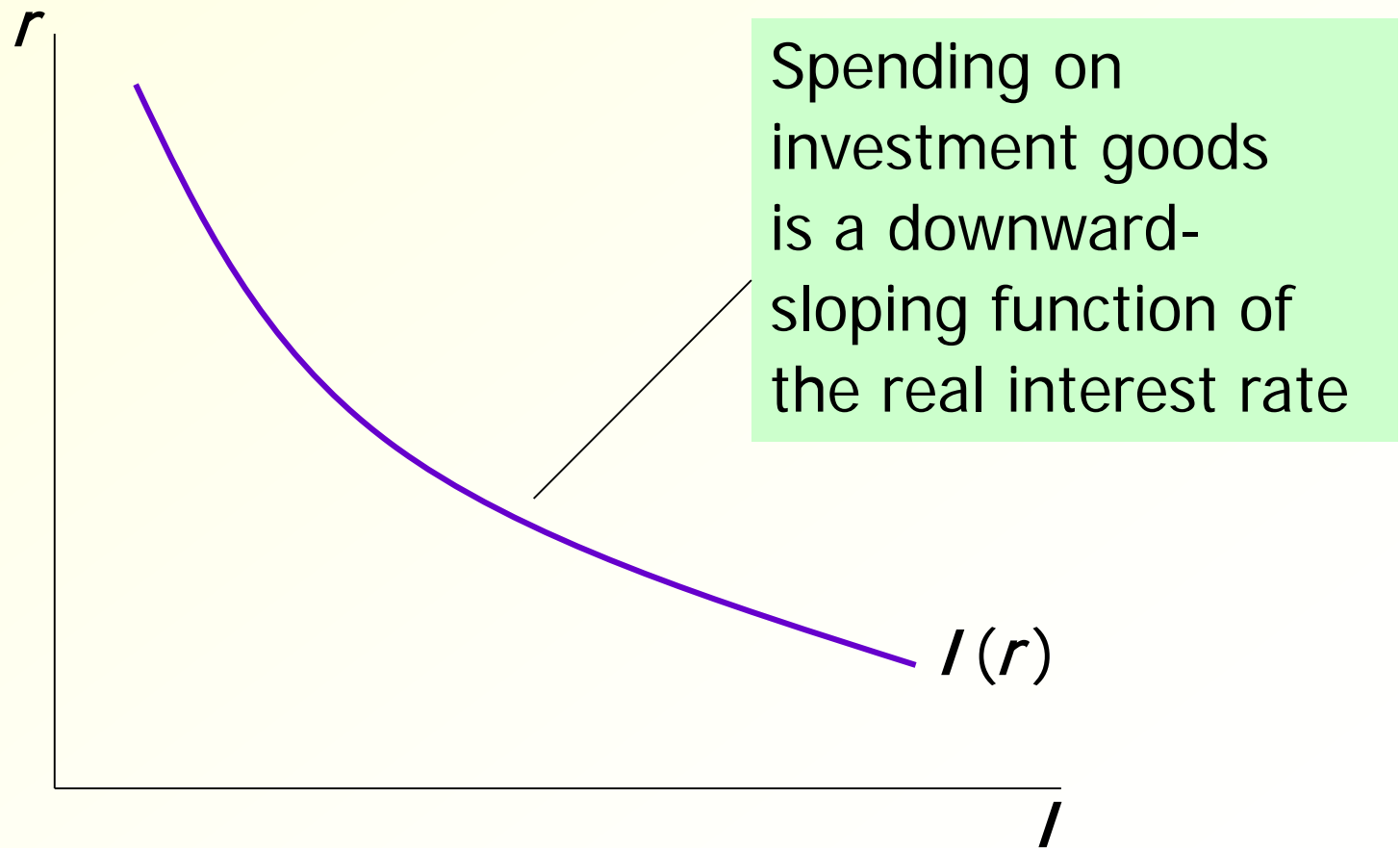


Investment, I

- The investment function is $I = I(r)$, where r denotes the **real interest rate (实际利率)**, 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, $\uparrow r \Rightarrow \downarrow I$

