CHAPTER 3

MACROECONOMICS

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National Income: Where It Comes From and Where It Goes

Modified for ECON 2204
by Bob Murphy

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

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

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

Returns to scale: a review

Initially $Y_1 = F(K_1, L_1)$

Scale all inputs by the same factor z:

$K_2 = zK_1$ and $L_2 = zL_1$

(*e.g.*, if $z = 1.2$, then all inputs are increased by 20%)

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**, $Y_2 < zY_1$

Returns to scale: Example 1

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

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

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

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

$$= z\sqrt{KL}$$

$$= z\,F(K,L)$$

constant returns to scale for any $z > 0$

Returns to scale: Example 2

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

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

$$= z^2 \left(K^2 + L^2 \right)$$

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

increasing returns to scale for any $z > 1$

NOW YOU TRY

Returns to scale

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

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

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

NOW YOU TRY

Answers, Part (a)

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

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

$$= z\,F(K,L)$$

constant returns to scale for any $z > 0$

NOW YOU TRY

Answers, Part (b)

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

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

$$= z(K + L)$$

$$= z\,F(K,L)$$

constant returns to scale for any ***z*** *> 0*

Assumptions

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

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

Determining GDP

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

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

The distribution of national income

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

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):

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

NOW YOU TRY

Compute & graph *MPL*

Compute & graph *MPL*

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

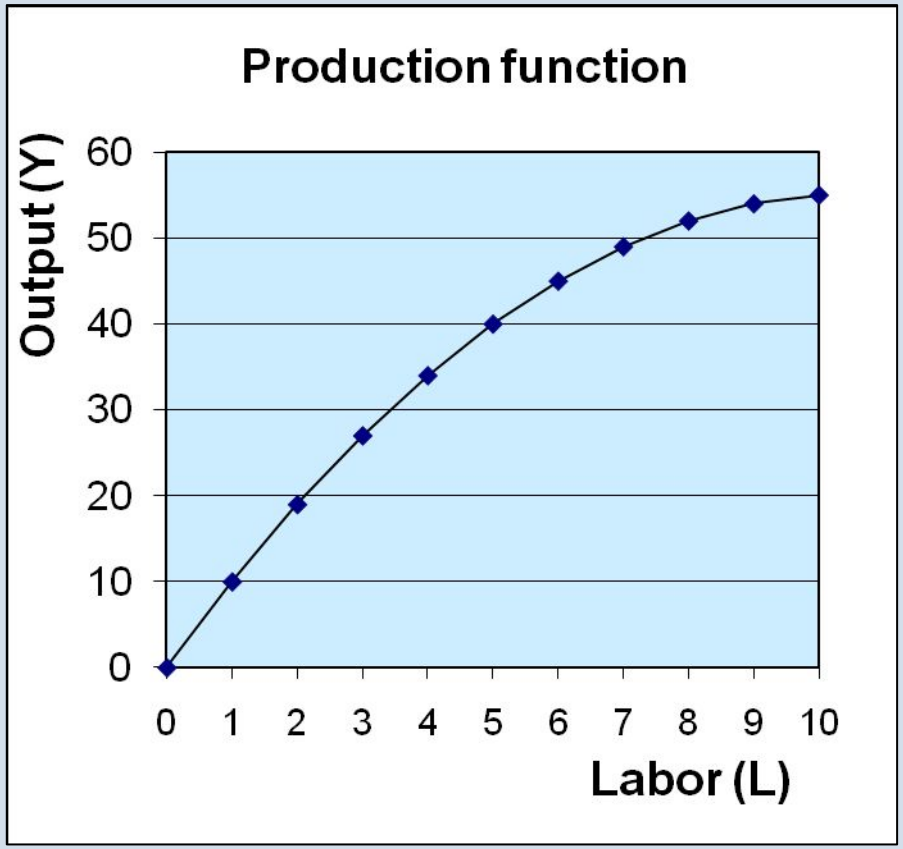
b. Graph the production function.

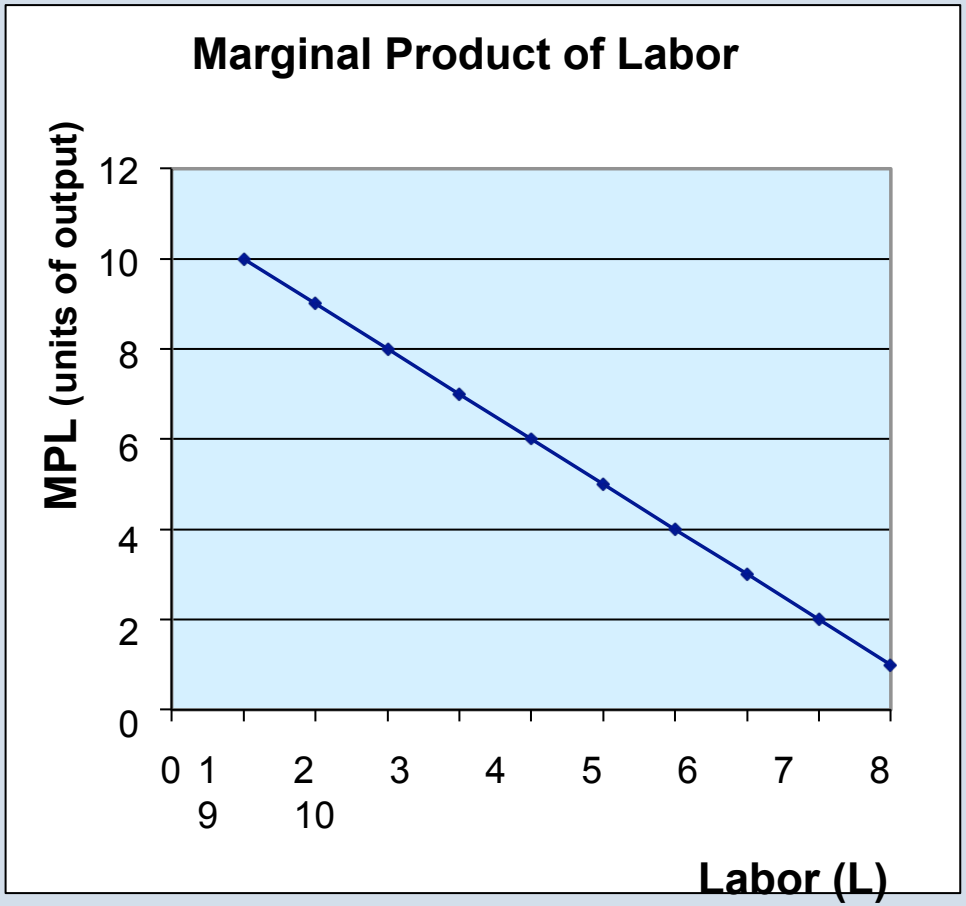
c. Graph the ***MPL*** curve with ***MPL*** on the vertical axis and ***L*** on the horizontal axis.

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	?

