CHAPTER 3

National Income: Where it Comes From and Where it Goes

MACROECONOMICS SIXTH EDITION

N. GREGORY MANKIW

PowerPoint® Slides by Ron Cronovich

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

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

Assumptions of the model

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

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

Determining GDP

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

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

Notation

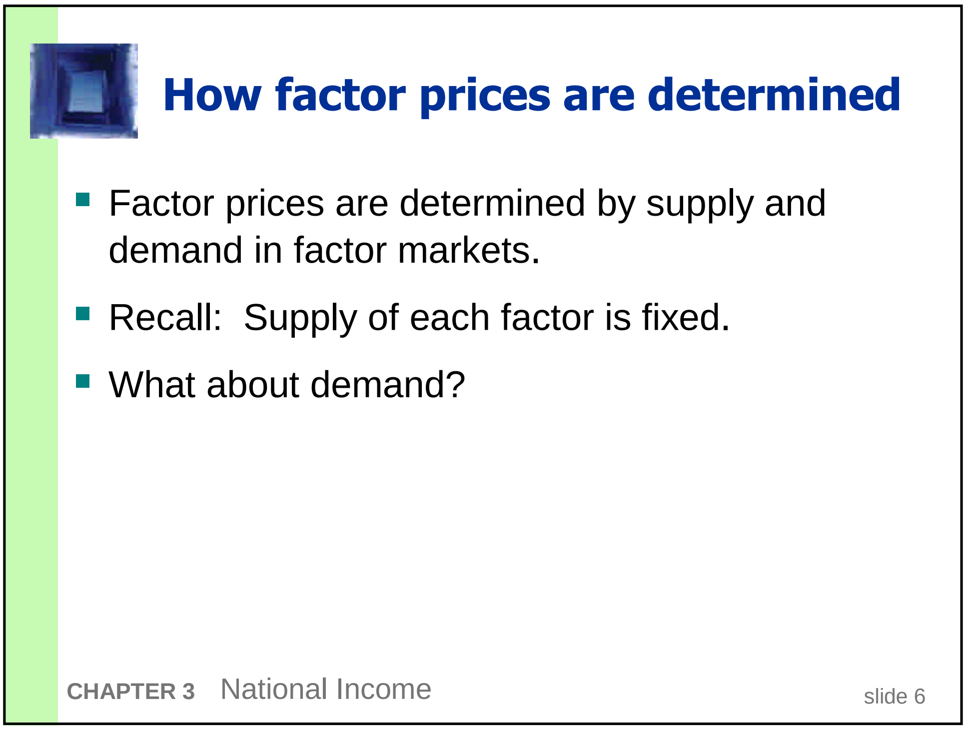
W = nominal wage

R = nominal rental rate

P = price of output

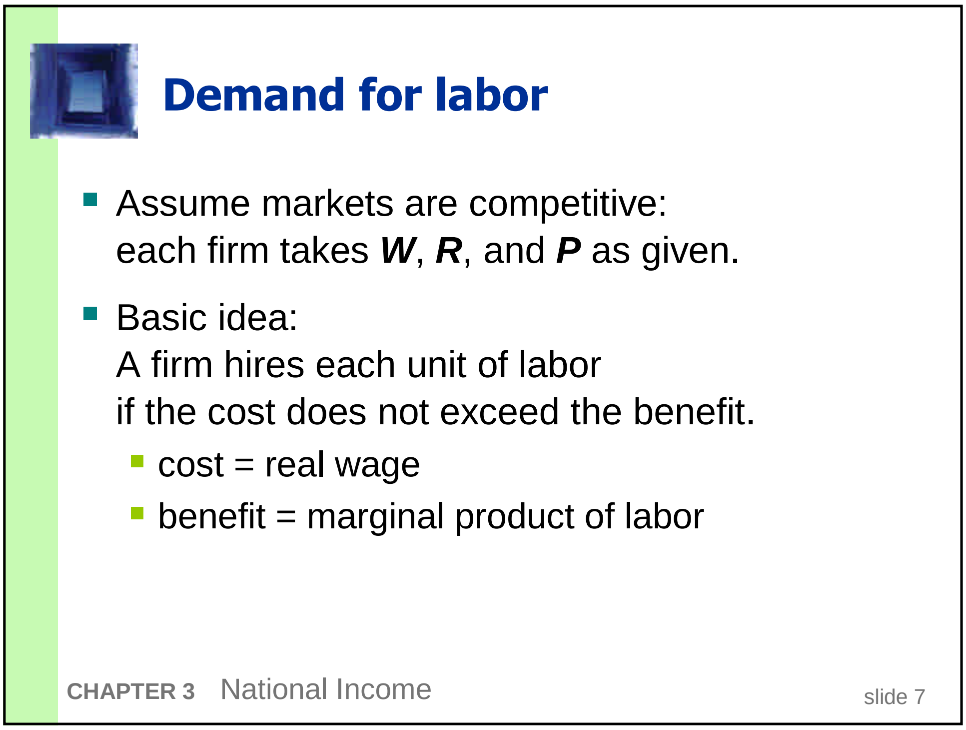
W/P = real wage
(measured in units of output)