The investment function






Government spending, G

- G includes government spending on goods and services.
- G excludes *transfer payments* (转移支付).
 - welfare for the poor
 - social security for the elderly
- Assume government spending and total taxes are exogenous:

$$\mathbf{G} = \overline{\mathbf{G}} \quad \text{and} \quad \mathbf{T} = \overline{\mathbf{T}}$$



The market for goods & services

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



The loanable funds (可贷资金) 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

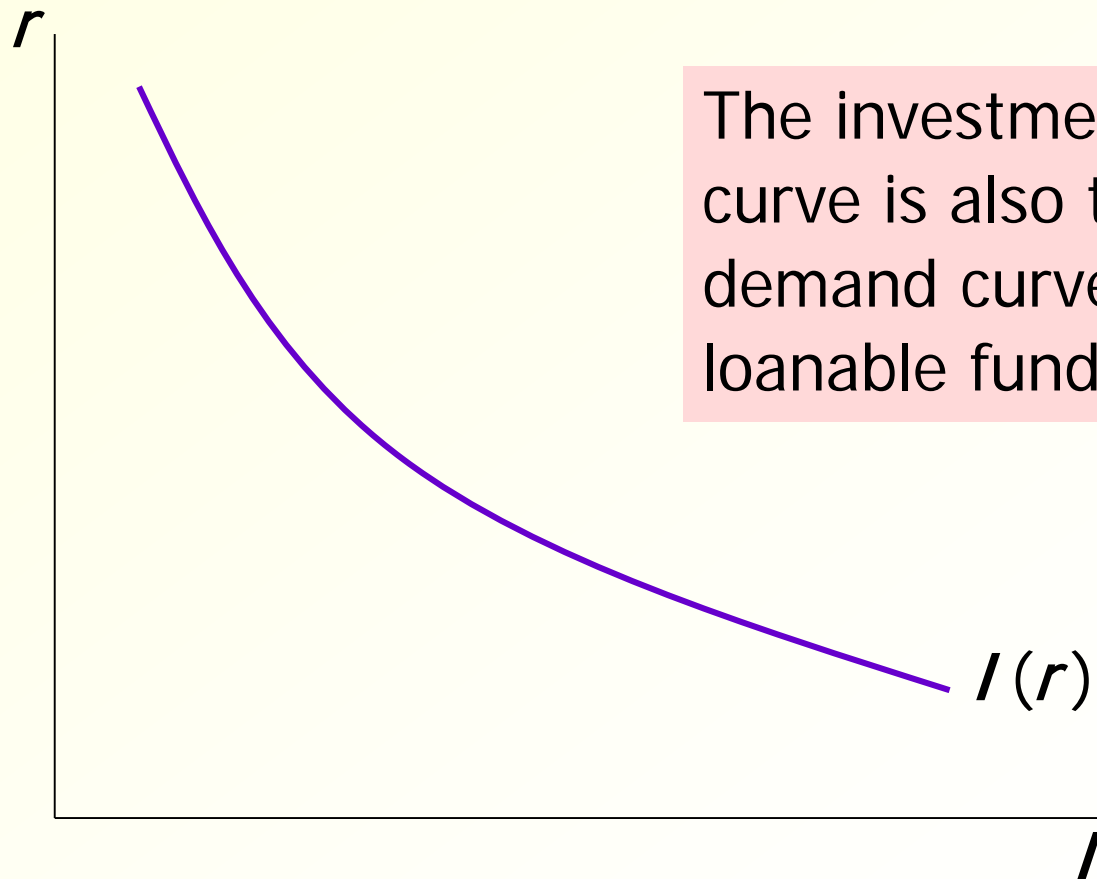


Demand for funds: Investment


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 (the 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 of the tax revenue it receives.