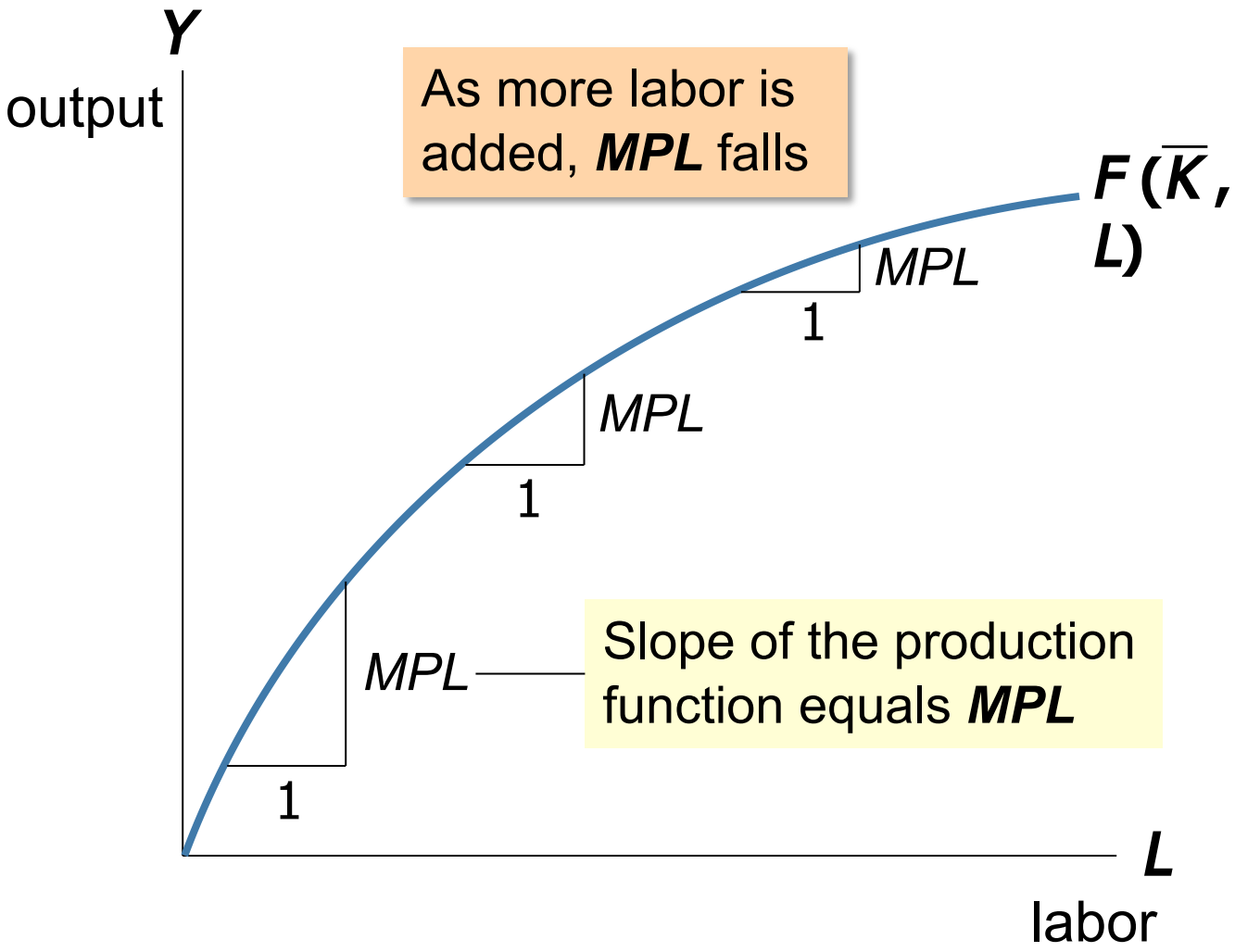
ANSWERS

Compute & graph *MPL*





MPL and the production function



Diminishing marginal returns

- As one input is increased (holding other inputs constant), its marginal product falls.
- Intuition:

  If ***L*** increases while holding ***K*** fixed

  machines per worker falls,

  worker productivity falls.

NOW YOU TRY

Identifying diminishing returns

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

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

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

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

2

ANSWERS

Identifying diminishing returns

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

No, ***MPL*** = 15 for all ***L***

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

Yes, ***MPL*** falls as ***L*** rises

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

Yes, ***MPL*** falls as ***L*** rises

NOW YOU TRY

MPL and labor demand

Suppose ***W/P*** = 6.

- If ***L*** = 3, should firm hire more or less labor? Why?

- 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

ANSWERS

MPL and labor demand

If ***L*** = 3, should firm hire more or less labor?

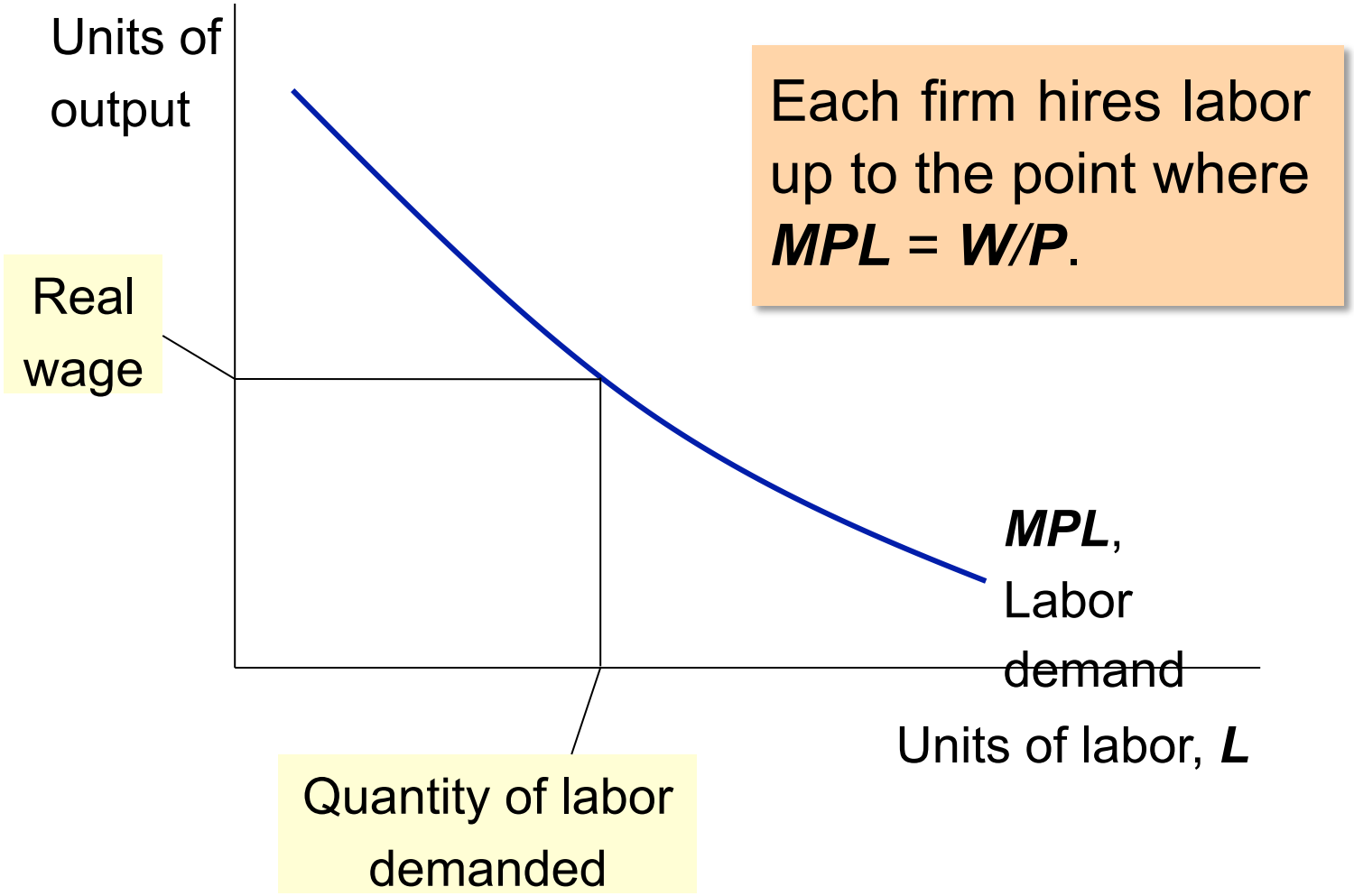
Answer: MORE, because the benefit of the 4th worker (*MPL* = 7) exceeds its cost (*W*/*P* = 6)

If ***L*** = 7, should firm hire more or less labor?

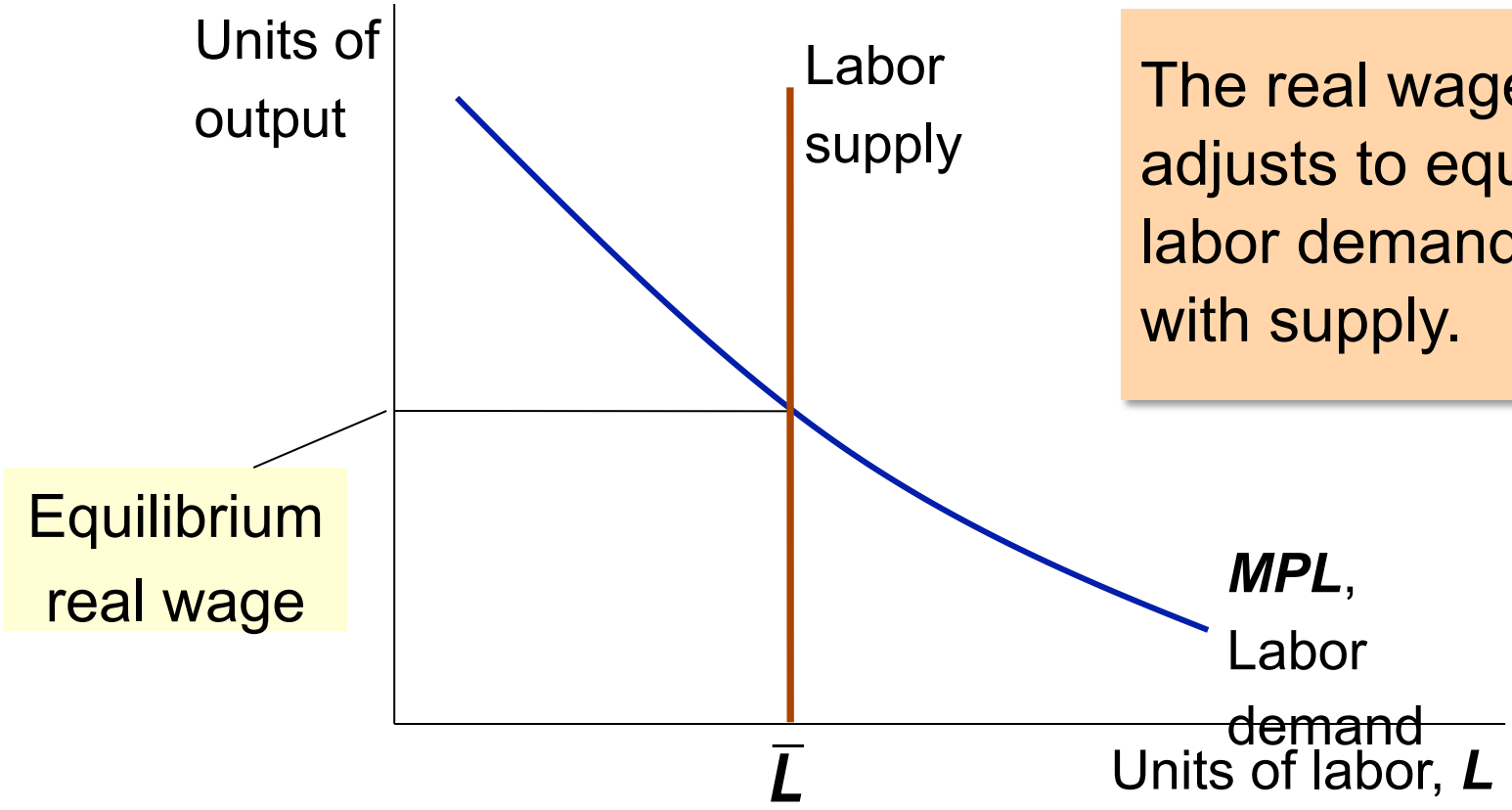
Answer: LESS, because the 7th but costs the firm *W*/*P* = 6.