R/P = real rental rate



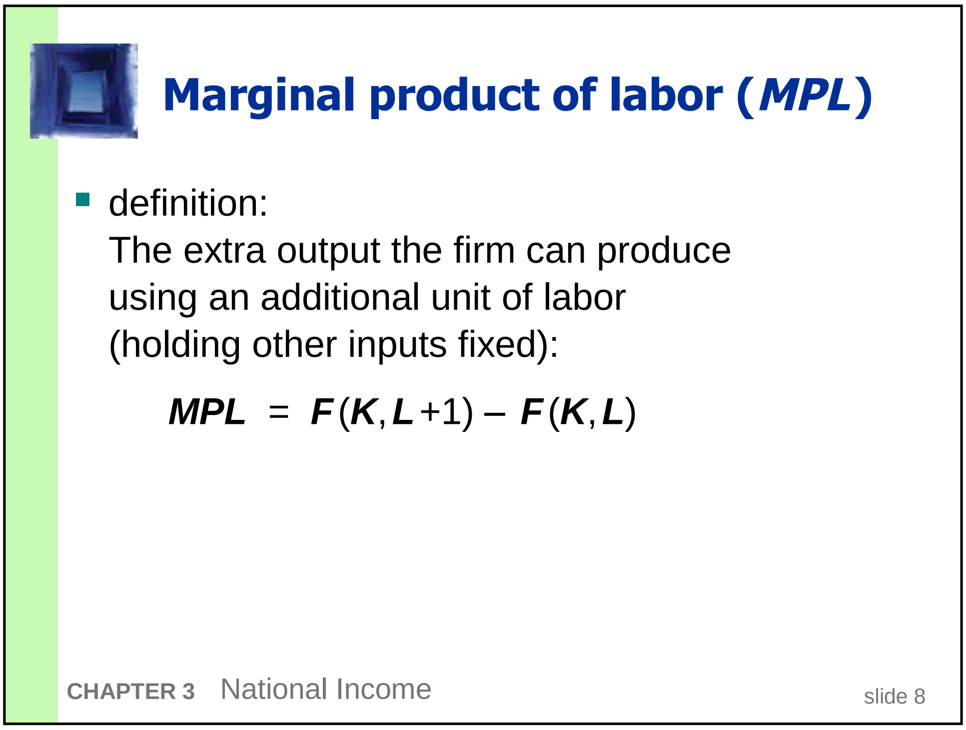
How factor prices are determined

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



Demand for labor

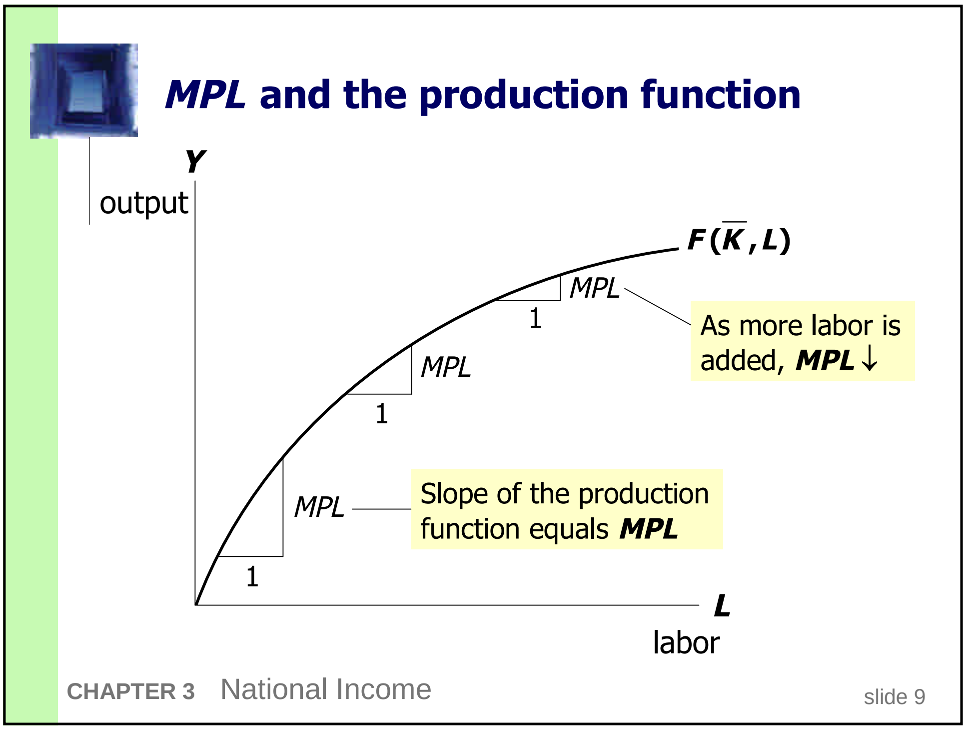
- Assume markets are competitive:
  each firm takes ***W***, ***R***, and ***P*** as given.
- Basic idea:
  A firm hires each unit of labor
  if the cost does not exceed the benefit.
  - cost = real wage
  - benefit = marginal product of labor



Marginal product of labor (*MPL*)

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

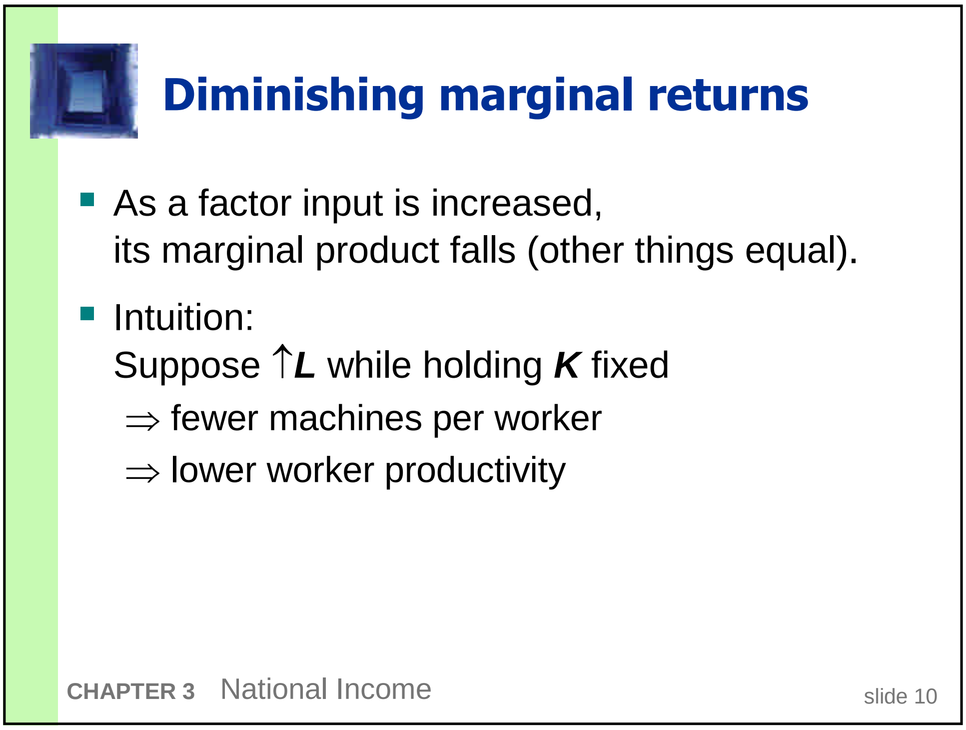
$$MPL = F(K, L+1) - F(K, L)$$



MPL and the production function

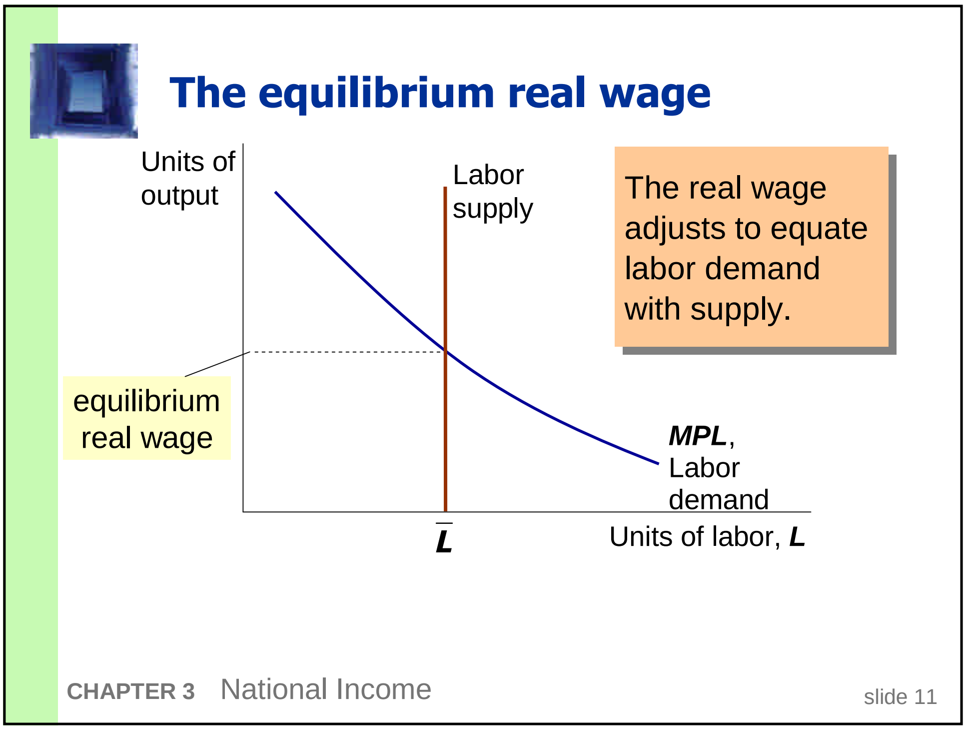
As more labor is added, ***MPL*** ↓

Slope of the production function equals ***MPL***



Diminishing marginal returns

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



The equilibrium real wage

The real wage adjusts to equate labor demand with supply.