Types of saving

- **private saving (私人储蓄)** $= (Y - T) - C$
- **public saving (公共储蓄)** $= T - G$
- **national saving (国民储蓄), S**
= private saving + public saving
 $= (Y - T) - C + T - G$
 $= Y - C - G$



Notation: Δ = change in a variable

- For any variable X , ΔX = “the change in X ”
 Δ is the Greek (uppercase) letter *Delta*

Examples:

- If $\Delta L = 1$ and $\Delta K = 0$, then $\Delta Y = \mathbf{MPL}$.

More generally, if $\Delta K = 0$, then $\mathbf{MPL} = \frac{\Delta Y}{\Delta L}$.

- $\Delta(Y - T) = \Delta Y - \Delta T$, so

$$\begin{aligned}\Delta C &= \mathbf{MPC} \times (\Delta Y - \Delta T) \\ &= \mathbf{MPC} \Delta Y - \mathbf{MPC} \Delta T\end{aligned}$$



EXERCISE:

Calculate the change in saving

Suppose $MPC = 0.8$ and $MPL = 20$.

For each of the following, compute ΔS :

- $\Delta G = 100$
- $\Delta T = 100$
- $\Delta Y = 100$
- $\Delta L = 10$



Answers

$$\begin{aligned}\Delta S &= \Delta Y - \Delta C - \Delta G = \Delta Y - 0.8(\Delta Y - \Delta T) - \Delta G \\ &= 0.2\Delta Y + 0.8\Delta T - \Delta G\end{aligned}$$

a. $\Delta S = -100$

b. $\Delta S = 0.8 \times 100 = 80$

c. $\Delta S = 0.2 \times 100 = 20$

d. $\Delta Y = \text{MPL} \times \Delta L = 20 \times 10 = 200,$

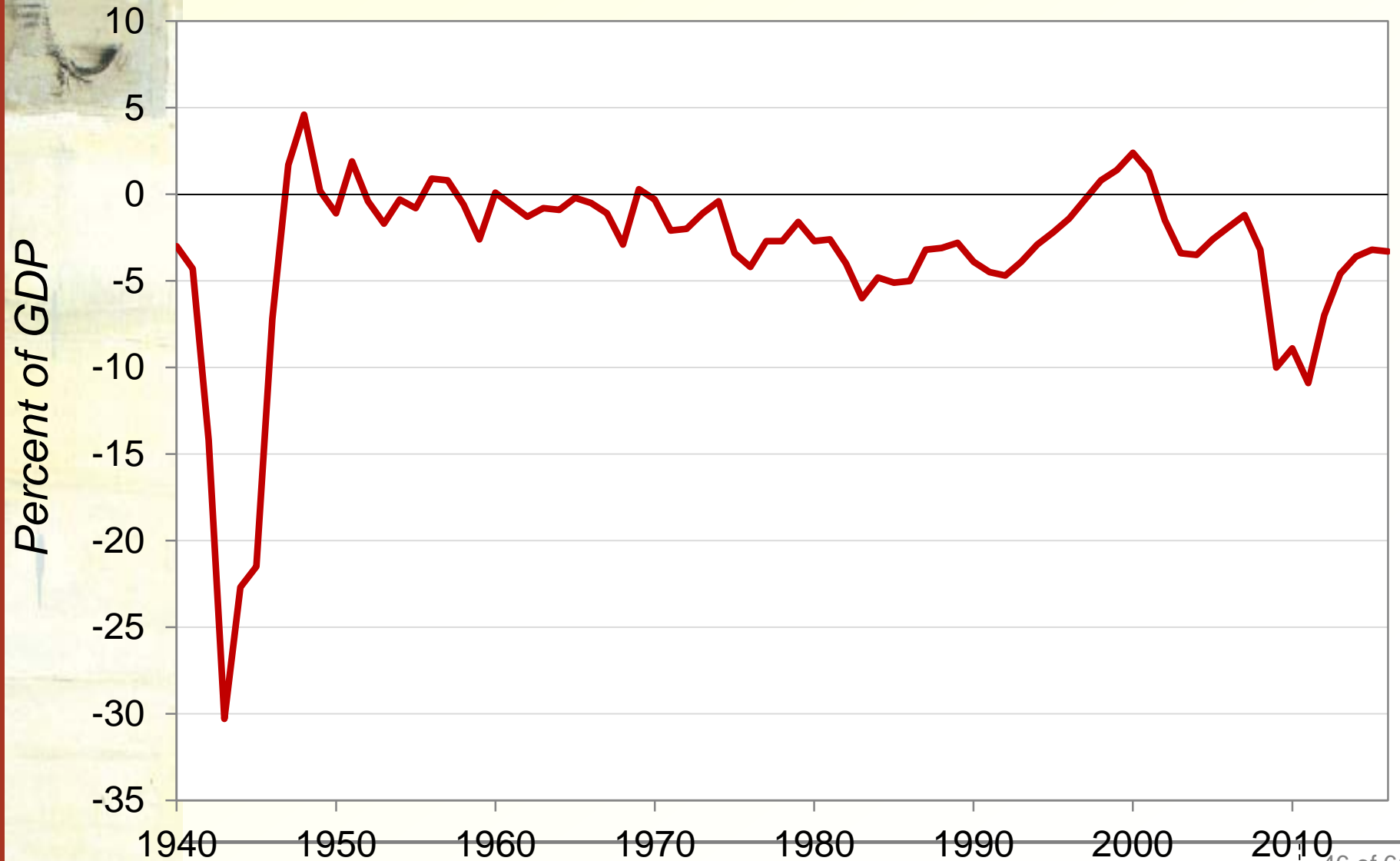
$$\Delta S = 0.2 \times \Delta Y = 0.2 \times 200 = 40.$$