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



The equilibrium real wage

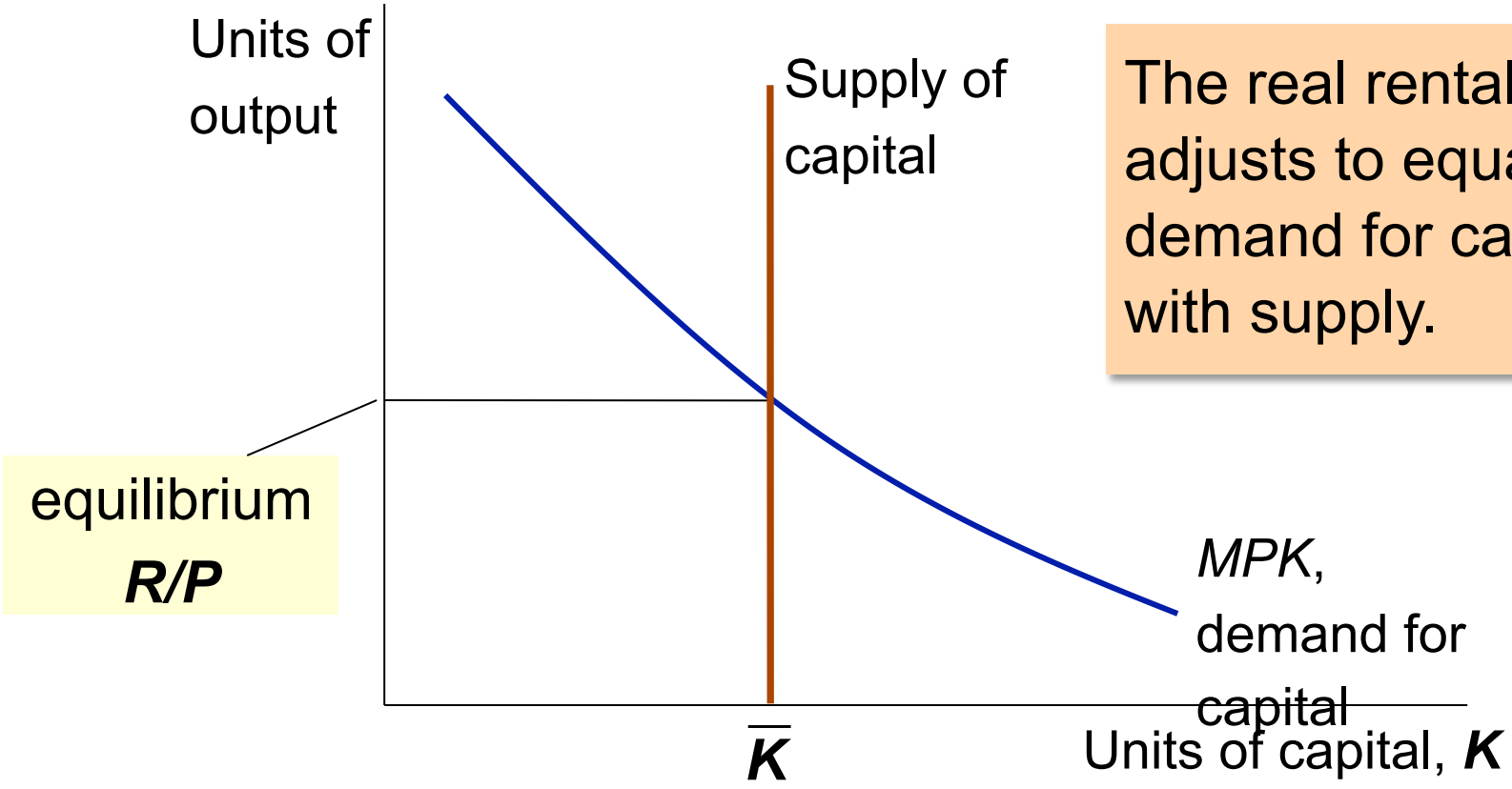


The real wage adjusts to equate labor demand with supply.

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*** falls as ***K*** rises
  - 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.

The neoclassical theory of distribution

- States that each factor input is paid its marginal product
- A good starting point for thinking about income distribution

How income is distributed to L and K

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

$$\bar{Y} = MPL \times \bar{L} + MPK \times \bar{K}$$

national income = labor income + capital income

How income is distributed to L and K

What About Profit? ***Define economic profit as:***

Economic Profit = $Y-(\frac{W}{P}\times L)-(\frac{R}{P}\times K)$

Economic Profit = $Y-(MPL\times L)-(MPK\times K)$

If production function is CRS, then:

$$Y=(MPL\times L)+(MPK\times K)$$

so that Economic Profit = 0

How income is distributed to L and K

Example of Euler's Theorem. To see this, use definition of CRS:

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

Differentiate with respect to z:

$$Ydz = F_1(zL, zK)Ldz + F_2(zL, zK)Kdz$$

and set z = 1 to obtain:

$$Y = F_1(L, K)L + F_2(L, K)K$$

How income is distributed to L and K

$$Y = F_1(L,K)L + F_2(L,K)K$$

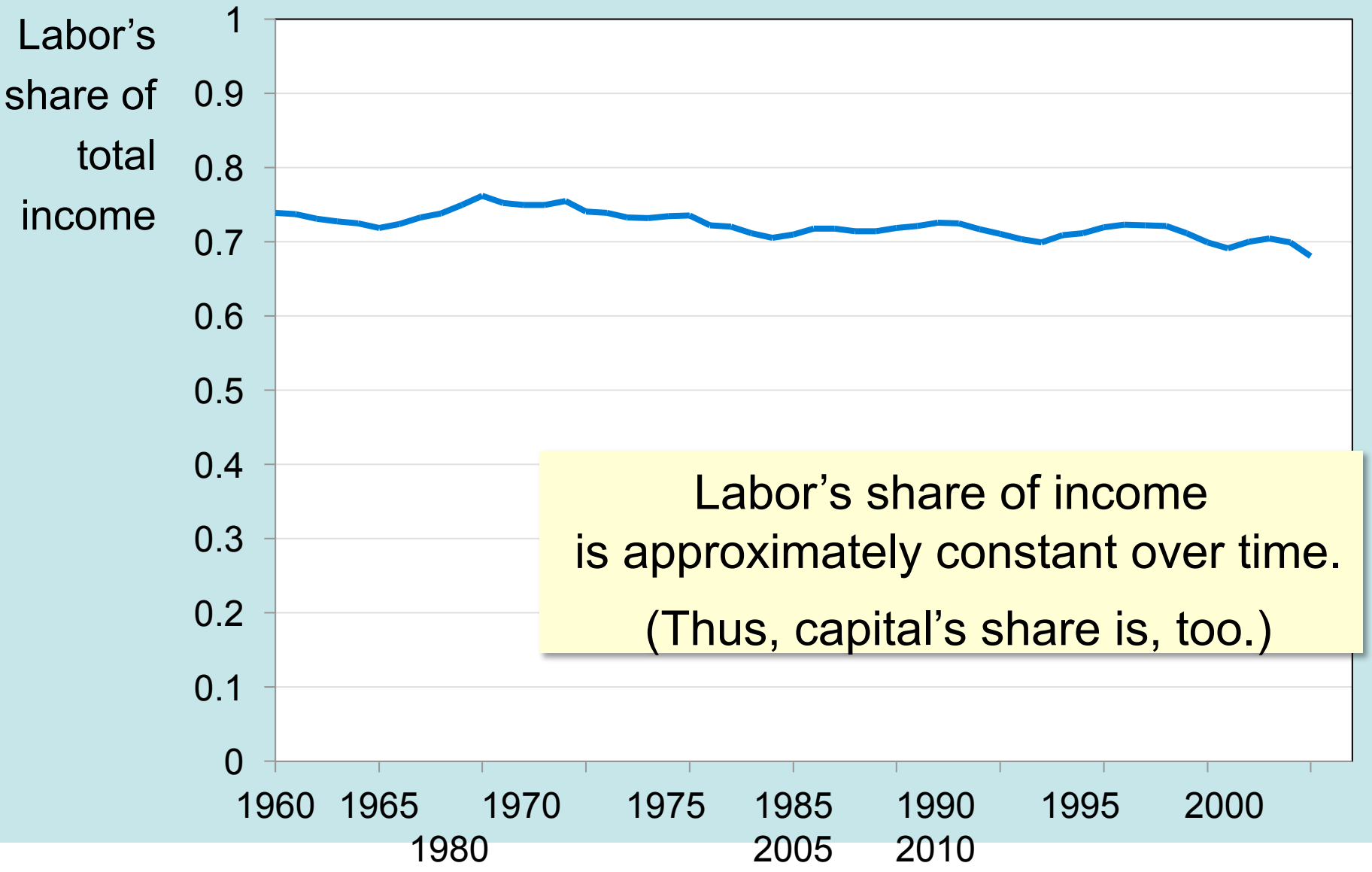
$$= (MPL \times L) + (MPK \times K)$$

where

$$F_1(L,K) = MPL$$

$$F_2(L,K) = MPK$$

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



The Cobb-Douglas production function

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

α = capital's 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.

The Cobb-Douglas production function

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

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

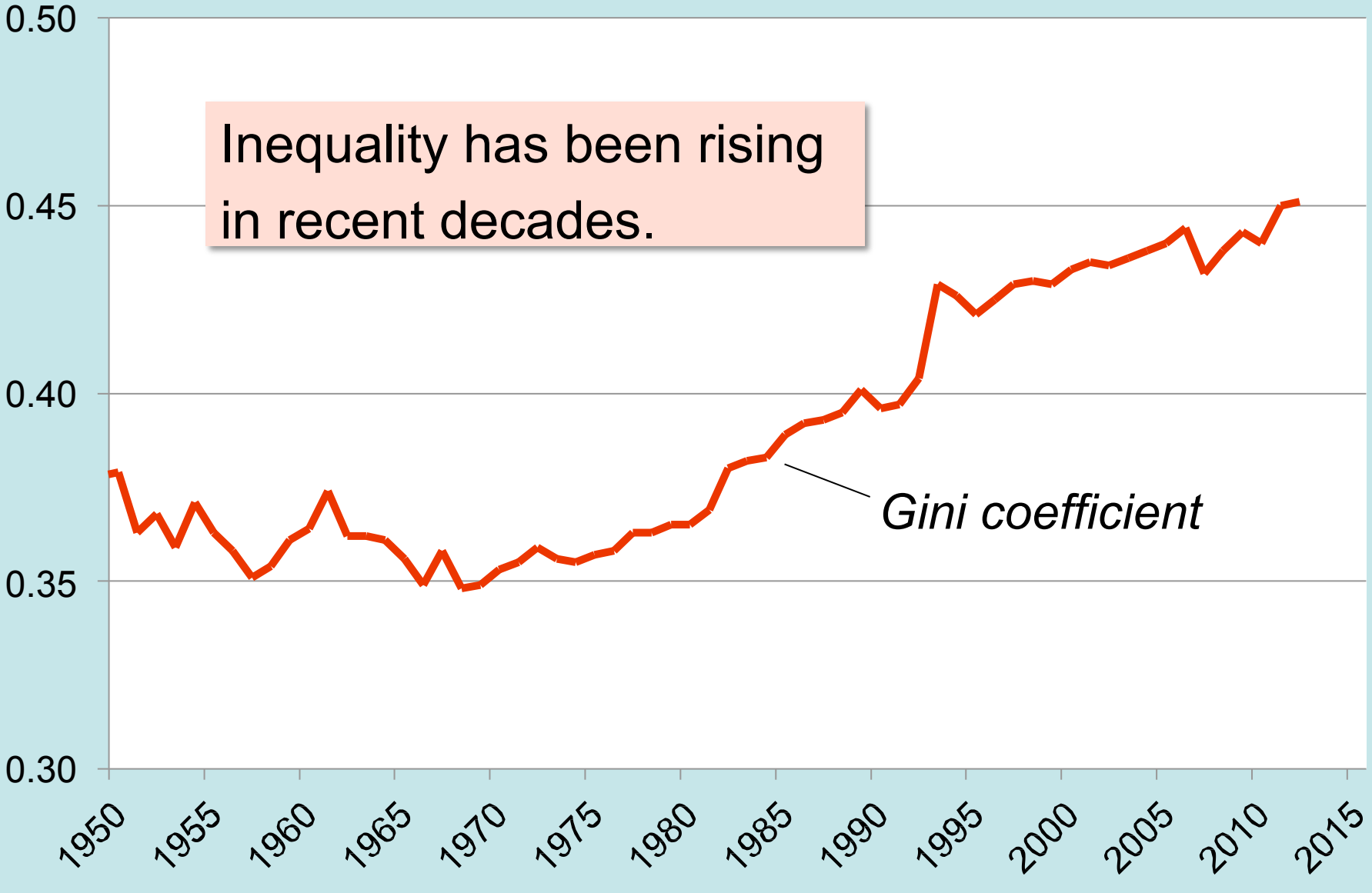
$$MPL = (1-\alpha) A K^{\alpha} L^{-\alpha} = (1-\alpha) \frac{Y}{L}$$

Labor productivity and wages

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

period	*productivity growth*	*real wage growth*
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. Result: Rising gap between wages of skilled and unskilled workers.

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 and services

Components of aggregate demand:

C = consumer demand for g&s

I = demand for investment goods

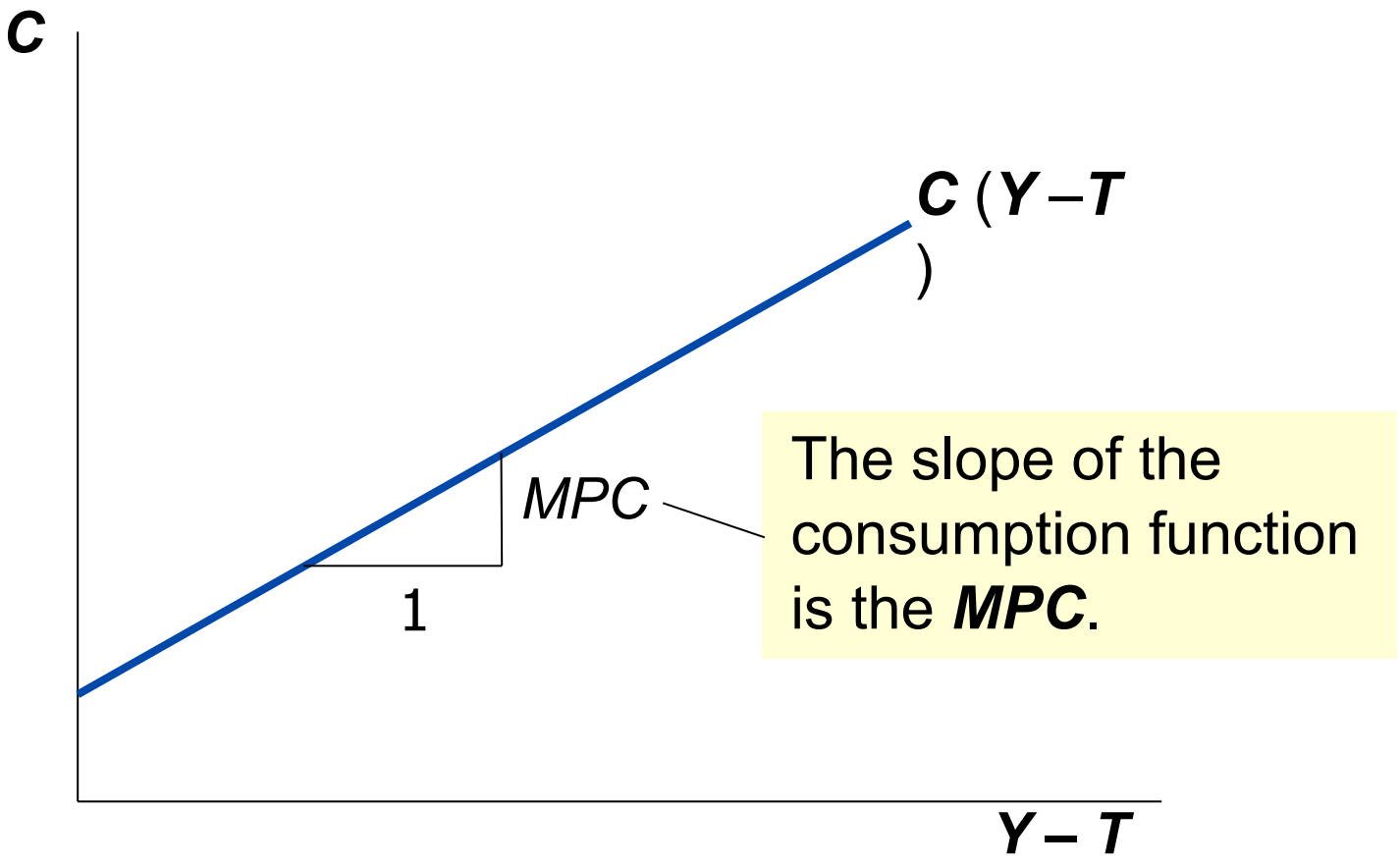
G = government demand for g&s

(closed economy: no ***NX***)

Consumption, C

- **Disposable income** is total income minus total taxes: $Y - T$.
- Consumption function: $C = C(Y - T)$
- Definition: **Marginal propensity to consume (MPC)** is the change in C when disposable income increases by one dollar.

The consumption function



Investment, I

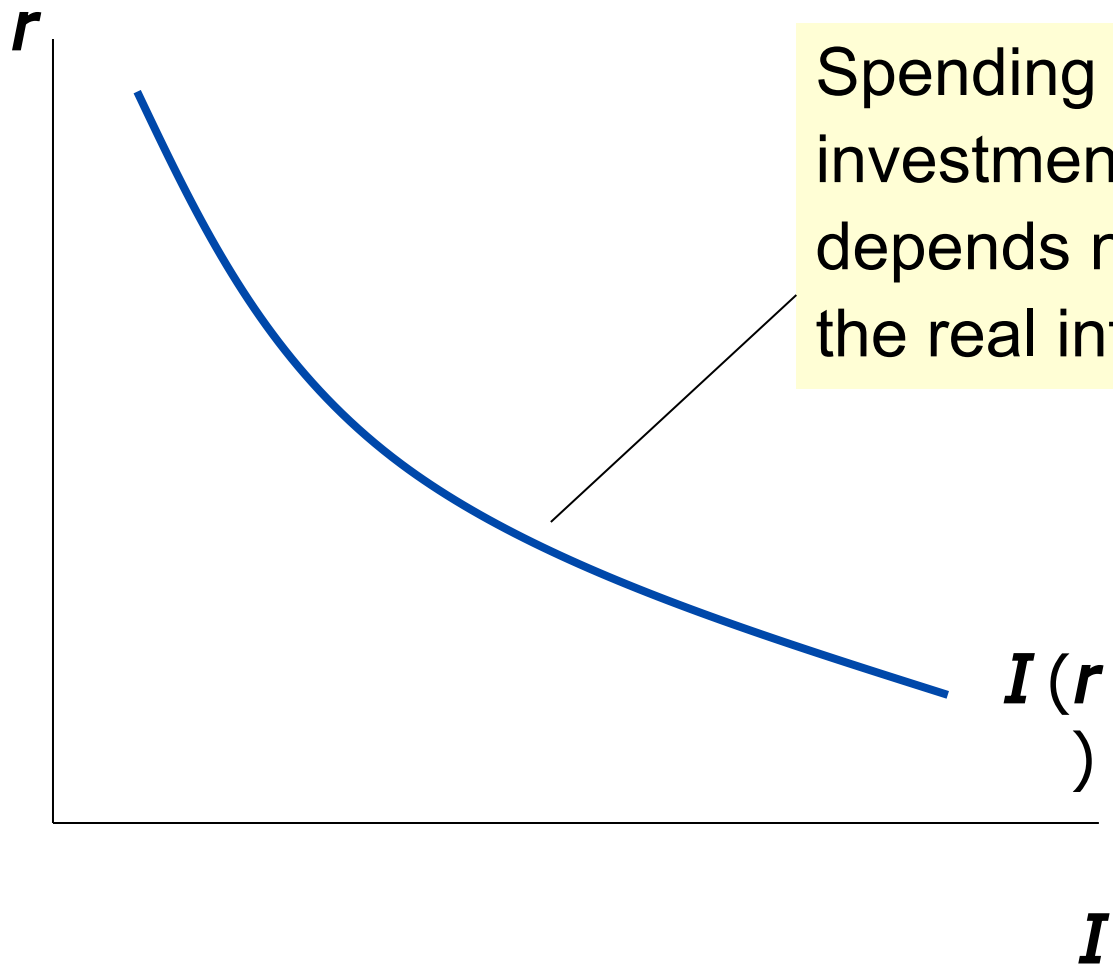
- The investment function is $I = I(r)$

  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, I depends negatively on r

The investment function



Spending on investment goods depends negatively on the real interest rate.

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:

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

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

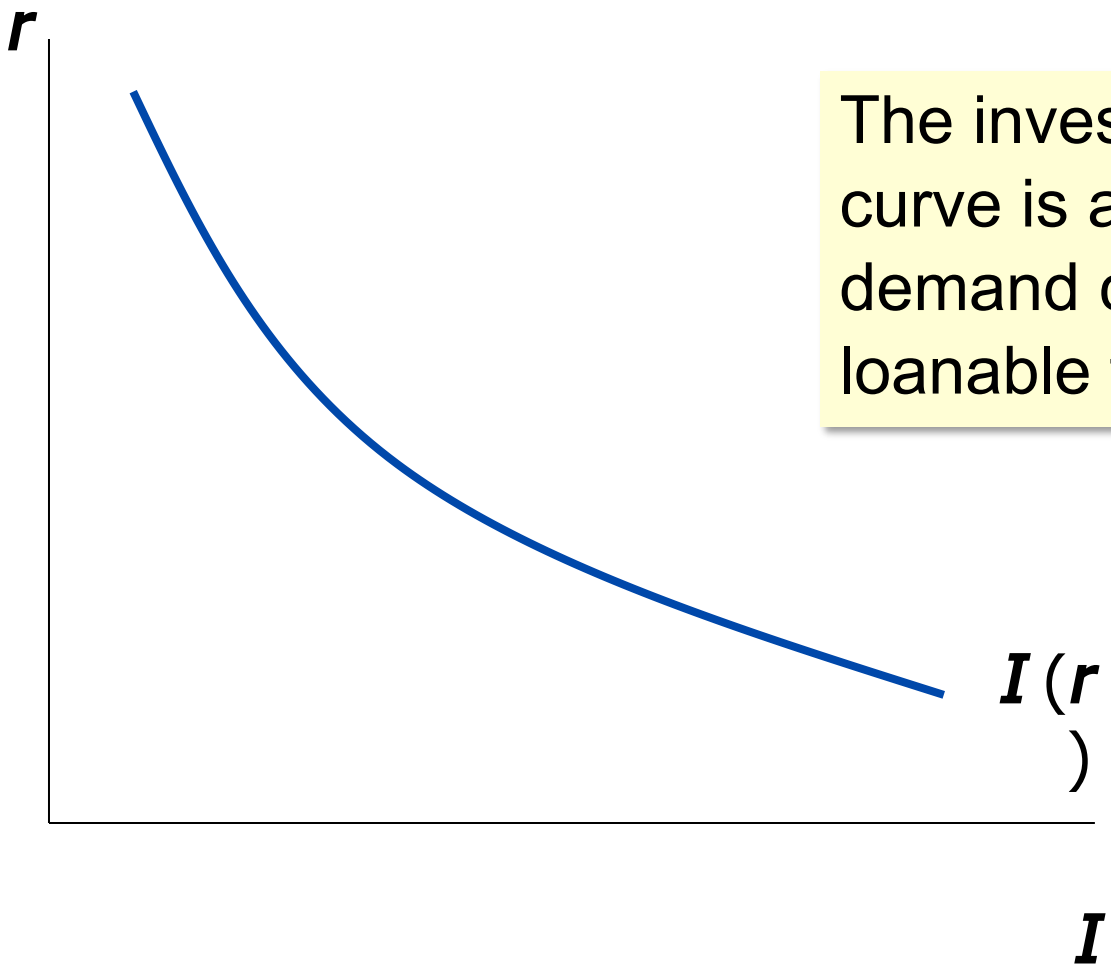
- A simple supply–demand model of the financial system.
- One asset: “loanable funds”
  - demand for funds: investment
  - supply of funds: saving
  - “price” of funds: real interest rate

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 and finance investment spending.
  - The government may also contribute to saving if it does not spend all the tax revenue it receives.

