



# CHAPTER 3

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

MACROECONOMICS SIXTH EDITION

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PowerPoint® Slides by Ron Cronovich



## **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

- 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



# Returns to scale: A review

Initially  $Y_1 = F(K_1, L_1)$

Scale all inputs by the same factor  $z$ :

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

(e.g., 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**,  $Y_2 < zY_1$



## 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  $z > 0$*



## Example 2

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

$$\begin{aligned} F(zK, zL) &= \sqrt{zK} + \sqrt{zL} \\ &= \sqrt{z}\sqrt{K} + \sqrt{z}\sqrt{L} \\ &= \sqrt{z}(\sqrt{K} + \sqrt{L}) \\ &= \sqrt{z}F(K, L) \end{aligned}$$

*decreasing  
returns to scale  
for any  $z > 1$*





## 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 for any  
 $z > 1$*



## *Now you try...*

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

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

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



## Answer to part (a)

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

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

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

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

$$= zF(K,L)$$

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



## Answer to part (b)

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

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

$$= z(K + L)$$

$$= zF(K, L)$$

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



# Assumptions of the model

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

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



# 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**, 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

**$R$**  = 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):

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



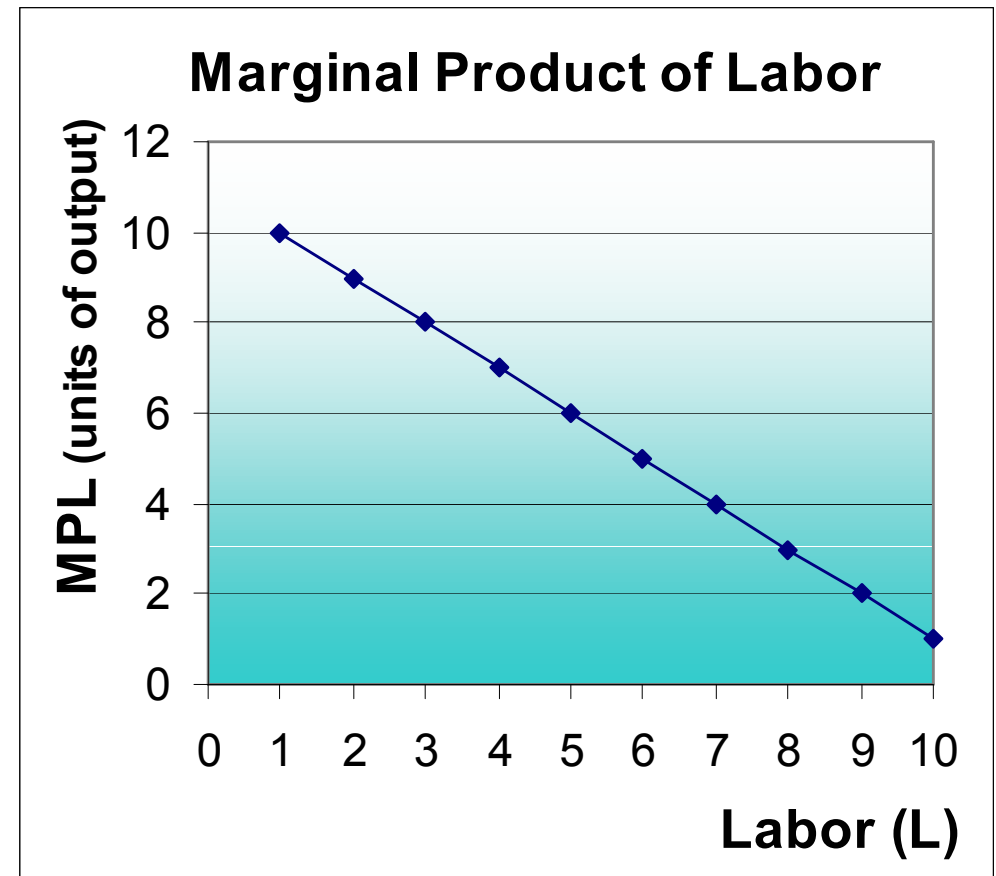
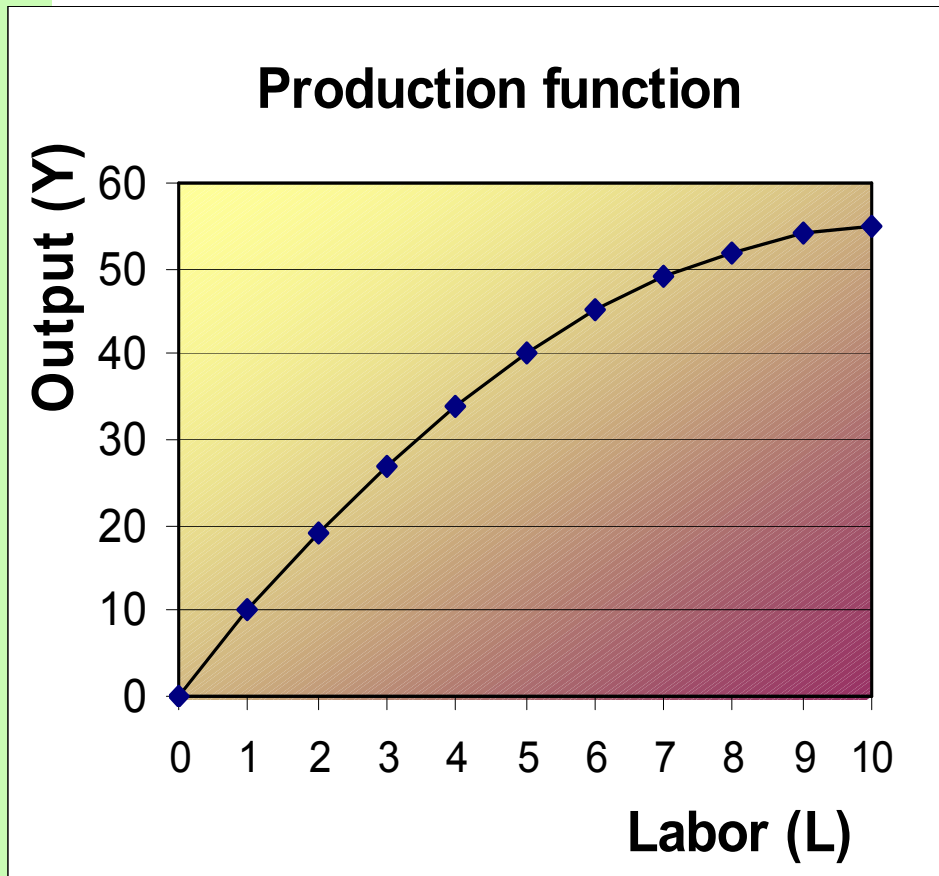
## Exercise: *Compute & graph MPL*

- 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.

<b><i>L</i></b>	<b><i>Y</i></b>	<b><i>MPL</i></b>
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:



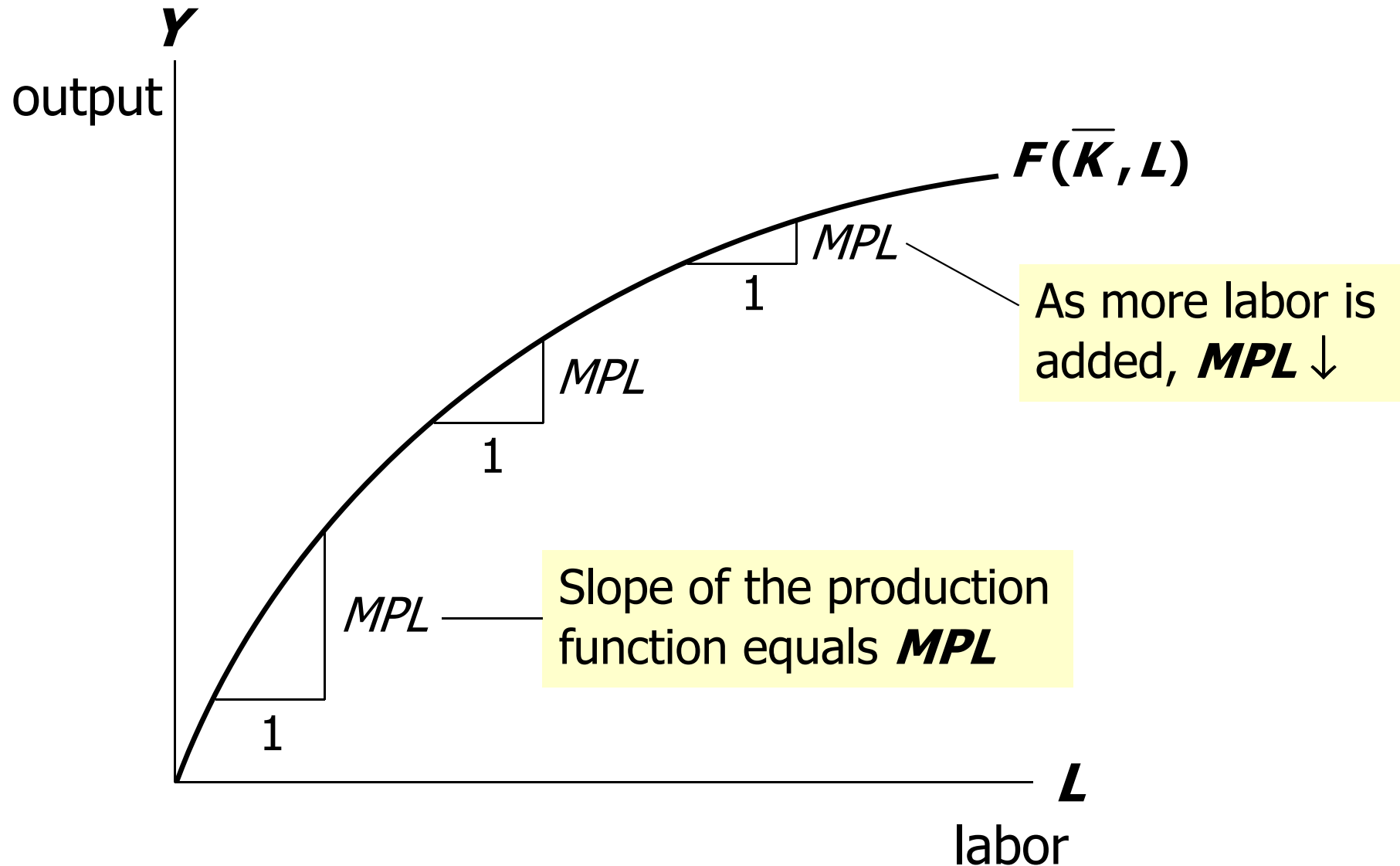


# Diminishing marginal returns

- 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



# *MPL* and the production function





## 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)

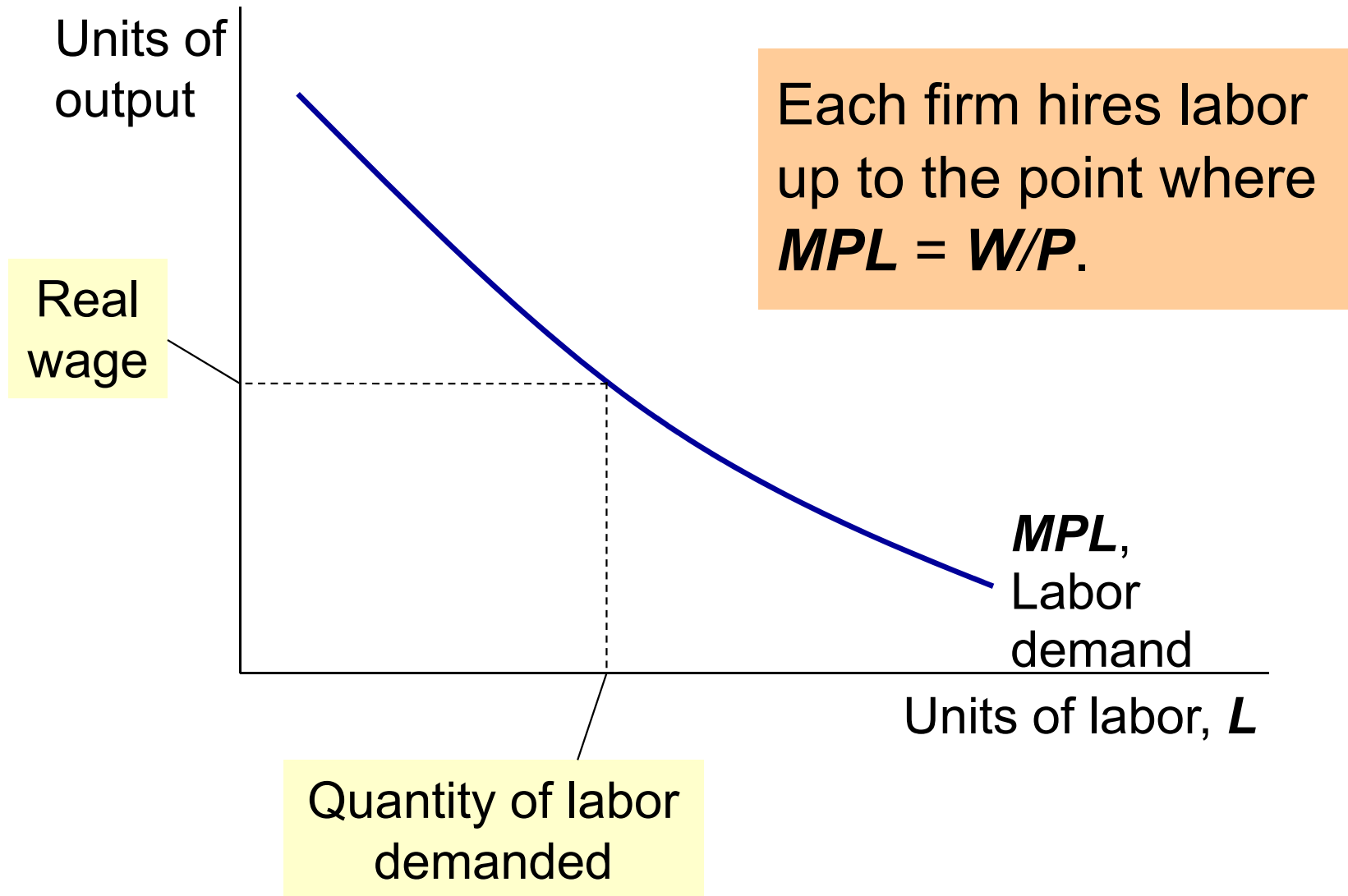
Suppose  $W/P = 6$ .