Budget surpluses and deficits

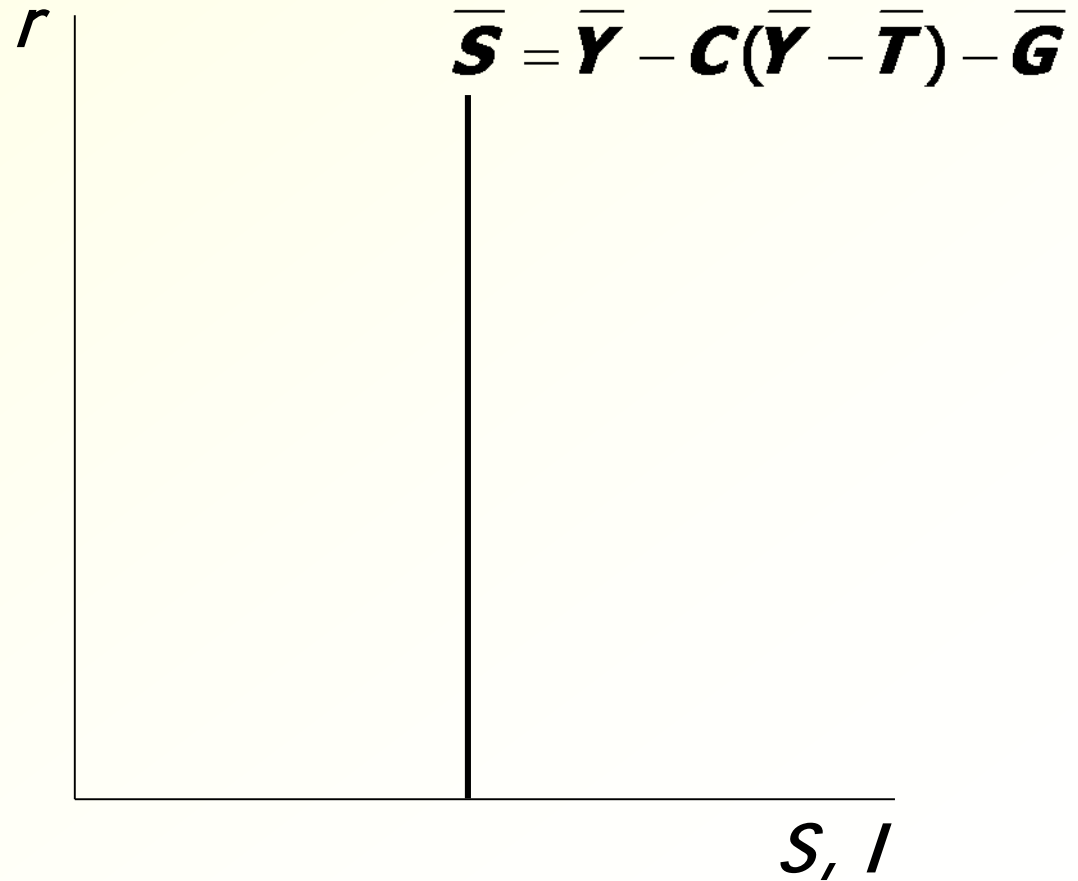
- When $T > G$,
budget surplus (预算盈余) = $(T - G)$ = public saving
- When $T < G$,
budget deficit (预算赤字) = $(G - T)$
and public saving is negative.
- When $T = G$,
budget is balanced and public saving = 0.