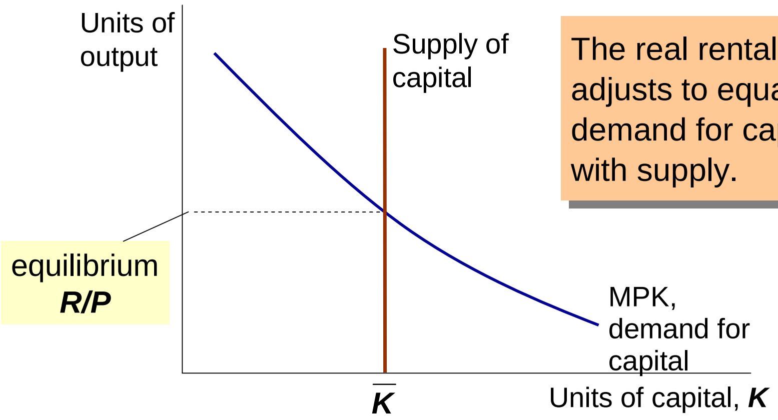
Determining the rental rate

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

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

- diminishing returns to capital: ***MPK***↓ as ***K***↑
- 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.

How income is distributed:

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

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

Demand for goods & services

Components of aggregate demand:

C = consumer demand for g & s

I = demand for investment goods

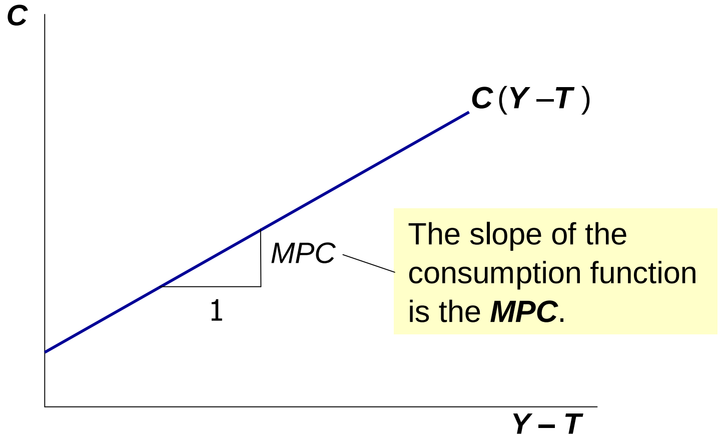
G = government demand for g & s

(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



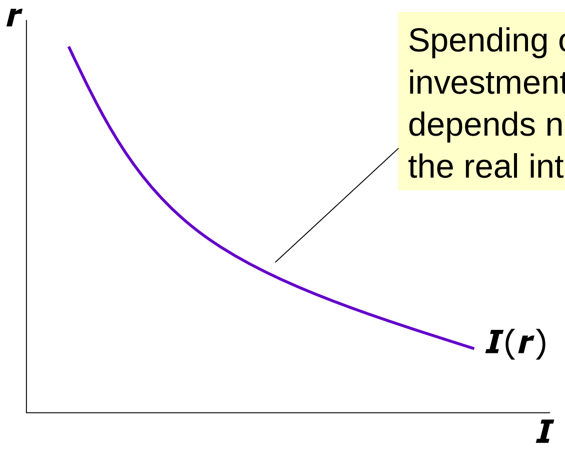
The slope of the consumption function is the ***MPC***.

Investment, *I*

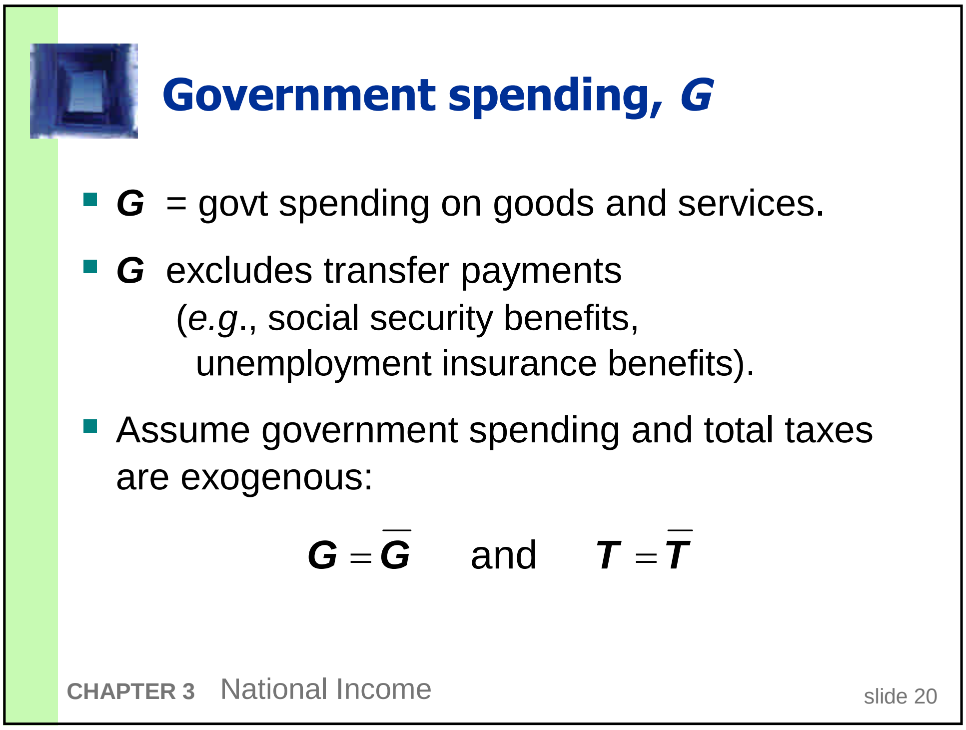
- The investment function is $I = I(r)$,
  where r denotes the **real interest rate**,
  the nominal interest rate corrected for inflation.
- The real interest rate is
  - the cost of borrowing
  - the opportunity cost of using one's own funds to finance investment spending.

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

The investment function



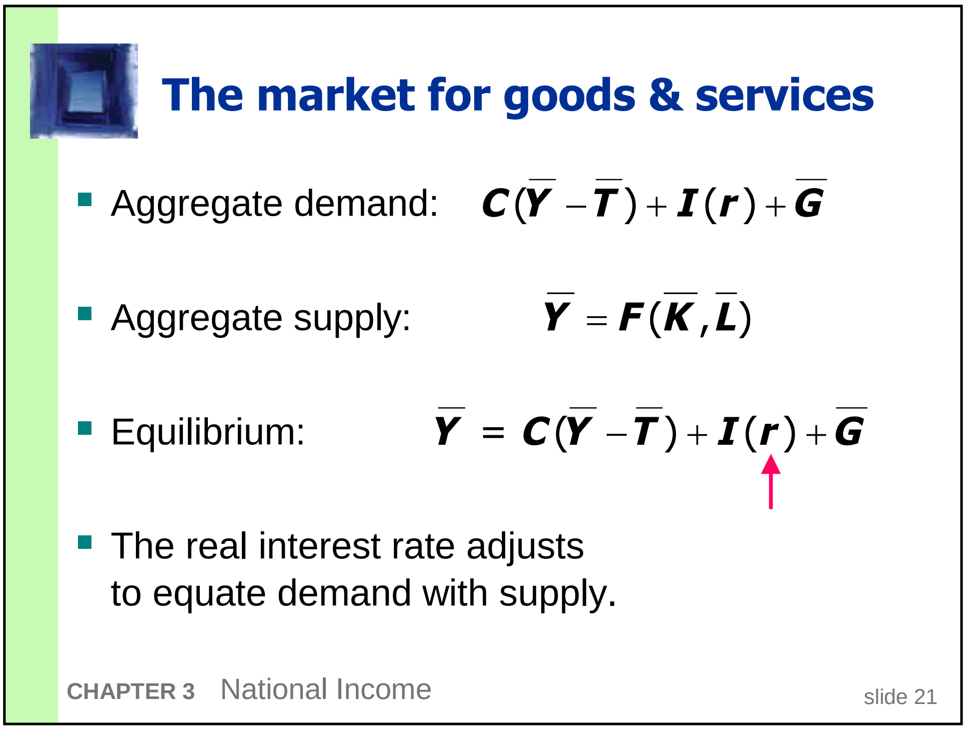
Spending on investment goods depends negatively on the real interest rate.