- 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

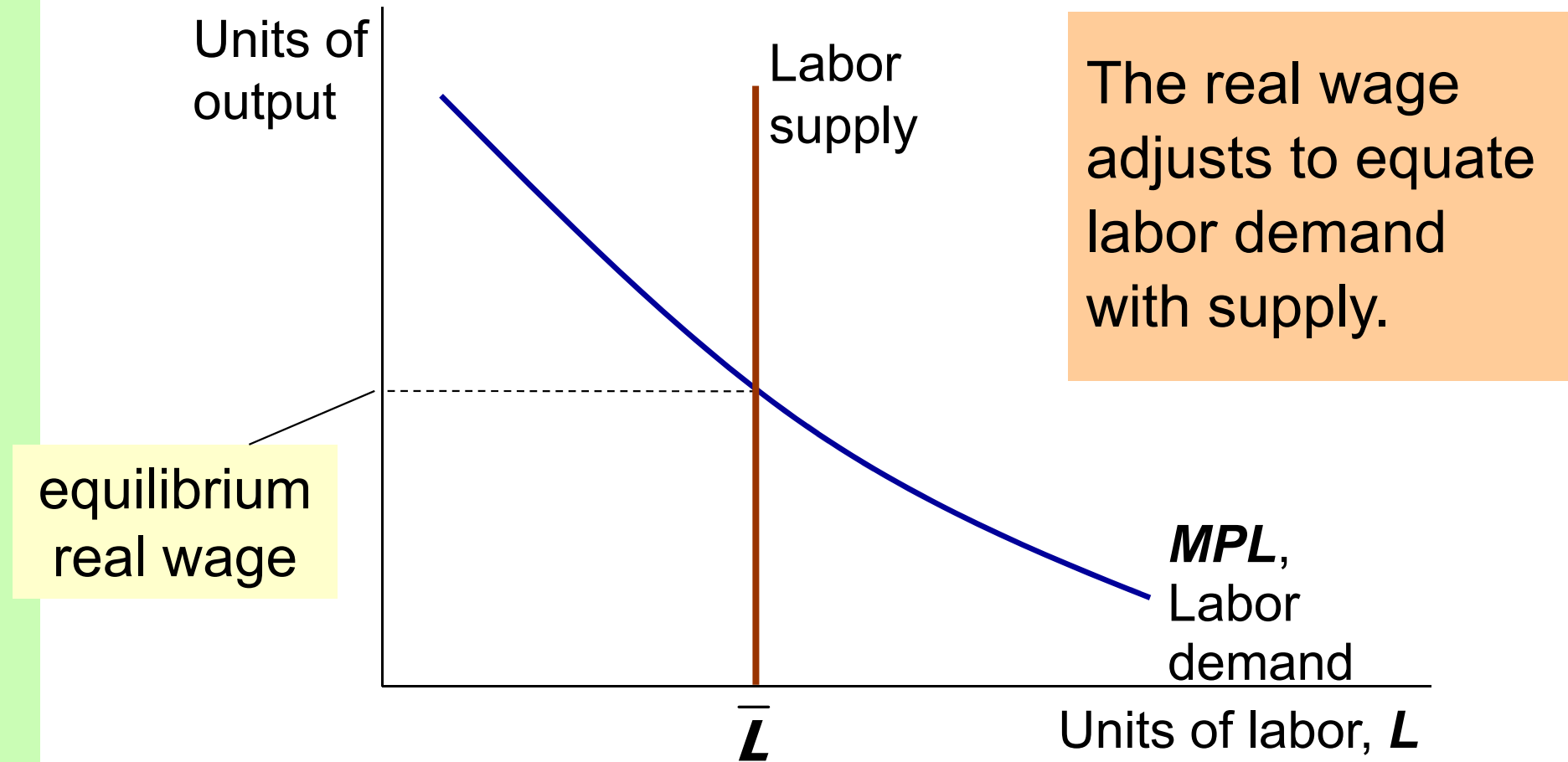


# *MPL* and the demand for labor





# The equilibrium real wage





# Determining the rental rate

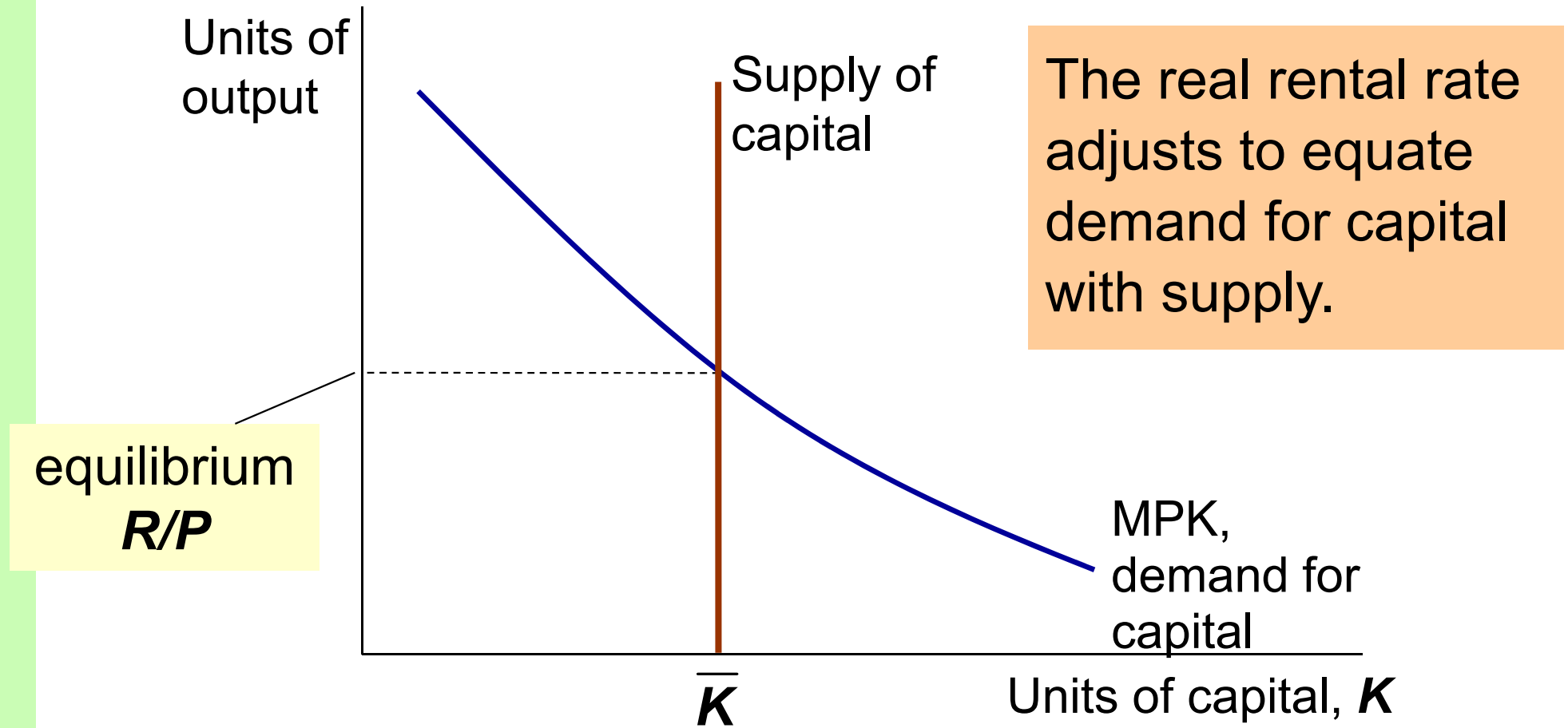
We have just seen that  $MPL = W/P$ .

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 Neoclassical Theory of Distribution

- states that each factor input is paid its marginal product
- is accepted by most economists



## How income is distributed:

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

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

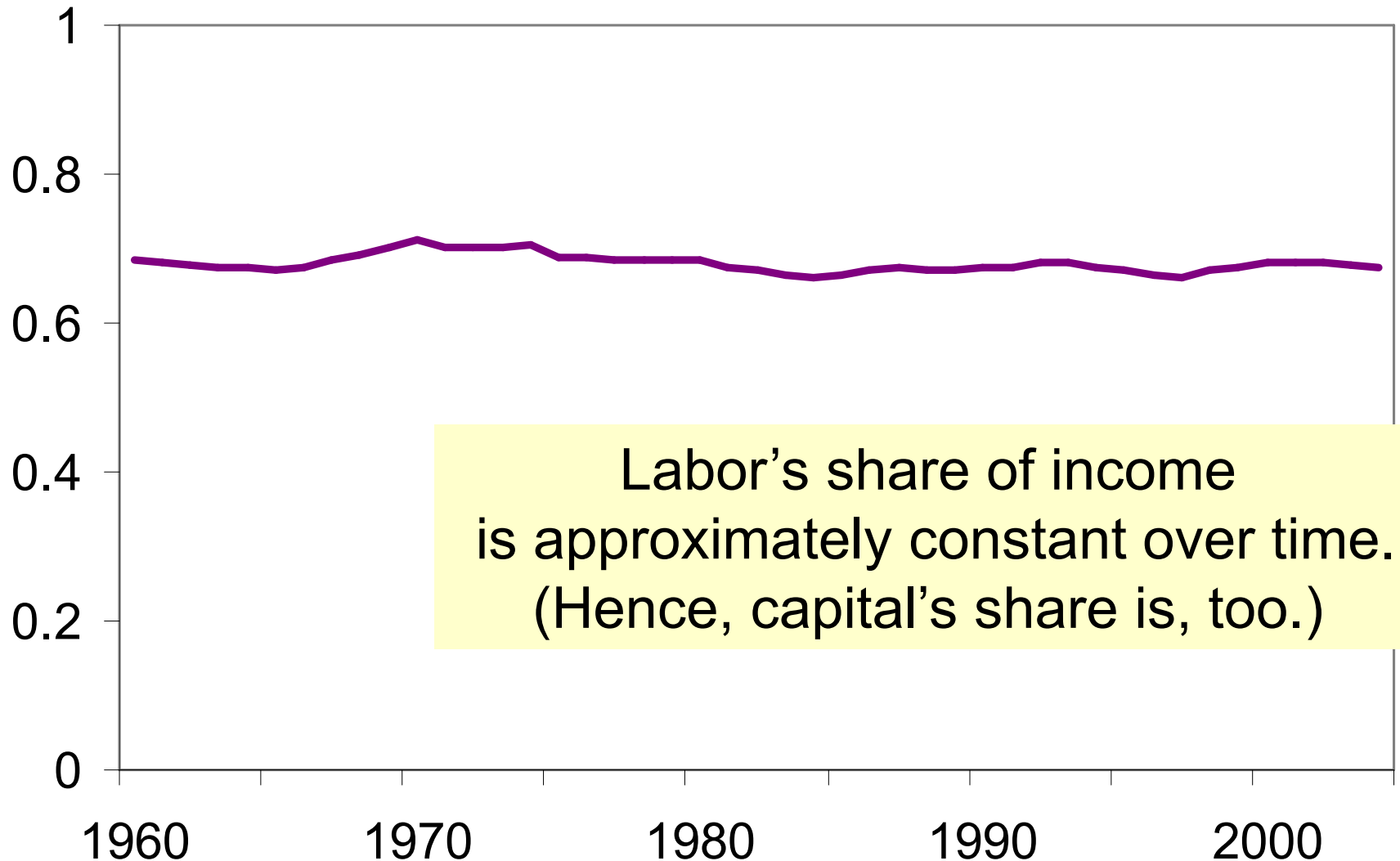
If production function has constant returns to scale, then