U.S. federal government surplus/deficit, 1940-2016

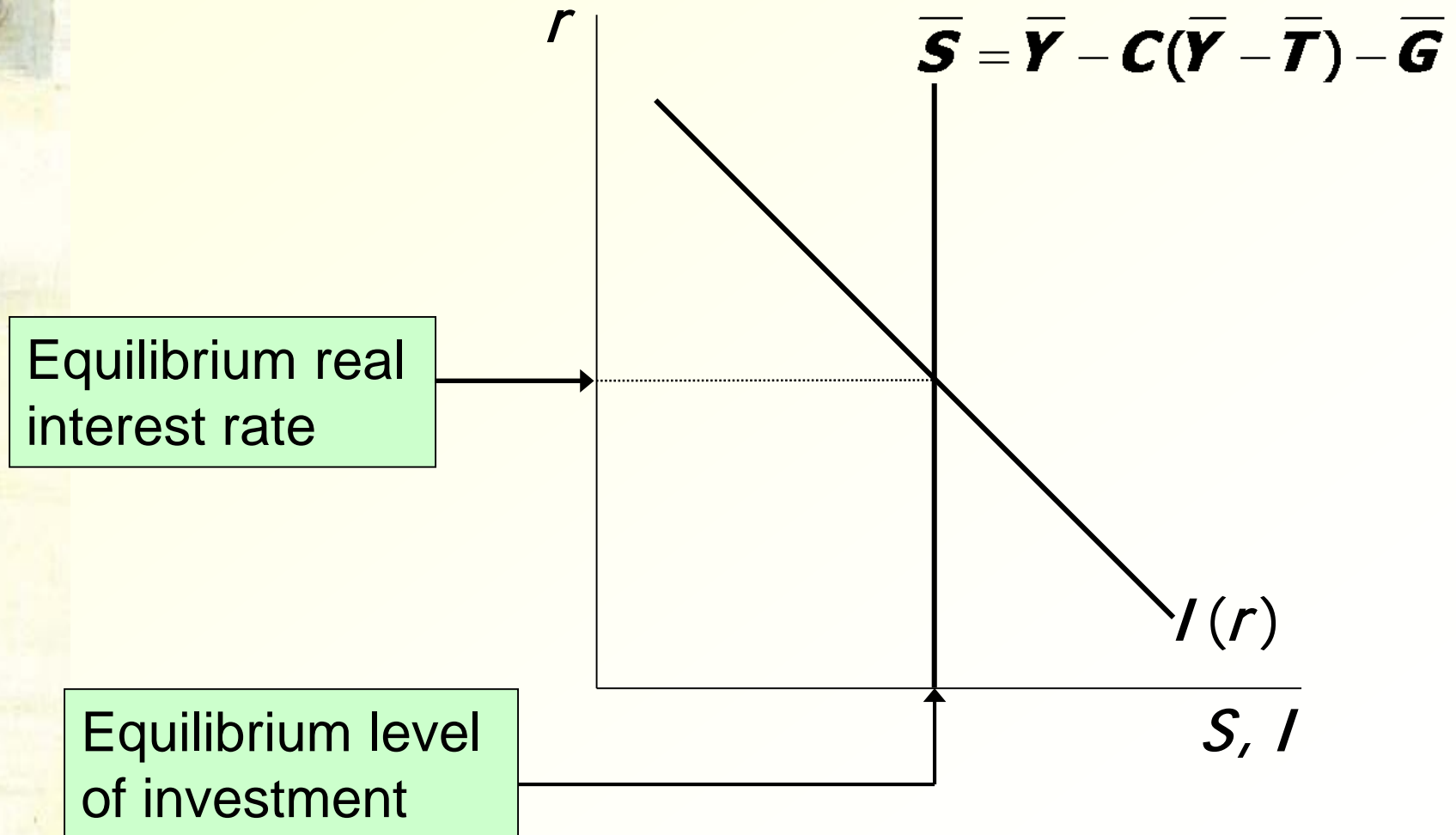


Loanable funds supply curve

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



Loanable funds market equilibrium



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



Mastering the loanable funds model

Things that shift the saving curve

- a. public saving
 - i. fiscal policy: changes in **G** or **T**
- b. private saving
 - i. preferences