Types of saving

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

Public saving $= T - G$

National saving, S

= private saving + public saving

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

$= Y - C - G$

Notation: Δ = change in a variable

- For any variable X, ΔX = "change in X"

Δ is the Greek (uppercase) letter *Delta*

Examples:

- If $\Delta L = 1$ and $\Delta K = 0$, then $\Delta Y = MPL$.
  More generally, if $\Delta K = 0$, then $\frac{\Delta Y}{\Delta L} = MPL$.

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

$$\Delta C = MPC \times (\Delta Y - \Delta T)$$

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

NOW YOU TRY

Calculate the change in saving

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

For each of the following, compute ΔS :

a. $\Delta G = 100$

b. $\Delta T = 100$

c. $\Delta Y = 100$

d. $\Delta L = 10$

ANSWERS

Calculate the change in saving

$$\Delta S = \Delta Y - \Delta C - \Delta G = \Delta Y - 0.8(\Delta Y - \Delta T) - \Delta G$$
$$= 0.2\,\Delta Y + 0.8\,\Delta T - \Delta G$$

a. $\Delta S = -100$

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

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

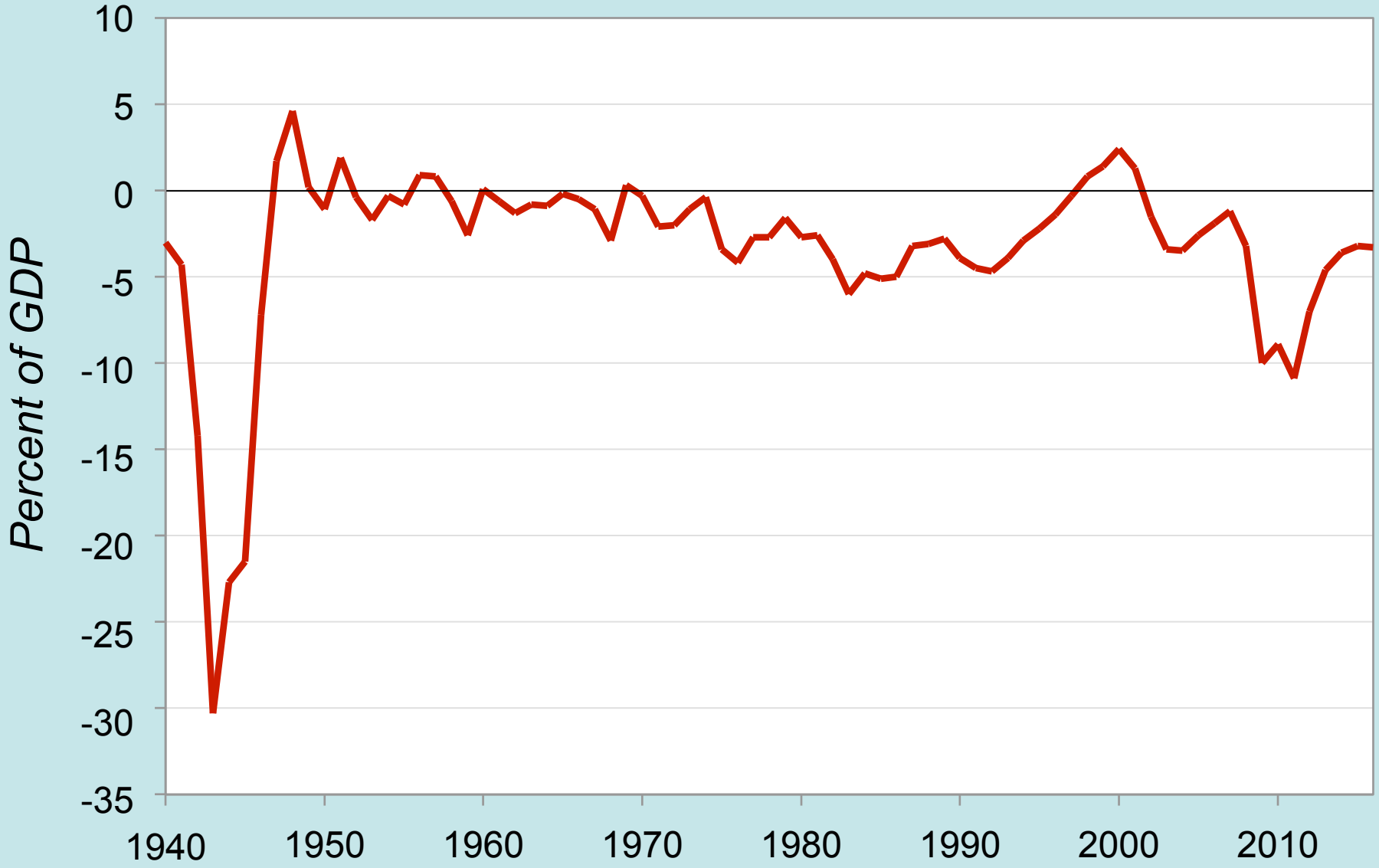
d. $\Delta Y = \text{MPL} \times \Delta L = 20 \times 10 = 200$, $\Delta S = 0.2 \times \Delta Y = 0.2 \times 200 = 40$.

Budget surpluses and deficits

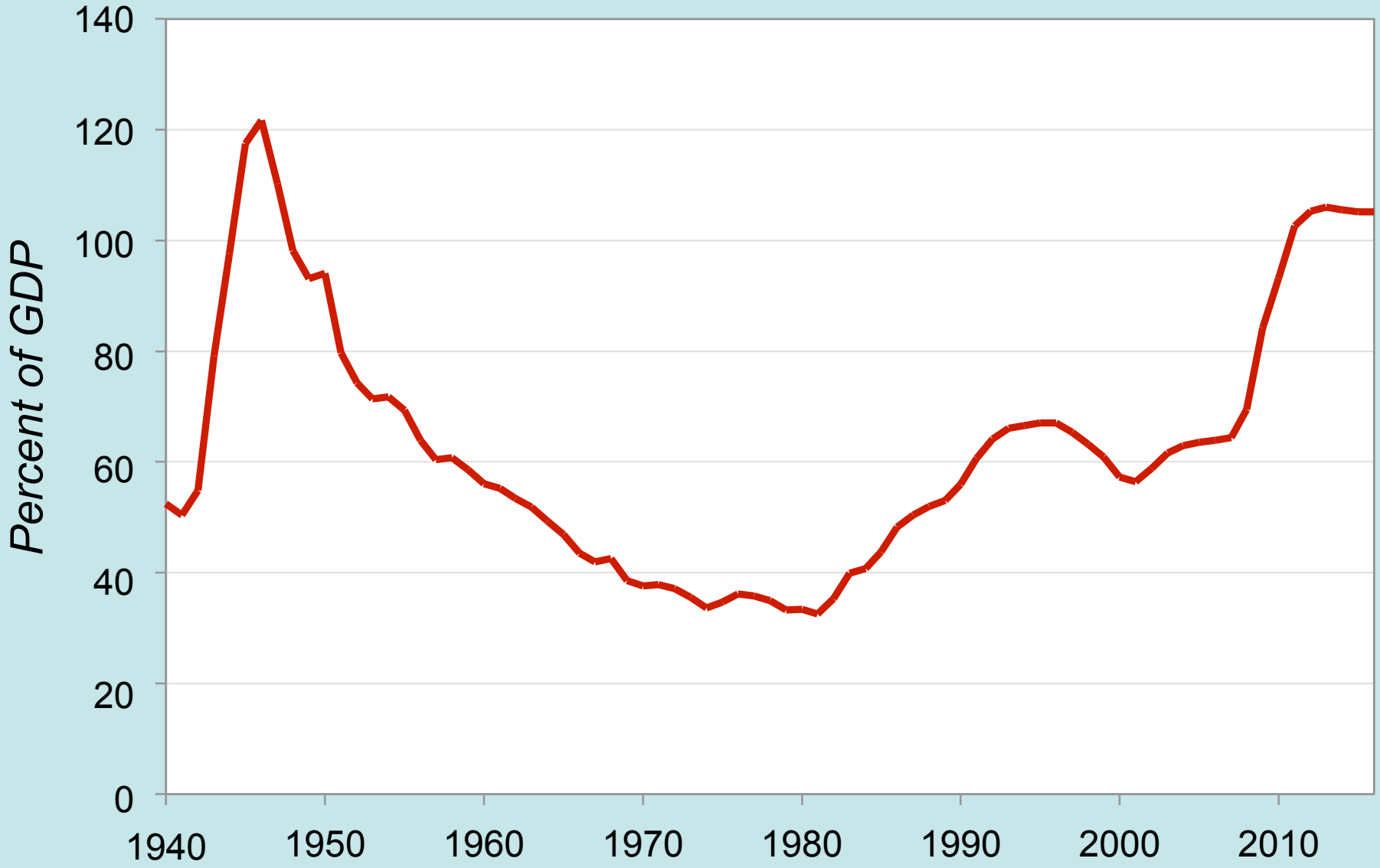
- If ***T*** > ***G***, **budget surplus** = (***T*** – ***G***) = public saving.
- If ***T*** < ***G***, **budget deficit** = (***G*** – ***T***) and public saving is negative.
- If ***T*** = ***G*** , **balanced budget**, public saving = 0.
- The U.S. government finances its deficit by issuing Treasury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