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



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

Labor's share of total income







# The Cobb-Douglas Production Function

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

$\alpha$  = 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:

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

where **A** represents the level of technology.



# The Cobb-Douglas Production Function

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

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

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



# 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 goods

***G*** = government demand for g & s

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

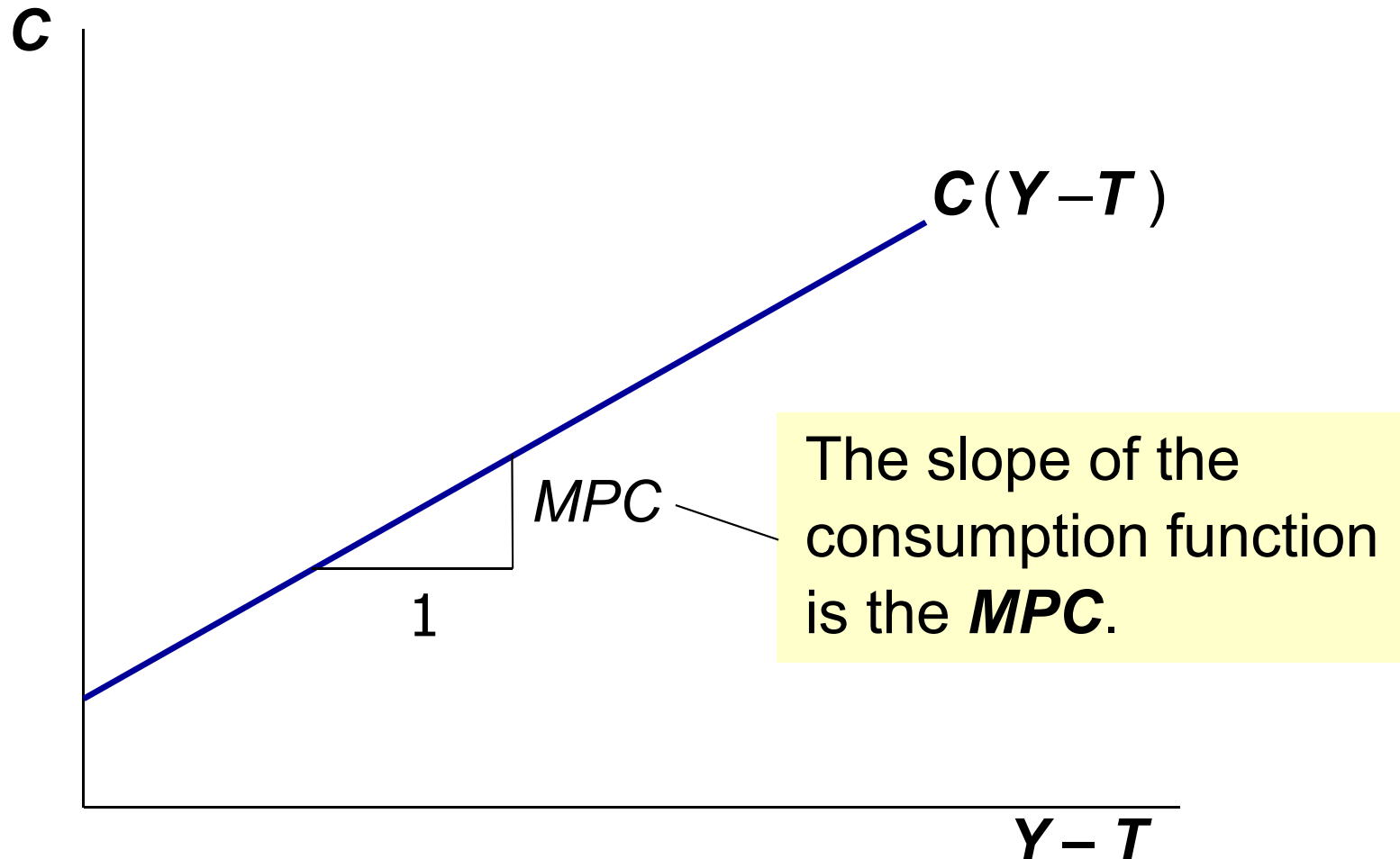


# Consumption, $C$

- 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.