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:

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



The market for goods & services

- Aggregate demand: $C(\overline{Y} - \overline{T}) + I(r) + \overline{G}$
- Aggregate supply: $\overline{Y} = F(\overline{K}, \overline{L})$
- Equilibrium: $\overline{Y} = C(\overline{Y} - \overline{T}) + I(\underset{\uparrow}{r}) + \overline{G}$
- The real interest rate adjusts
  to equate demand with supply.

The loanable funds market

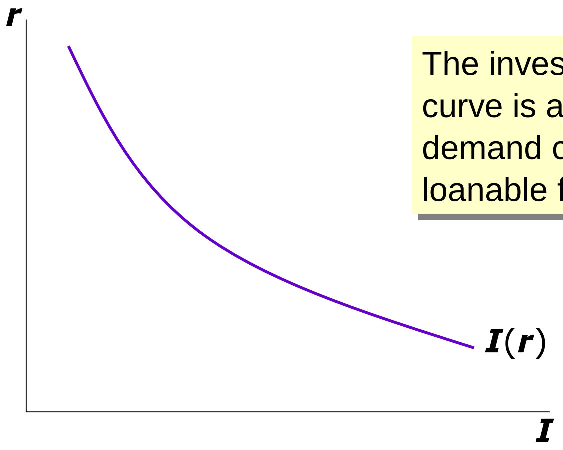
- A simple supply-demand model of the financial system.
- One asset: “loanable funds”
  - demand for funds: investment
  - supply of funds: saving
  - “price” of funds: real interest rate

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

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

public saving = $T - G$

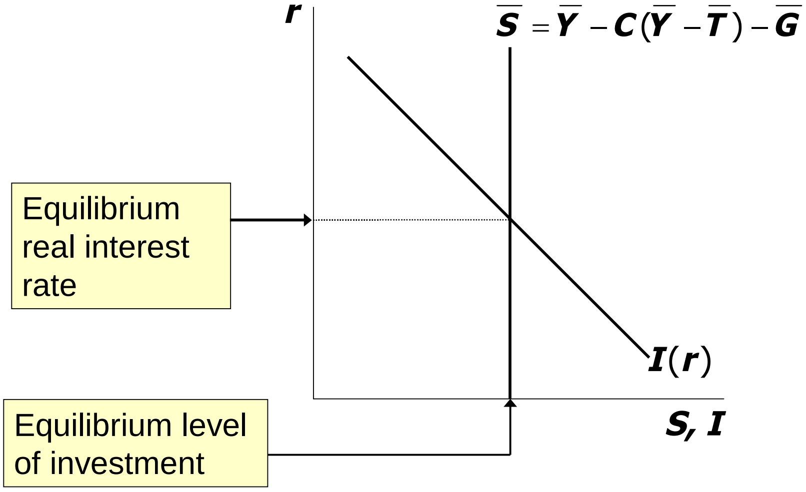
national saving, S

= private saving + public saving

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

$= Y - C - G$

Loanable funds market equilibrium



Equilibrium real interest rate

Equilibrium level of investment

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

$Y = C + I + G$ *(goods market eq'm)*

Thus, Eq'm in L.F. market $\Leftrightarrow$ Eq'm in goods market

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CASE STUDY:
The Reagan deficits

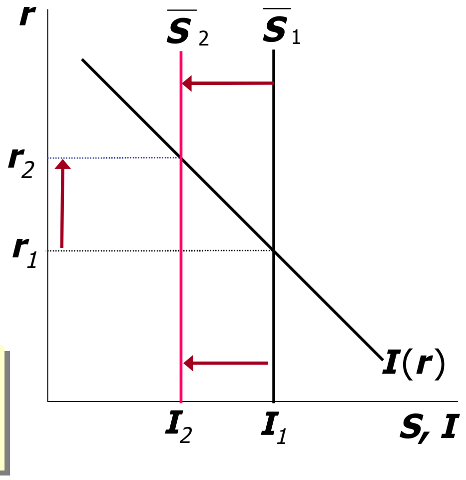
- Reagan policies during early 1980s:
  - increases in defense spending: $\Delta G > 0$
  - big tax cuts: $\Delta T < 0$
- Both policies reduce national saving:

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

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

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?

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

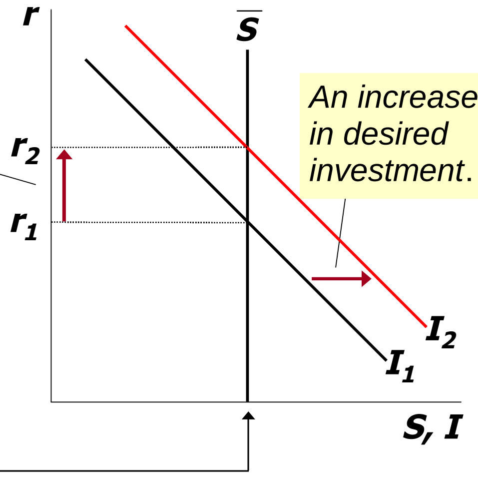
$T–G$, S, and I are expressed as a percent of GDP
All figures are averages over the decade shown.

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

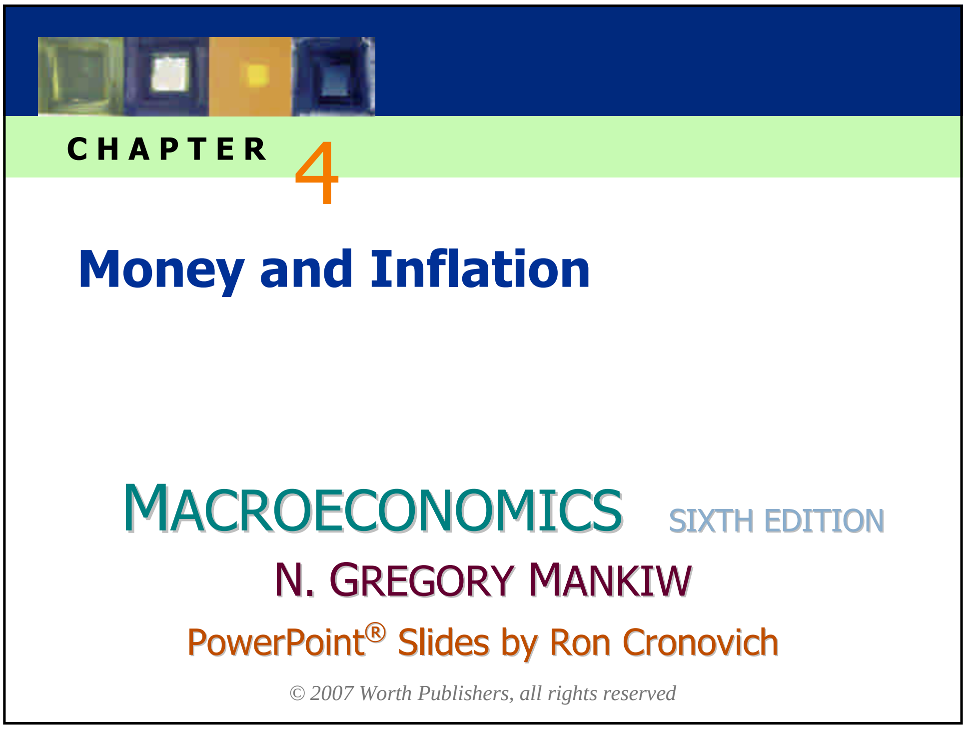
An increase in investment demand



…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.