U.S. federal government surplus/deficit

1940-2016

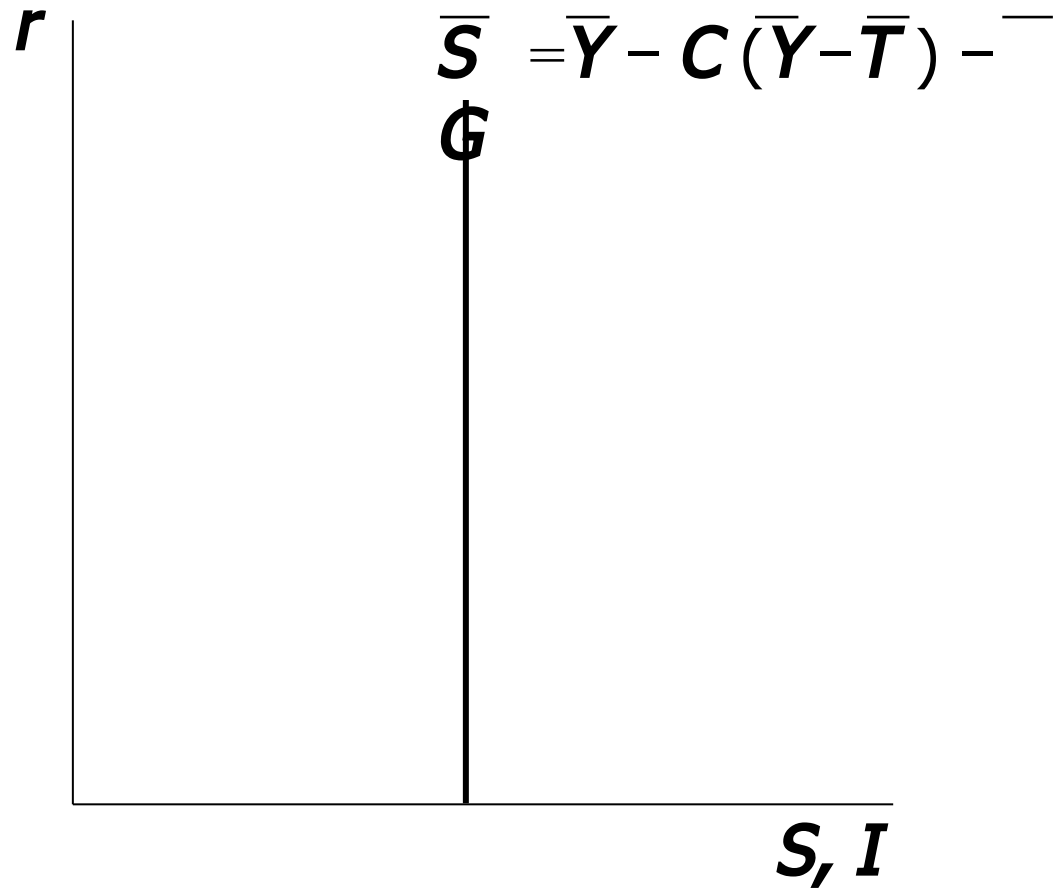


U.S. federal government debt, **1940-2016**

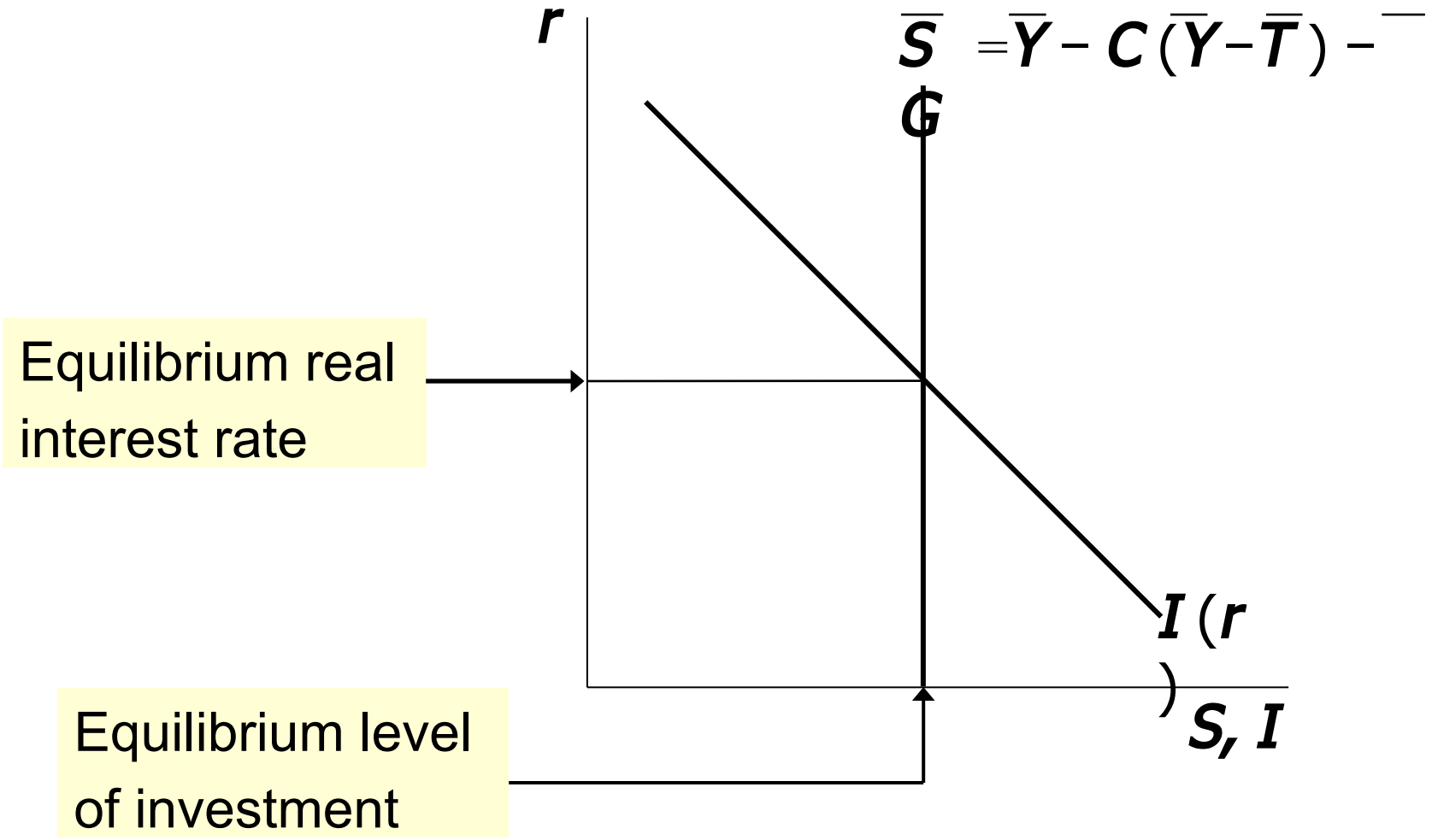


Loanable funds supply curve

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 in equilibrium, then

$$Y - C - G = I$$

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

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

Thus,

Eq'm in L.F. market $\Leftrightarrow$ 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: $\Delta \bar{G} > 0$
  - big tax cuts: $\Delta \bar{T} < 0$
- Both policies reduce national saving:

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

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

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

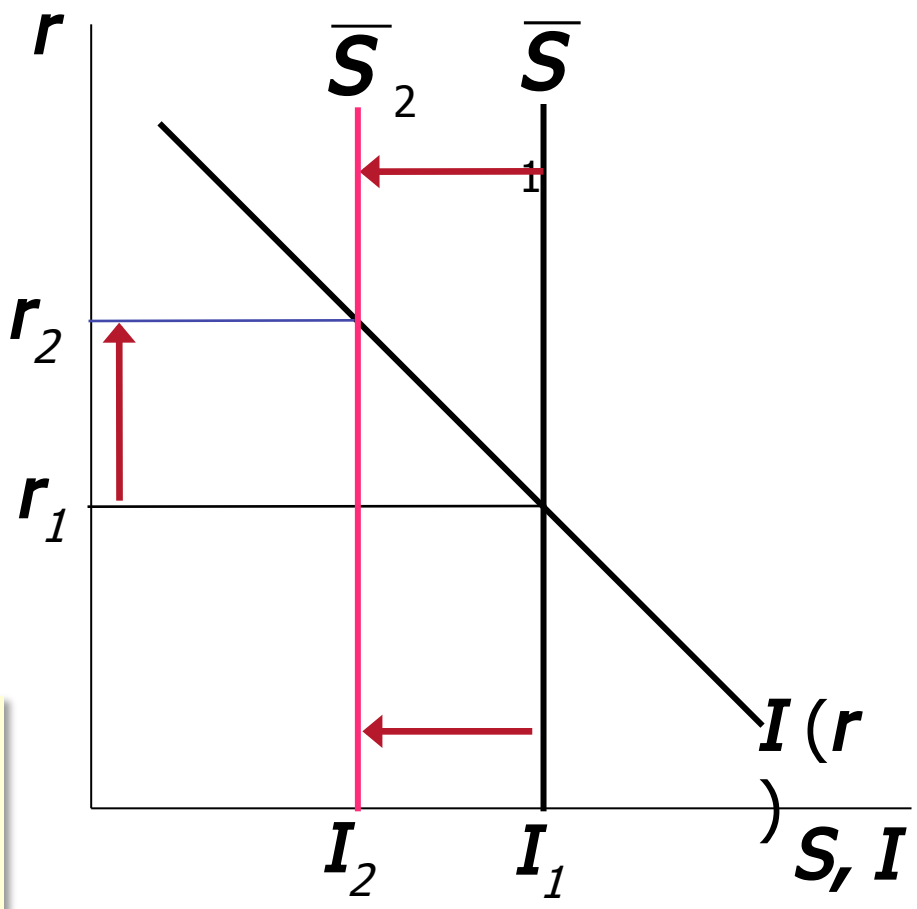
CASE STUDY:

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?

	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*

All figures are averages over the decade shown.

NOW YOU TRY

The effects of saving incentives

- 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?

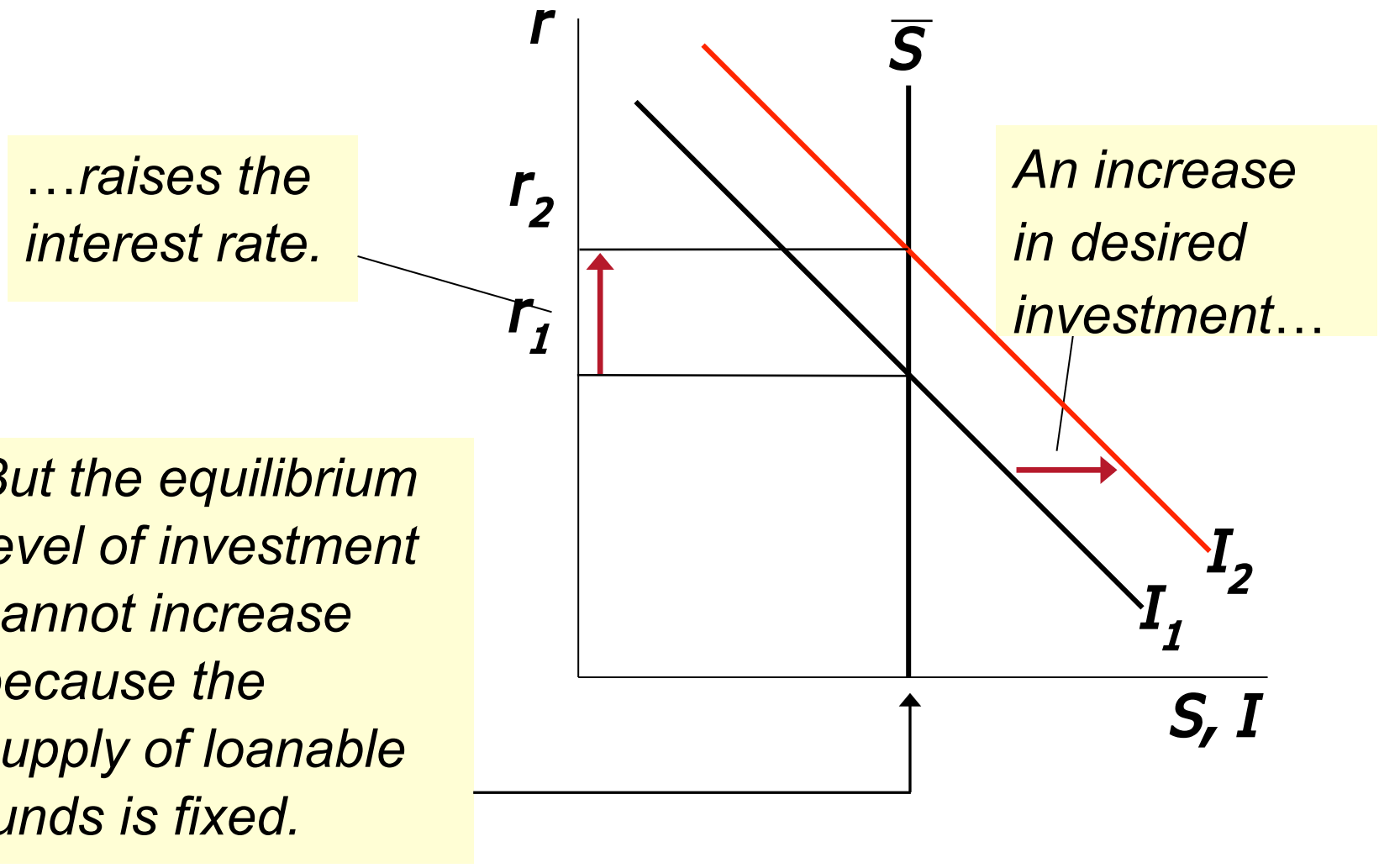
Mastering the loanable funds model

(continued)

Things that shift the investment curve:

- some technological innovations
  - to take advantage of some innovations, firms must buy new investment goods
- tax laws that affect investment
  - *e.g.,* investment tax credit

An increase in investment demand

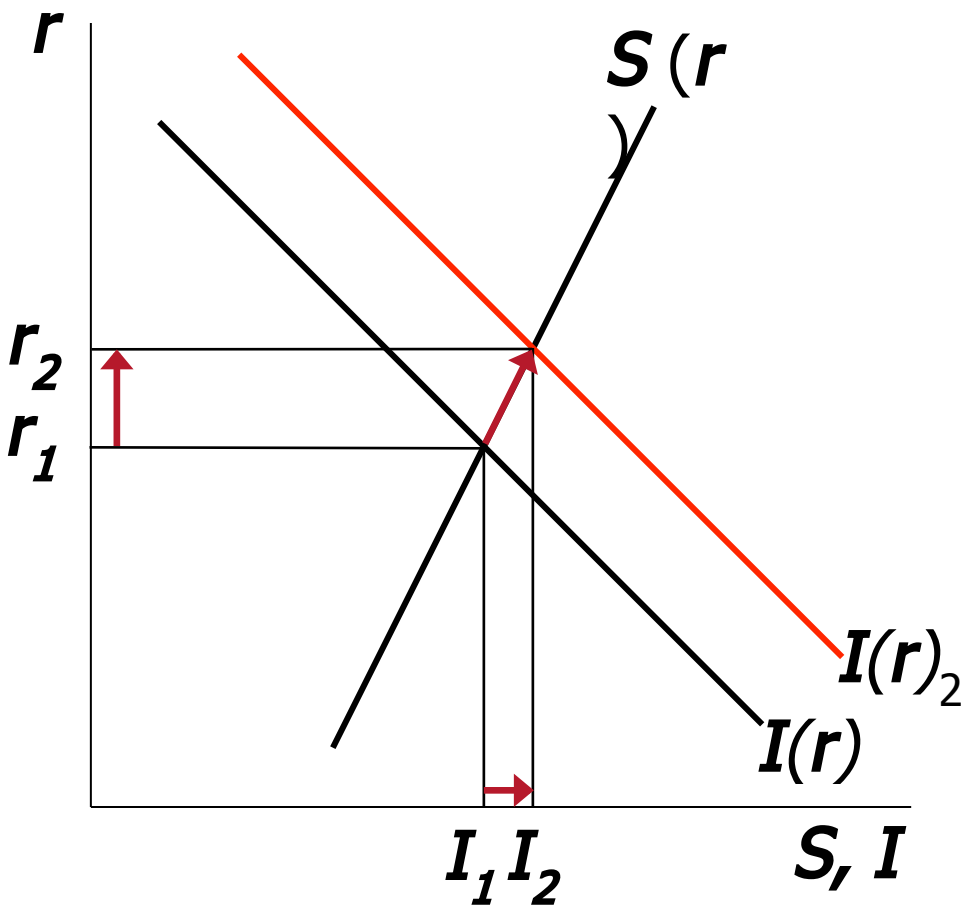


Saving and the interest rate

- 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, and 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.