# The consumption function





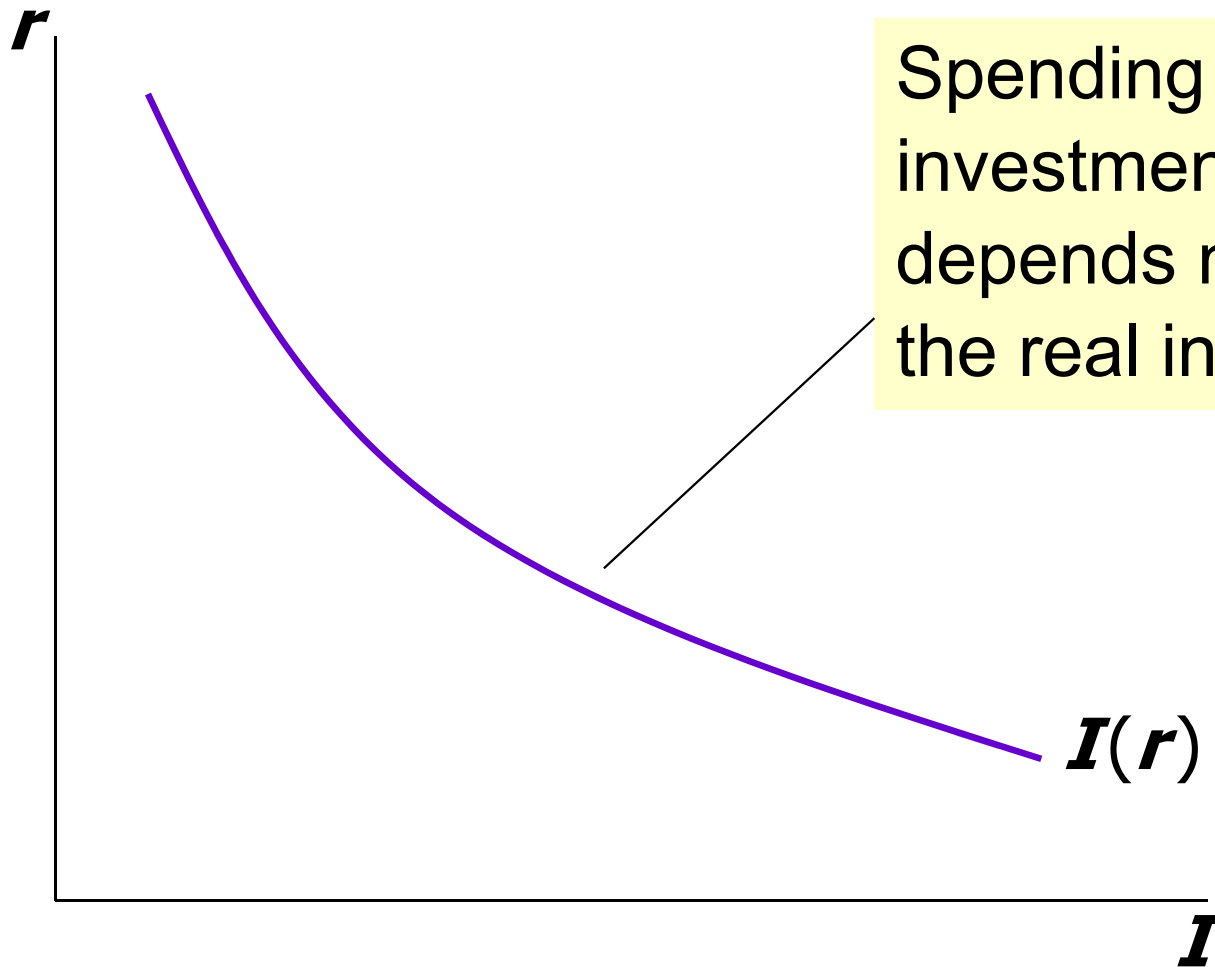
# Investment, $I$

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



# 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:

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



# 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



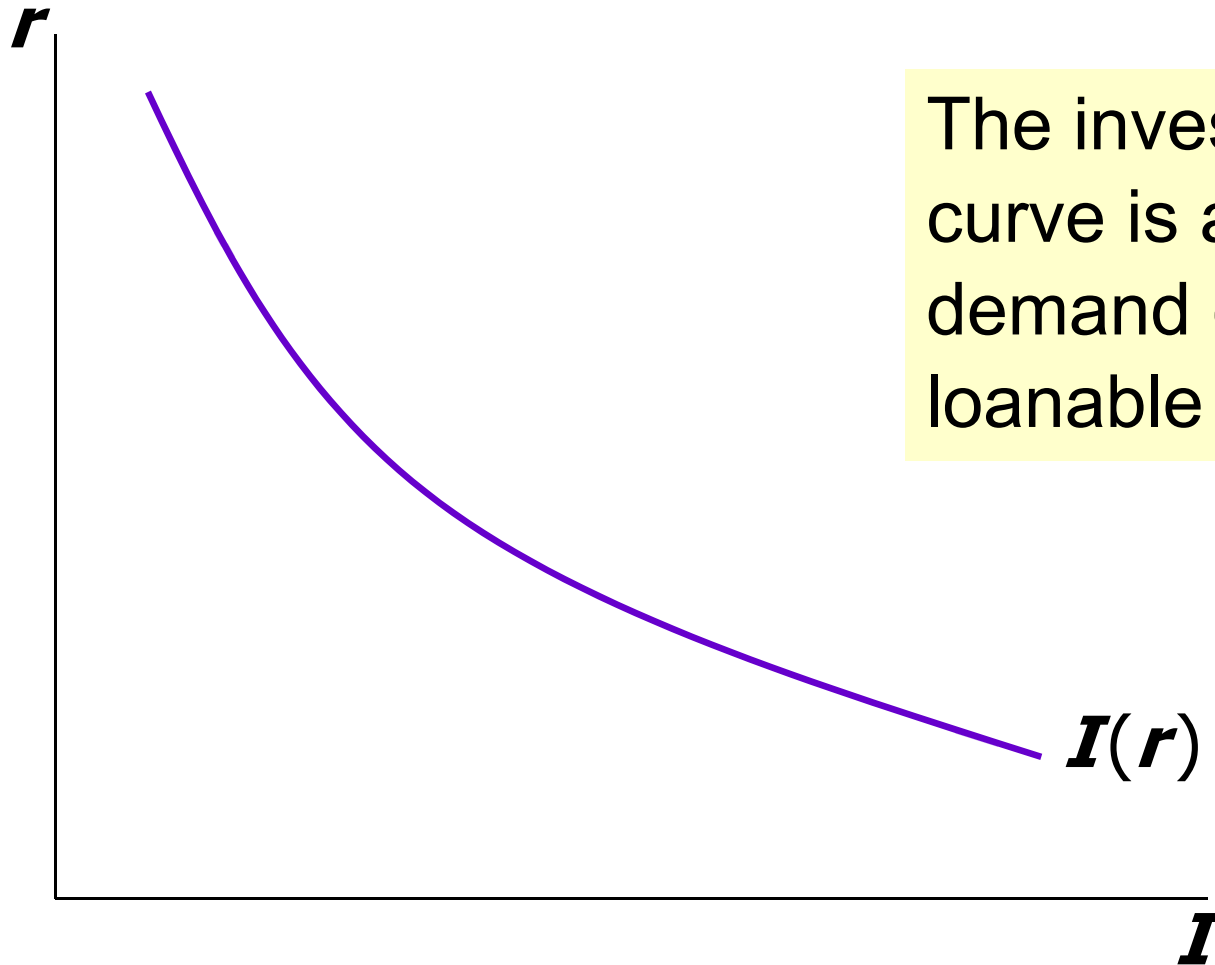
# Demand for funds: Investment

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

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

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

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

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

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

$$= Y - C - G$$



## ***Notation:* $\Delta$ = change in a variable**

- For any variable  $X$ ,  $\Delta X$  = “the change in  $X$ ”  
 $\Delta$  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  $MPL = \frac{\Delta Y}{\Delta L}$ .

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

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





## EXERCISE:

# Calculate the change in saving

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

For each of the following, compute  $\Delta S$  :