 - ii. tax laws that affect saving

CASE STUDY

“Reaganomics” in the U.S.

- Ronald Reagan’s policies during early 1980s:
 - increases in defense spending: $\Delta \mathbf{G} > 0$
 - big tax cuts: $\Delta \mathbf{T} < 0$
- According to our model, both policies reduce national saving:

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

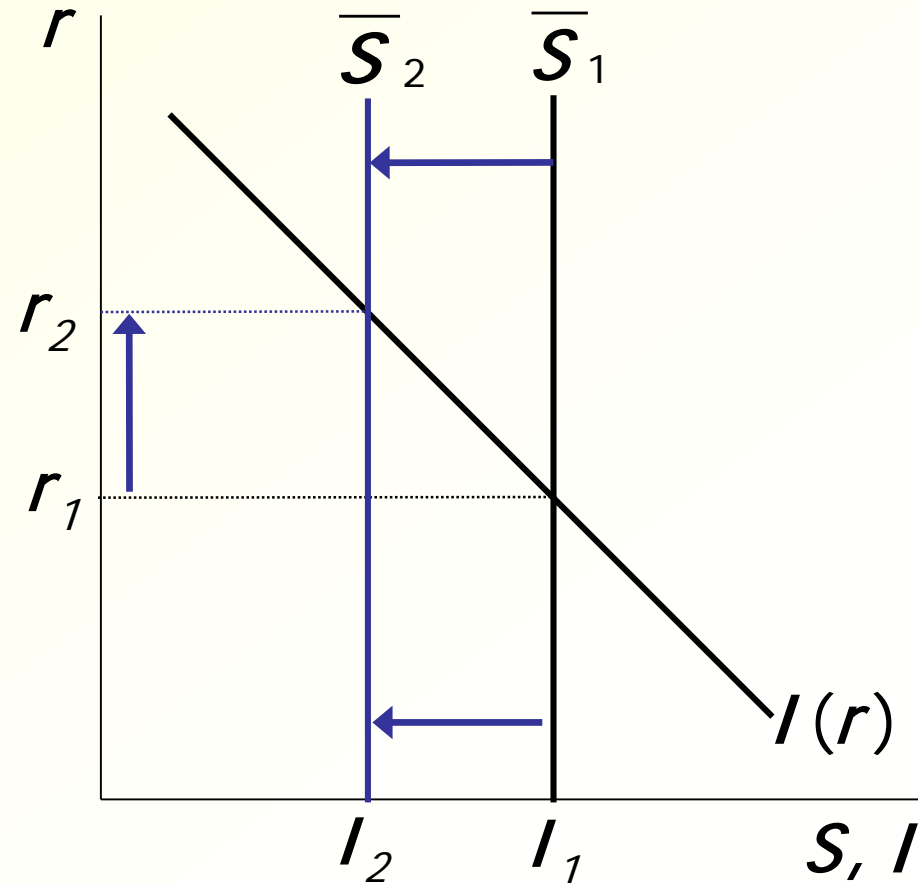
$$\uparrow \bar{\mathbf{G}} \Rightarrow \downarrow \bar{\mathbf{S}}$$