CHAPTER 4

Money and Inflation

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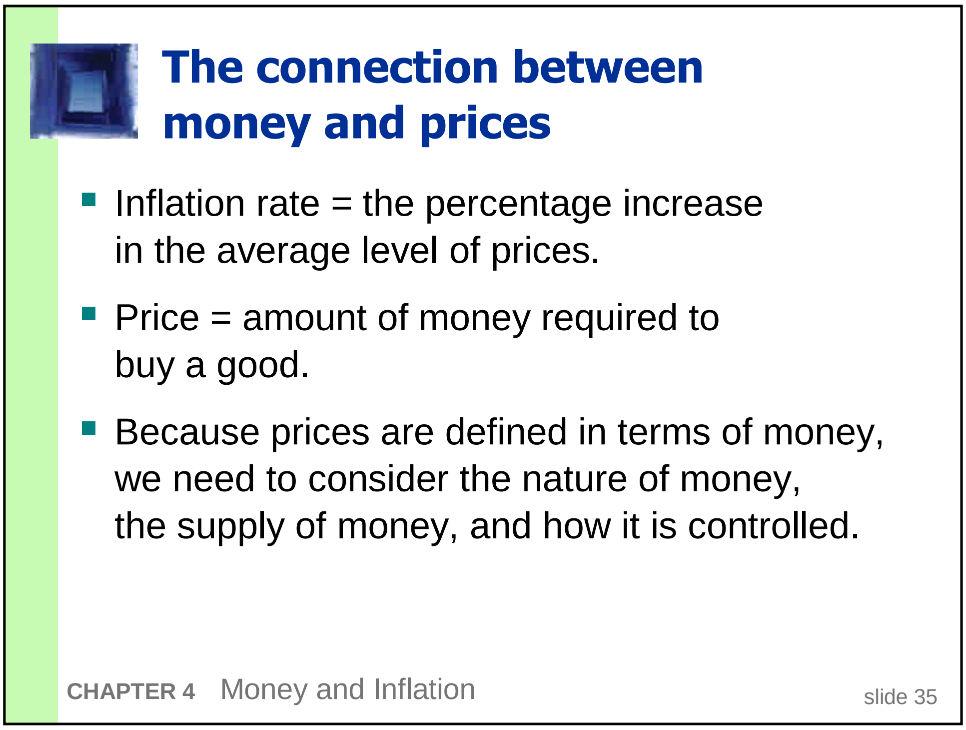


The connection between money and prices

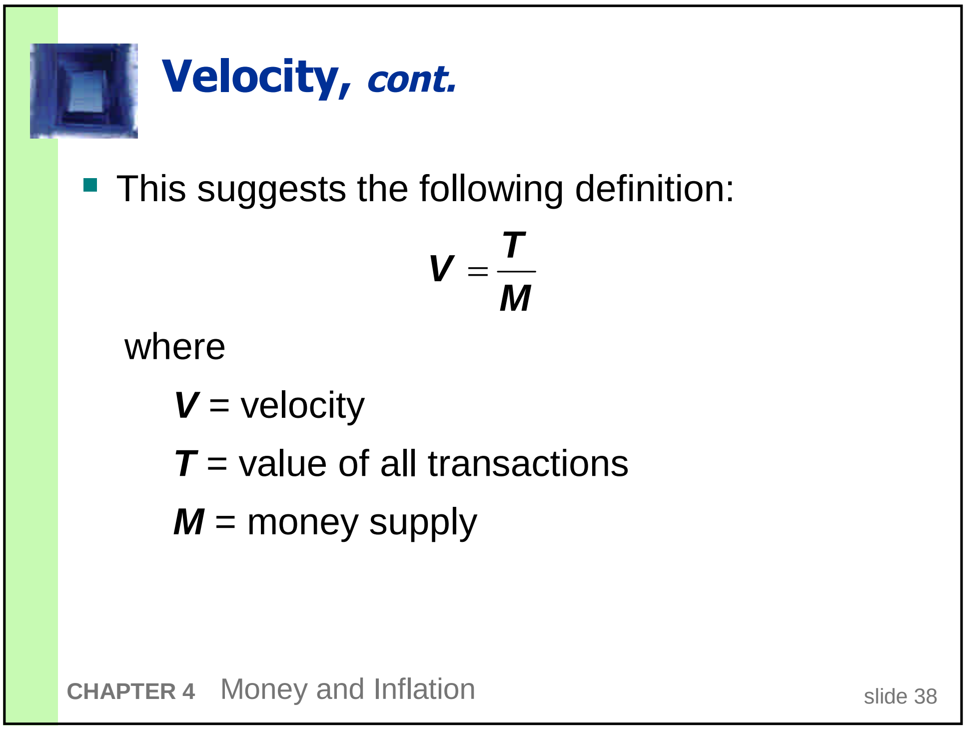
- Inflation rate = the percentage increase in the average level of prices.
- Price = amount of money required to buy a good.
- Because prices are defined in terms of money, we need to consider the nature of money, the supply of money, and how it is controlled.

The Quantity Theory of Money

- A simple theory linking the inflation rate to the growth rate of the money supply.
- Begins with the concept of **velocity**…

Velocity

- basic concept: the rate at which money circulates
- definition: the number of times the average dollar bill changes hands in a given time period
- example: In 2007,
  - $500 billion in transactions
  - money supply = $100 billion
  - The average dollar is used in five transactions in 2007
  - So, velocity = 5



Velocity, *cont.*

- This suggests the following definition:

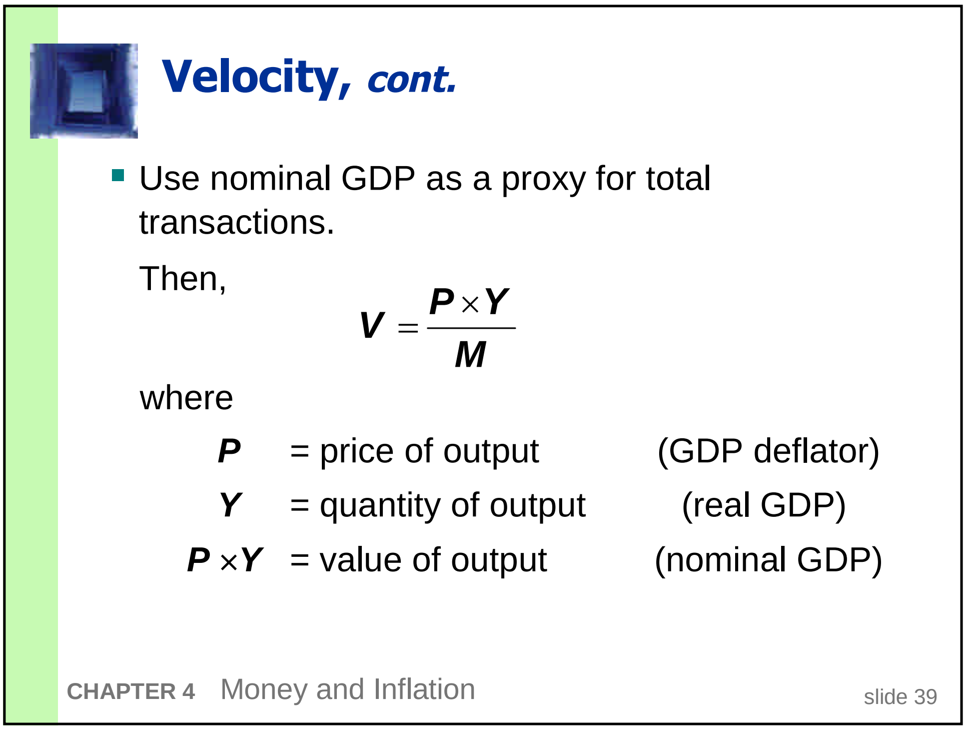
$$V = \frac{T}{M}$$

where

V = velocity

T = value of all transactions

M = money supply



Velocity, *cont.*

- Use nominal GDP as a proxy for total transactions.

Then,

$$V = \frac{P \times Y}{M}$$

where

P = price of output (GDP deflator)

Y = quantity of output (real GDP)

$P \times Y$ = value of output (nominal GDP)

The quantity equation

- The **quantity equation**

$$M \times V = P \times Y$$

  follows from the preceding definition of velocity.

- It is an *identity:*
  it holds by definition of the variables.

Money demand and the quantity equation

- M/P = **real money balances**, the purchasing power of the money supply.

- A simple money demand function:

$$(M/P)^d = kY$$

  where

  k = how much money people wish to hold for each dollar of income.

  (k is exogenous)

Money demand and the quantity equation

- money demand: $(\boldsymbol{M}/\boldsymbol{P})^d = \boldsymbol{kY}$
- quantity equation: $\boldsymbol{M} \times \boldsymbol{V} = \boldsymbol{P} \times \boldsymbol{Y}$
- The connection between them: $\boldsymbol{k} = 1/\boldsymbol{V}$
- When people hold lots of money relative to their incomes (***k*** is high), money changes hands infrequently (***V*** is low).

Back to the quantity theory of money

- starts with quantity equation
- assumes ***V*** is constant & exogenous: $\boldsymbol{V} = \overline{\boldsymbol{V}}$
- With this assumption, the quantity equation can be written as

$$\boldsymbol{M} \times \overline{\boldsymbol{V}} = \boldsymbol{P} \times \boldsymbol{Y}$$

The quantity theory of money, *cont.*

$$\boldsymbol{M \times \overline{V} = P \times Y}$$

How the price level is determined:

- With ***V*** constant, the money supply determines nominal GDP (***P*** × ***Y***).
- Real GDP is determined by the economy's supplies of ***K*** and ***L*** and the production function (Chap 3).
- The price level is
  P = (nominal GDP)/(real GDP).

The quantity theory of money, *cont.*

π (Greek letter "pi") denotes the inflation rate:

$$\pi = \frac{\Delta P}{P}$$

The result from the preceding slide was:

$$\frac{\Delta M}{M} = \frac{\Delta P}{P} + \frac{\Delta Y}{Y}$$

Solve this result for π to get

$$\boxed{\pi = \frac{\Delta M}{M} - \frac{\Delta Y}{Y}}$$

The quantity theory of money, *cont.*

$$\pi = \frac{\Delta M}{M} - \frac{\Delta Y}{Y}$$

- Normal economic growth requires a certain amount of money supply growth to facilitate the growth in transactions.
- Money growth in excess of this amount leads to inflation.

The quantity theory of money, *cont.*

$$\pi = \frac{\Delta M}{M} - \frac{\Delta Y}{Y}$$

$\Delta Y/Y$ depends on growth in the factors of production and on technological progress (all of which we take as given, for now).

Hence, the Quantity Theory predicts a one-for-one relation between changes in the money growth rate and changes in the inflation rate.

Confronting the quantity theory with data

The quantity theory of money implies

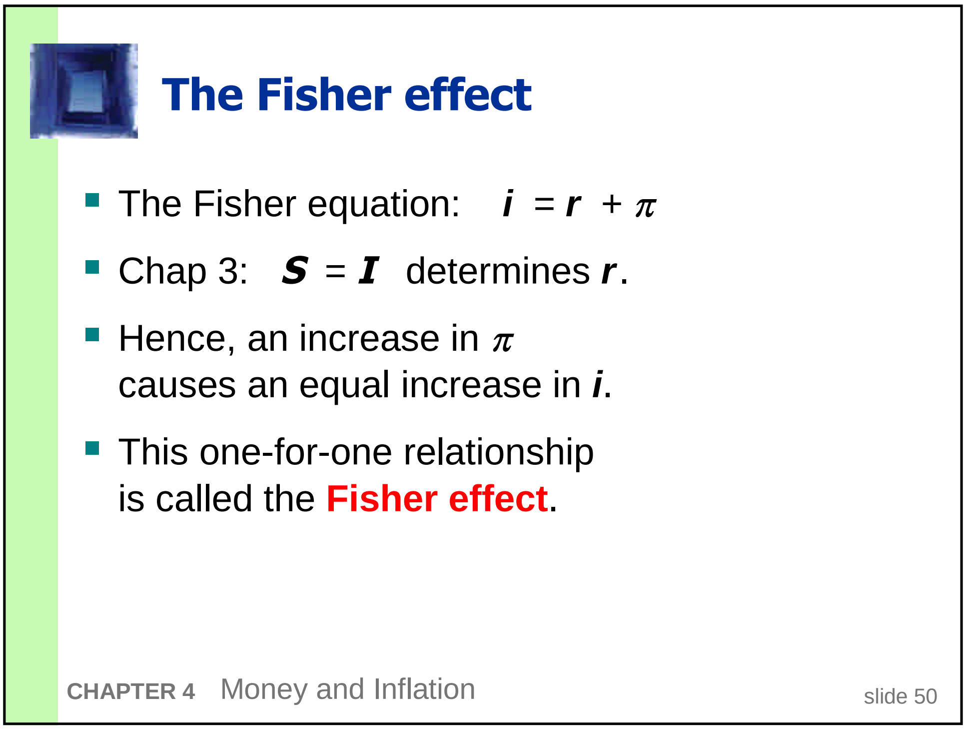
1. countries with higher money growth rates should have higher inflation rates.
2. the long-run trend behavior of a country's inflation should be similar to the long-run trend in the country's money growth rate.

Are the data consistent with these implications?