a.  $\Delta G = 100$

b.  $\Delta T = 100$

c.  $\Delta Y = 100$

d.  $\Delta L = 10$



## *Answers*

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

a.  $\Delta \mathbf{S} = -100$

b.  $\Delta \mathbf{S} = 0.8 \times 100 = 80$

c.  $\Delta \mathbf{S} = 0.2 \times 100 = 20$

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

$$\Delta \mathbf{S} = 0.2 \times \Delta \mathbf{Y} = 0.2 \times 200 = 40.$$



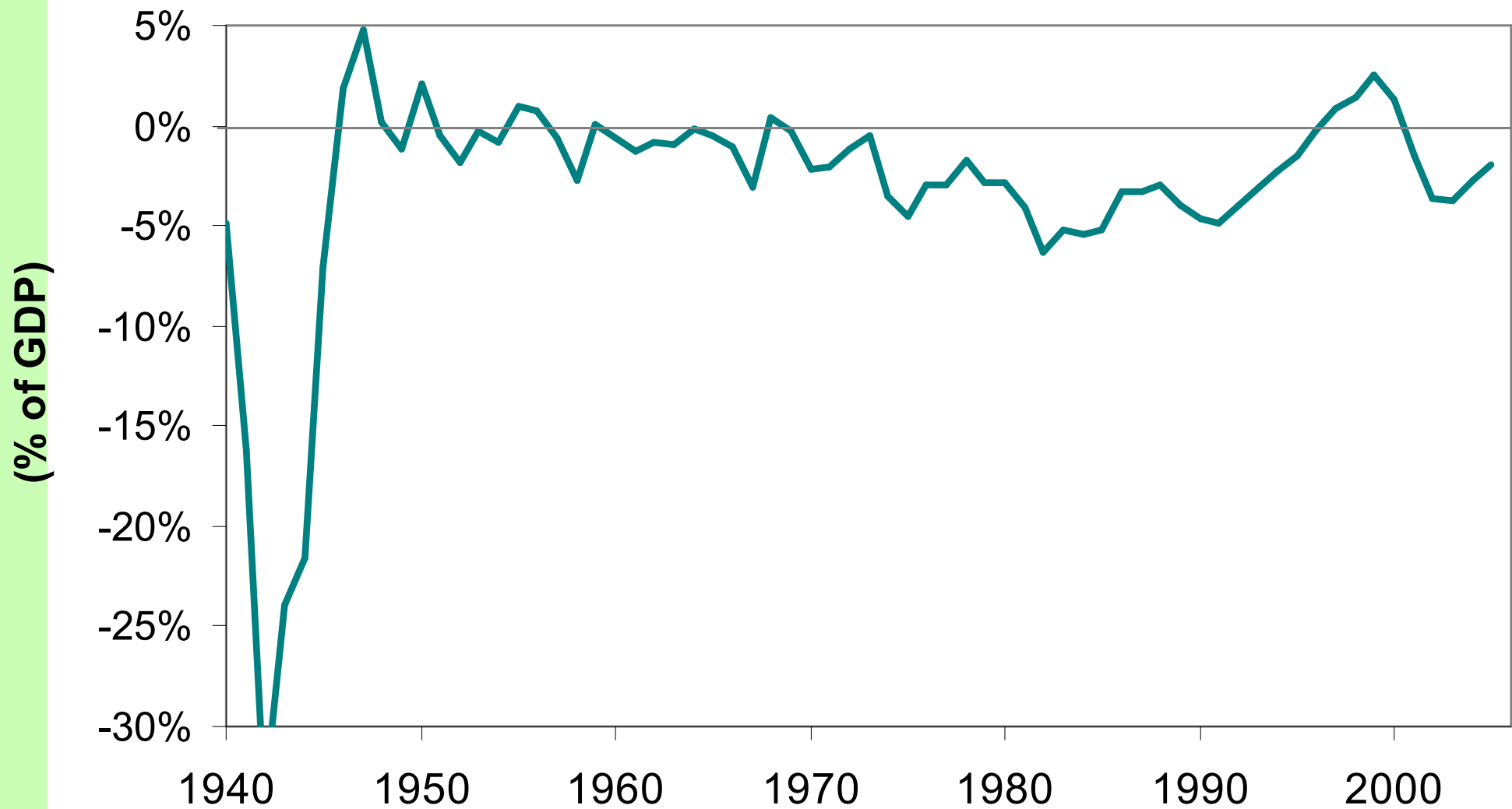
*digression:*

## 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.



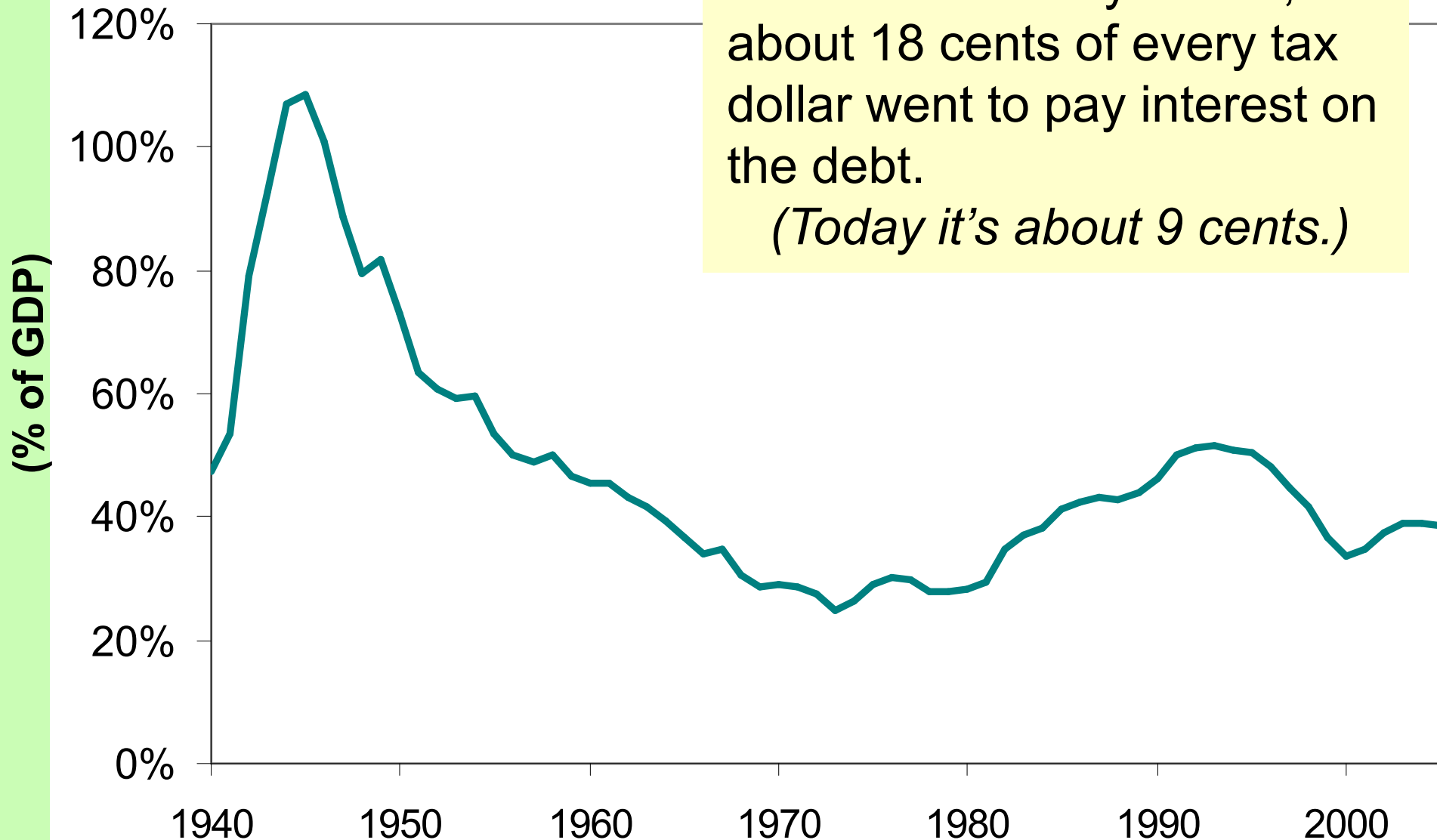
# U.S. Federal Government Surplus/Deficit, 1940-2005





# U.S. Federal Government Debt, 1940-2005

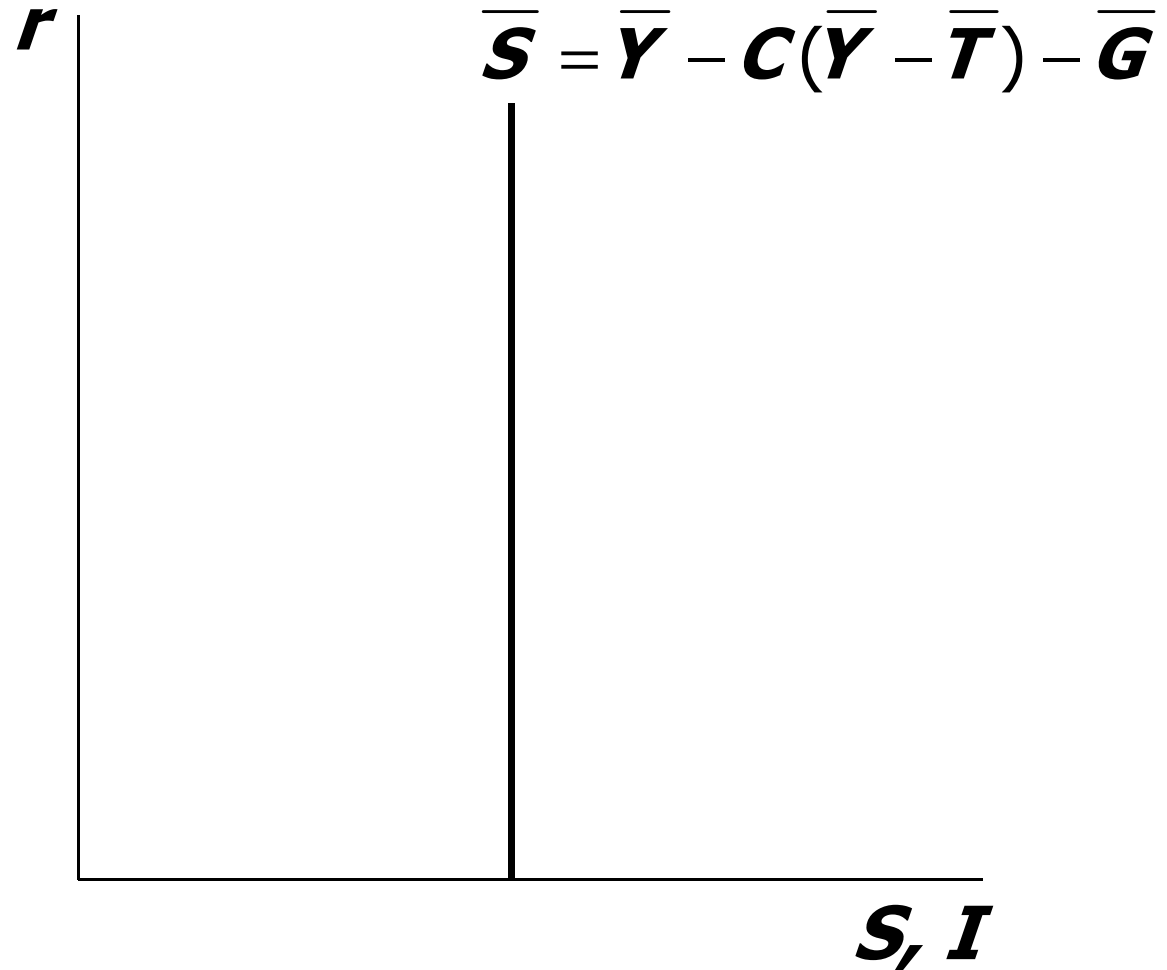
**Fact:** In the early 1990s,  
about 18 cents of every tax  
dollar went to pay interest on  
the debt.  
*(Today it's about 9 cents.)*