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

1. The Reagan deficits, cont.

1. The increase in the deficit reduces national saving...
2. ...which causes the real interest rate to rise...

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






Are the data consistent with these results?

variable	1970s	1980s
$T - G$	-2.2	-3.9
S	19.6	17.4
r	1.1	6.3
I	19.9	19.4

$T - G$, S , and I are expressed as a percent of GDP

*Government purchases **crowd out** (挤出) investment.*



Mastering the loanable funds model

Things that shift the investment curve:

a. certain technological innovations

- to take advantage of the innovation, firms must buy new investment goods

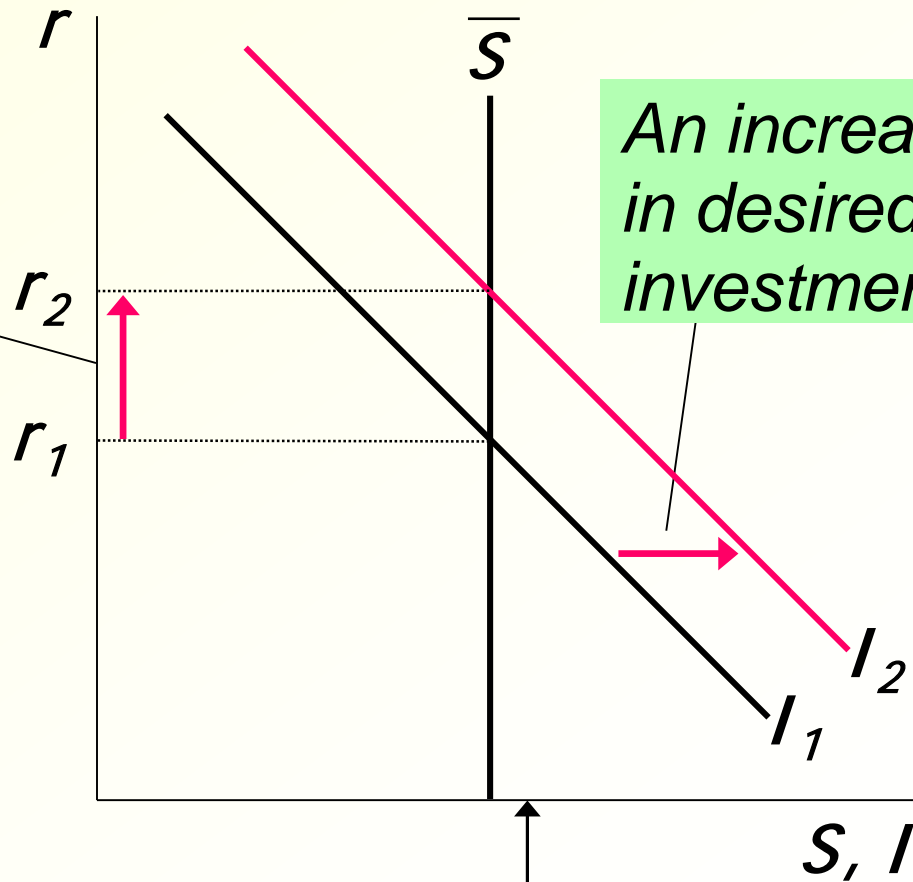
b. tax laws that affect investment

- investment tax credit


An increase in investment demand

...raises the interest rate.