Inflation and interest rates

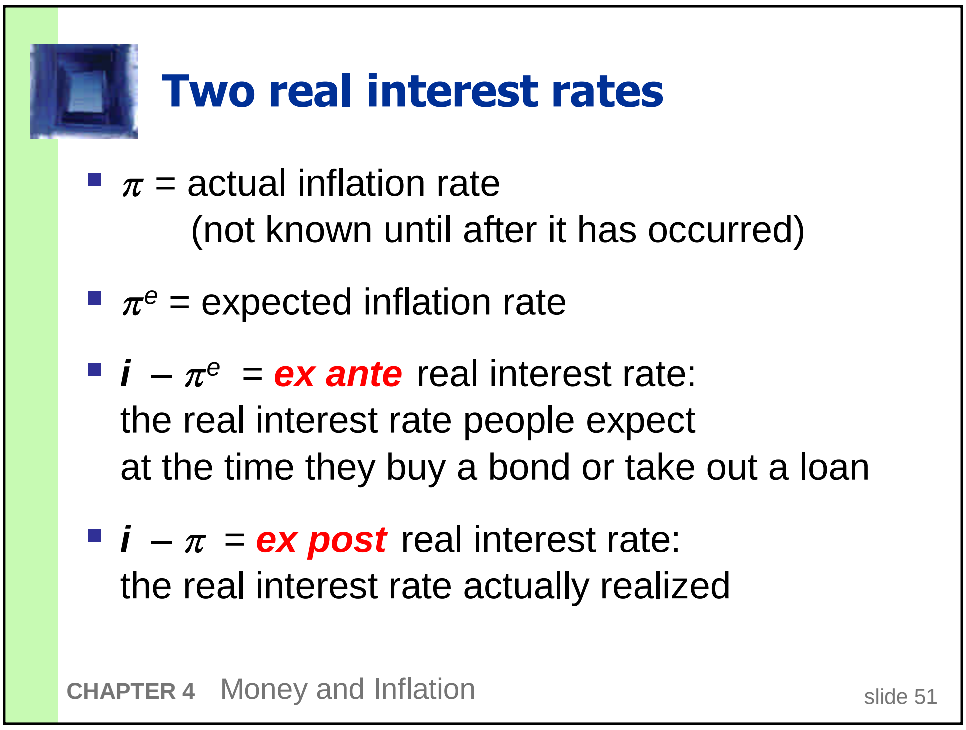
- Nominal interest rate, $\boldsymbol{i}$
  not adjusted for inflation
- Real interest rate, $\boldsymbol{r}$
  adjusted for inflation:

$$\boldsymbol{r} = \boldsymbol{i} - \pi$$



The Fisher effect

- The Fisher equation: $i = r + \pi$
- Chap 3: $S = I$ determines r.
- Hence, an increase in π causes an equal increase in i.
- This one-for-one relationship is called the **Fisher effect**.



Two real interest rates

- π = actual inflation rate
  (not known until after it has occurred)
- π^e = expected inflation rate
- $i - \pi^e$ = ***ex ante*** real interest rate:
  the real interest rate people expect
  at the time they buy a bond or take out a loan
- $i - \pi$ = ***ex post*** real interest rate:
  the real interest rate actually realized

Money demand and the nominal interest rate

- In the quantity theory of money, the demand for real money balances depends only on real income ***Y***.
- Another determinant of money demand: the nominal interest rate, ***i***.
  - the opportunity cost of holding money (instead of bonds or other interest-earning assets).
- Hence, ↑***i*** ⇒ ↓ in money demand.

The money demand function

$$(M/P)^d = L(i, Y)$$

$(M/P)^d$ = real money demand, depends

- negatively on ***i***

  i is the opp. cost of holding money
- positively on ***Y***

  higher ***Y*** ⇒ more spending

  ⇒ so, need more money

("***L***" is used for the money demand function because money is the most liquid asset.)

The money demand function

$$(M/P)^d = L(i, Y)$$

$$= L(r + \pi^e, Y)$$

When people are deciding whether to hold money or bonds, they don't know what inflation will turn out to be.

Hence, the nominal interest rate relevant for money demand is $r + \pi^e$.

What determines what

$$\frac{M}{P} = L(r + \pi^e, Y)$$

variable	how determined *(in the long run)*
M	exogenous (the Fed)
r	adjusts to make $S = I$
Y	$\overline{Y} = F(\overline{K}, \overline{L})$
P	adjusts to make $\frac{M}{P} = L(i, Y)$

How P responds to ΔM

$$\frac{M}{P} = L(r + \pi^e, Y)$$

- For given values of r, Y, and π^e, a change in M causes P to change by the same percentage – just like in the quantity theory of money.

How P responds to $\Delta\pi^e$

$$\frac{M}{P} = L(r + \pi^e, Y)$$

- For given values of r, Y, and M ,

$$\uparrow \pi^e \;\Rightarrow\; \uparrow i \text{ (the Fisher effect)}$$

$$\Rightarrow\; \downarrow (M/P)^{\text{d}}$$

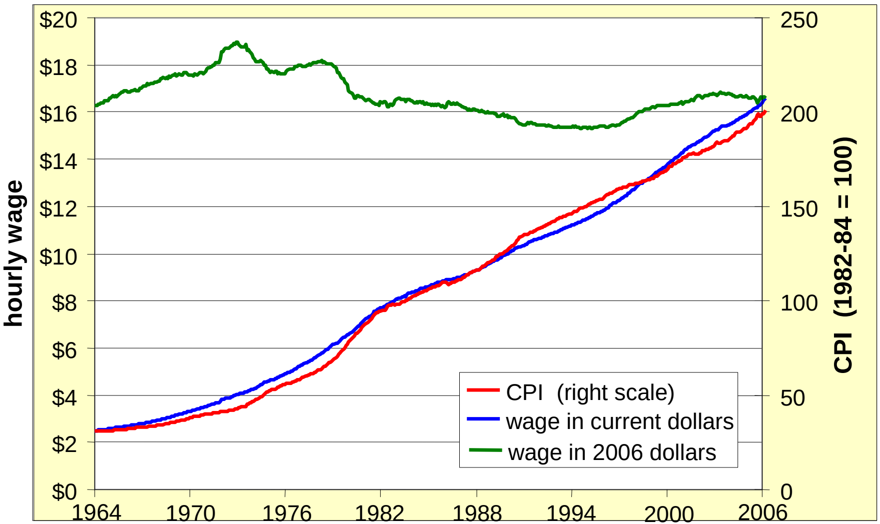
$$\Rightarrow\; \uparrow P \text{ to make } (M/P) \text{ fall}$$

to re-establish eq'm

A common misperception

- Common misperception:
  inflation reduces real wages
- This is true only in the short run, when nominal wages are fixed by contracts.
- (Chap. 3) In the long run,
  the real wage is determined by
  labor supply and the marginal product of labor,
  not the price level or inflation rate.
- Consider the data…

Average hourly earnings and the CPI, 1964-2006



The classical view of inflation

- *The classical view:*
  A change in the price level is merely a change in the units of measurement.

One benefit of inflation

- Nominal wages are rarely reduced, even when the equilibrium real wage falls.
  This hinders labor market clearing.
- Inflation allows the real wages to reach equilibrium levels without nominal wage cuts.
- Therefore, moderate inflation improves the functioning of labor markets.