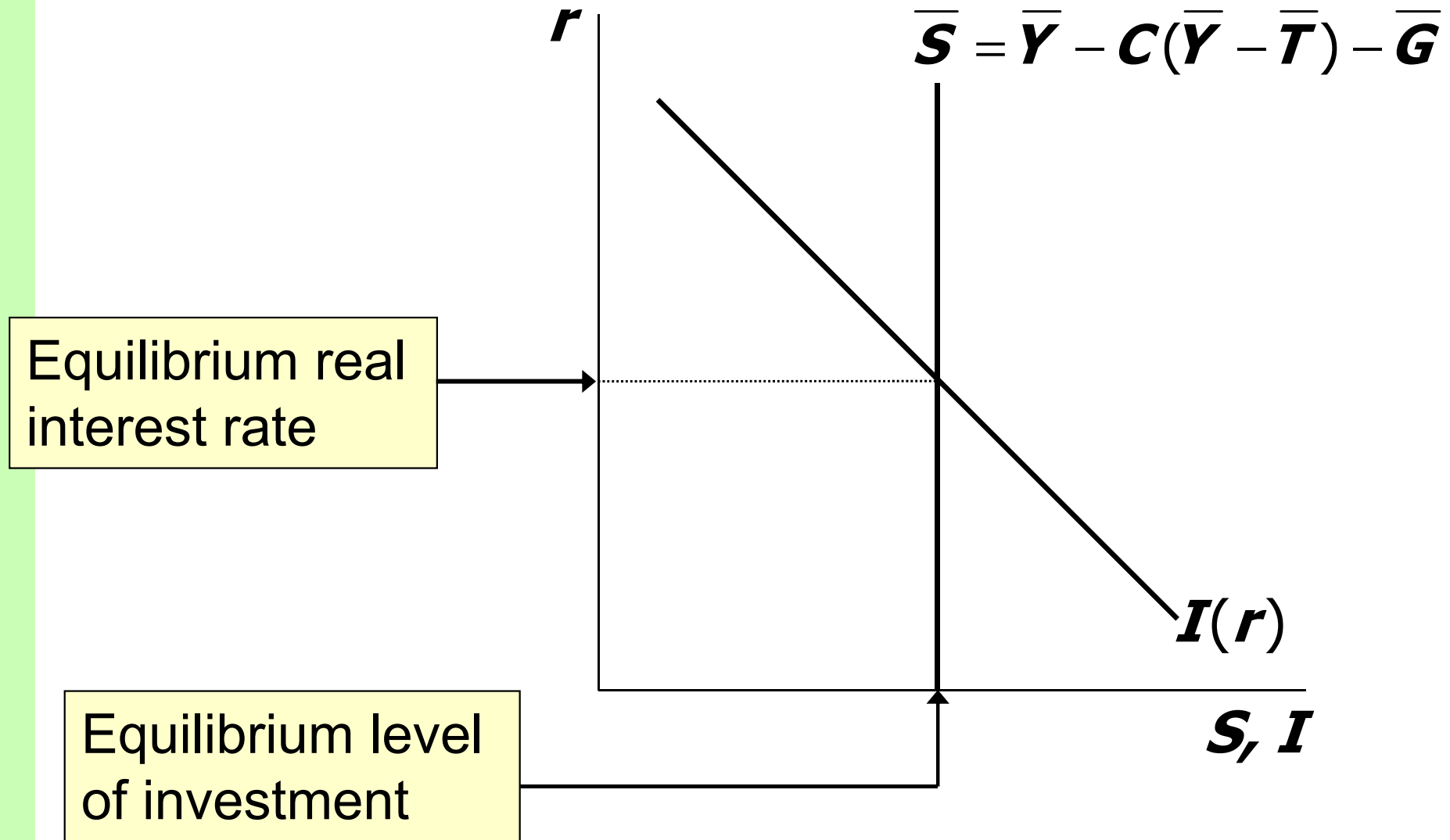
# Loanable funds supply curve

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

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

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:

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

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

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

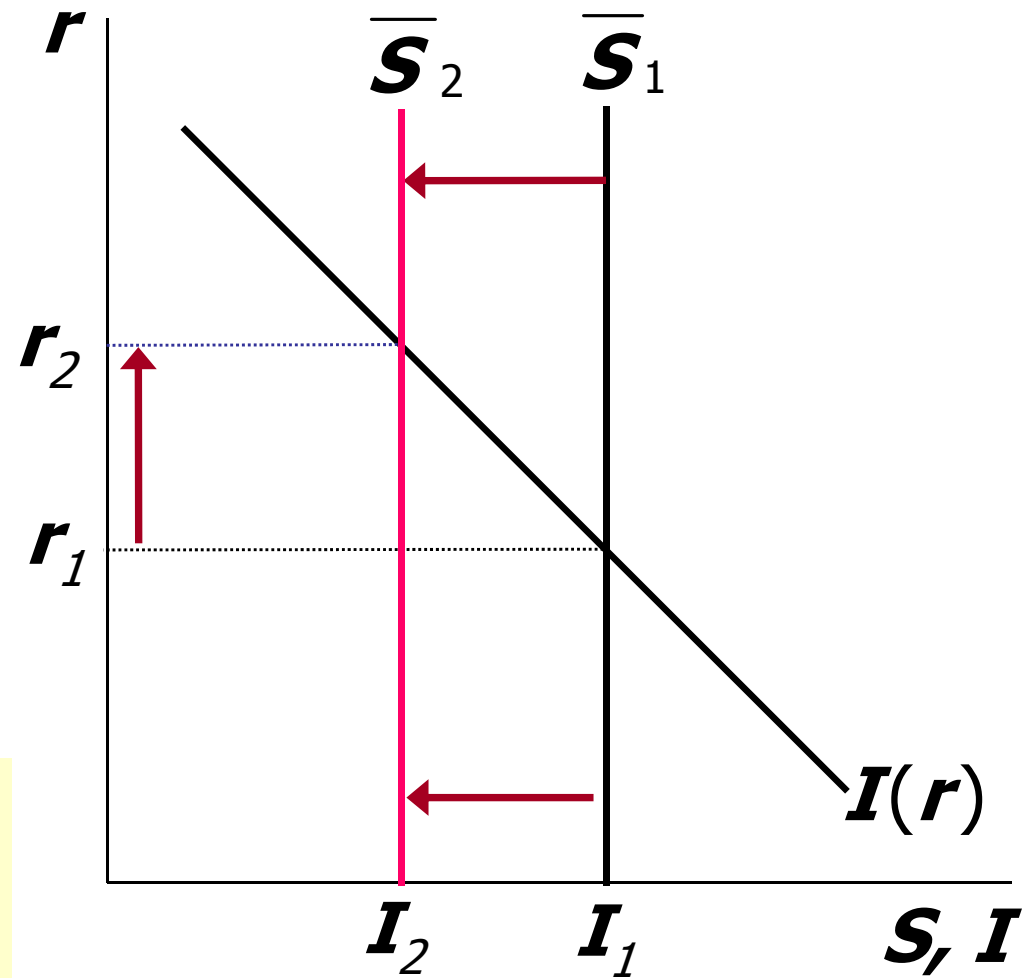


# CASE STUDY: The Reagan deficits

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>
<b><i>T – G</i></b>	–2.2	–3.9
<b><i>S</i></b>	19.6	17.4
<b><i>r</i></b>	1.1	6.3
<b><i>I</i></b>	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...*