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




An increase in desired investment...




Chapter summary

- Total output is determined by
 - how much capital and labor the economy has
 - 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

- The economy's output is used for
 - consumption
(which depends on disposable income)
 - investment
(depends on the real interest rate)
 - government spending (exogenous)
- The real interest rate adjusts to equate the demand for and supply of
 - goods and services
 - loanable funds

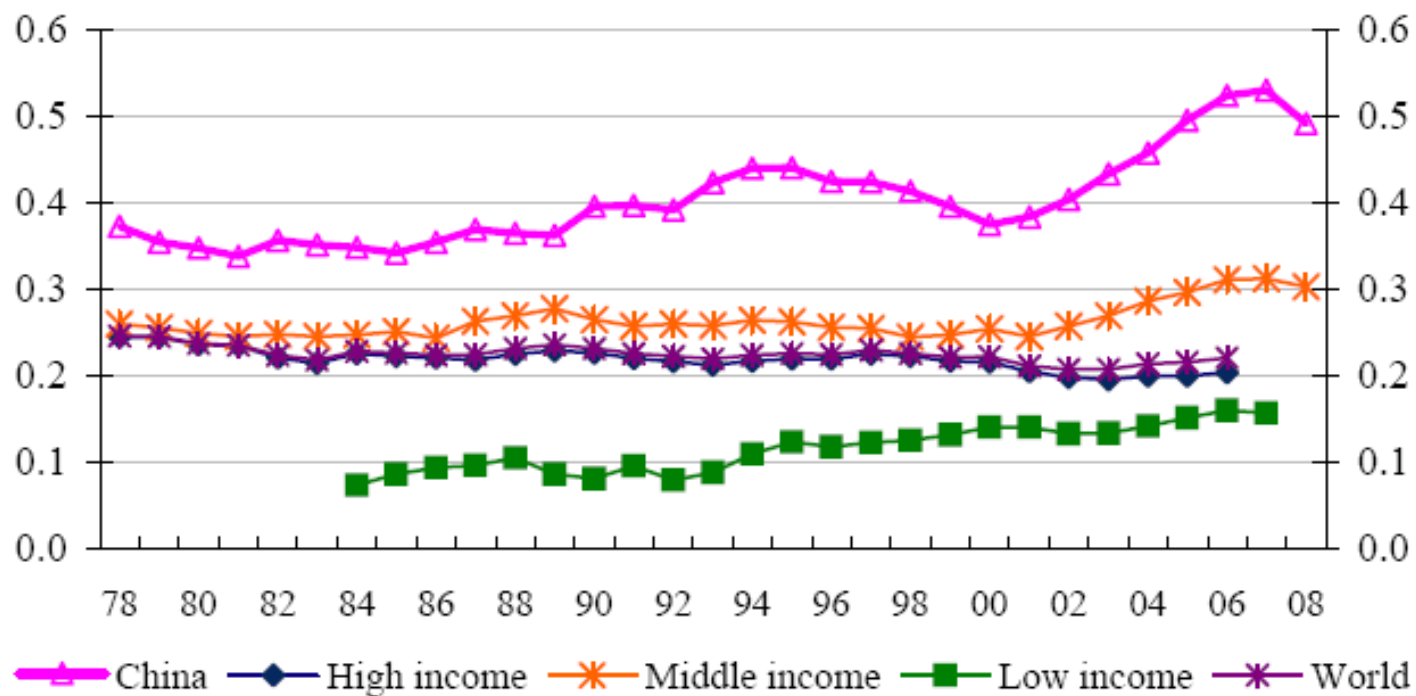


Chapter summary

- 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.

China's Saving Rate

A. China vs. Major Country Groups by Income



China's Saving Rate