- 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

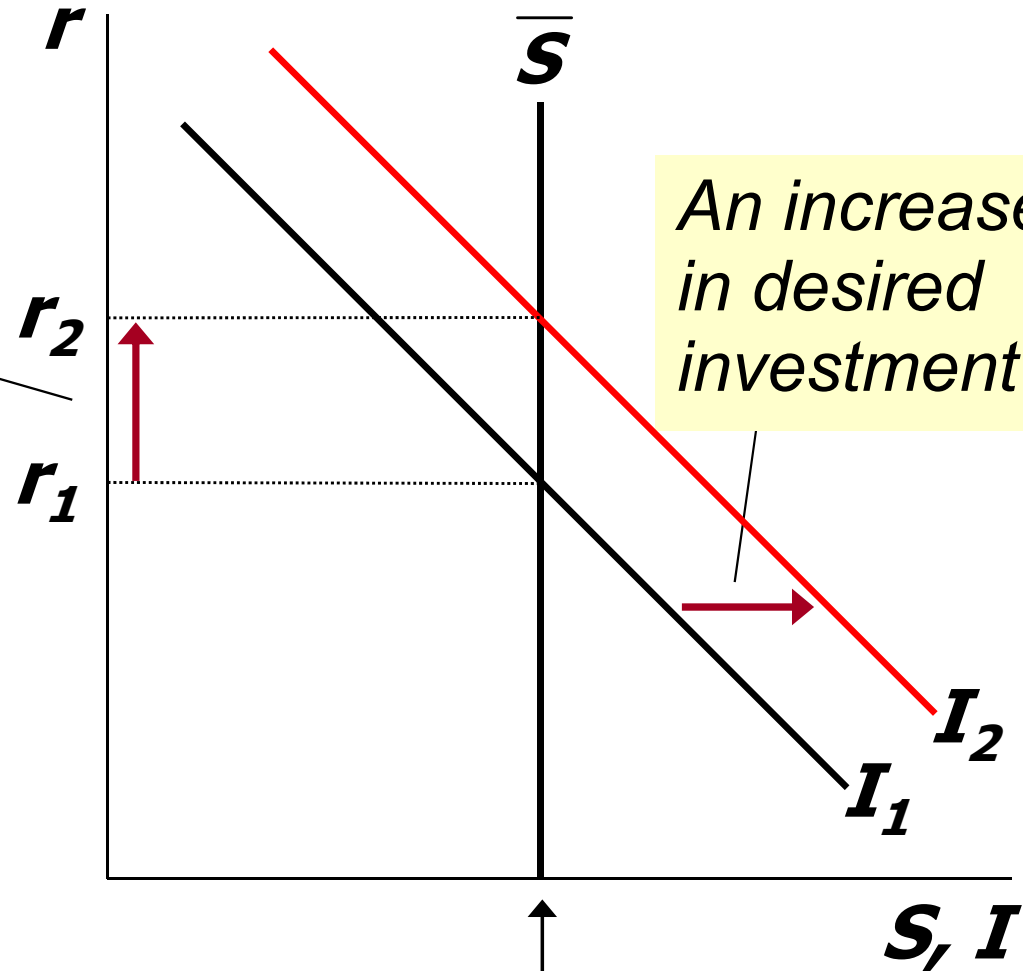
- some technological innovations
  - to take advantage of the innovation, firms must buy new investment goods
- tax laws that affect investment
  - investment tax credit



# An increase in investment demand

...raises the interest rate.

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







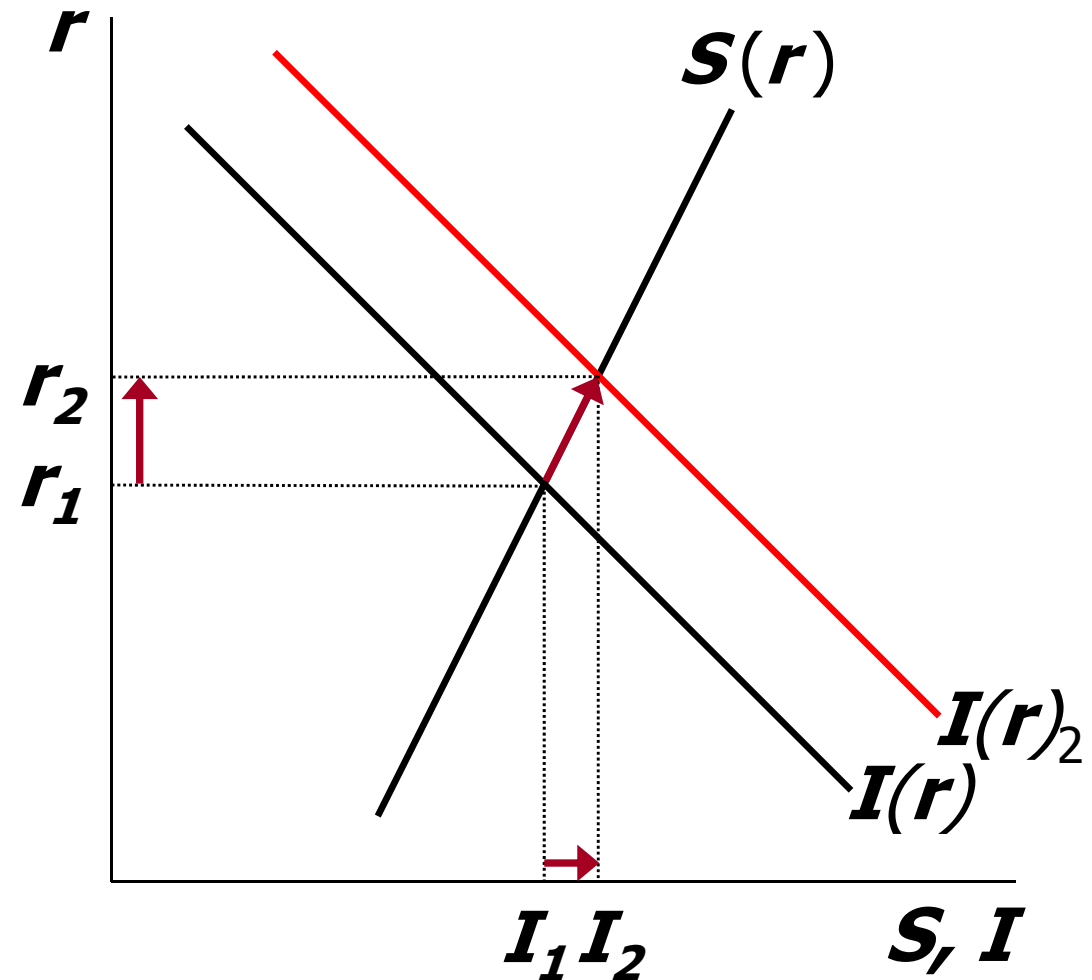
# Saving and the interest rate

- 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 $r$

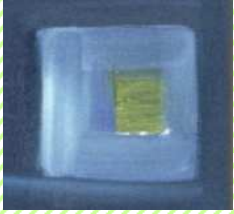
An increase in investment demand raises  $r$ , which induces an increase in the quantity of saving, which allows  $I$  to increase.





# 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.