The Classical Dichotomy

Real variables: Measured in physical units – quantities and relative prices, *for example:*

- quantity of output produced
- real wage: output earned per hour of work
- real interest rate: output earned in the future by lending one unit of output today

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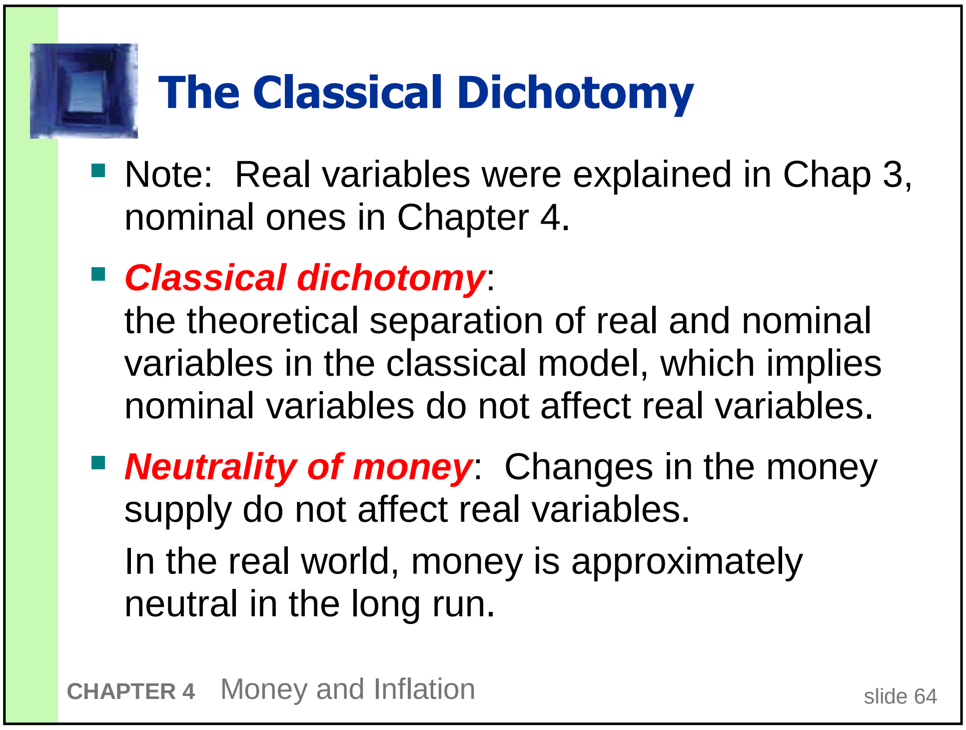
The Classical Dichotomy

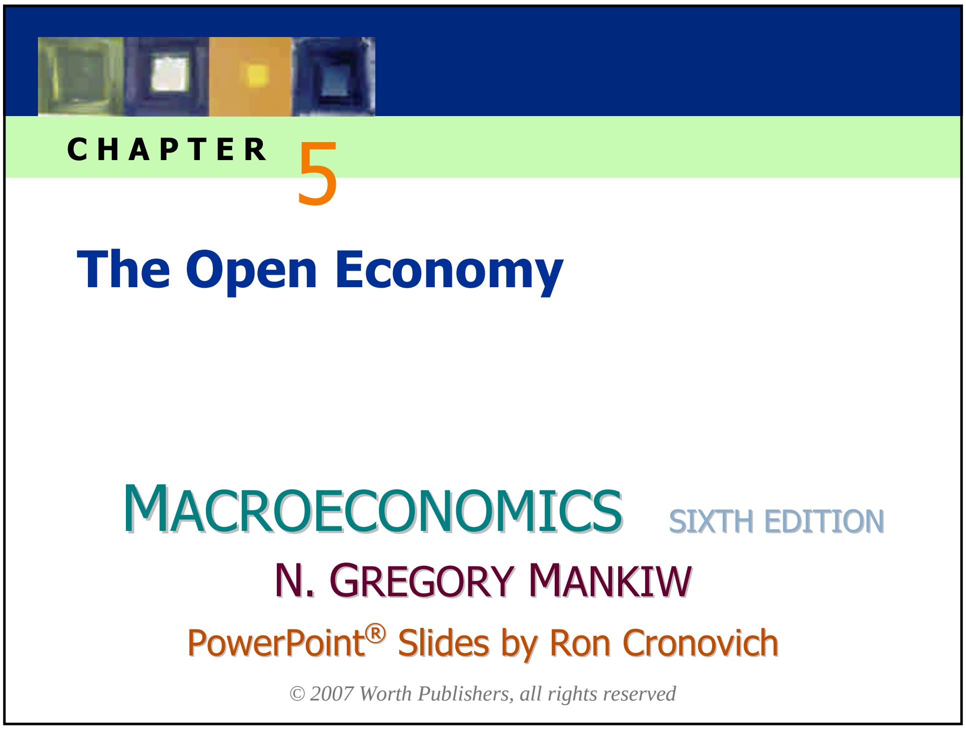
Nominal variables: Measured in money units, *e.g.,*

- nominal wage: Dollars per hour of work.
- nominal interest rate: Dollars earned in future by lending one dollar today.
- the price level: The amount of dollars needed to buy a representative basket of goods.



The Classical Dichotomy

- Note: Real variables were explained in Chap 3, nominal ones in Chapter 4.
- ***Classical dichotomy***:
  the theoretical separation of real and nominal variables in the classical model, which implies nominal variables do not affect real variables.
- ***Neutrality of money***: Changes in the money supply do not affect real variables.
  In the real world, money is approximately neutral in the long run.



CHAPTER 5

The Open Economy

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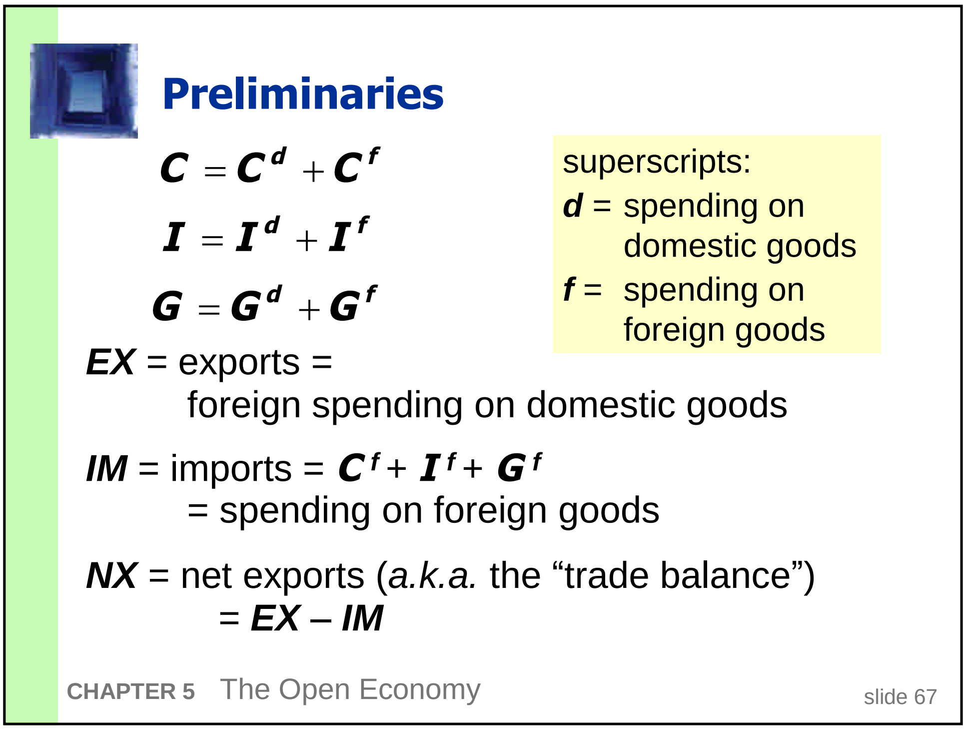
In an open economy,

- spending need not equal output
- saving need not equal investment



Preliminaries

$$C = C^d + C^f$$

$$I = I^d + I^f$$

$$G = G^d + G^f$$

superscripts:
d = spending on domestic goods
f = spending on foreign goods

EX = exports =
foreign spending on domestic goods

IM = imports = $C^f + I^f + G^f$
= spending on foreign goods

NX = net exports (*a.k.a.* the "trade balance")
= ***EX – IM***

GDP = expenditure on domestically produced g & s

$$Y = C^d + I^d + G^d + EX$$

$$= (C - C^f) + (I - I^f) + (G - G^f) + EX$$

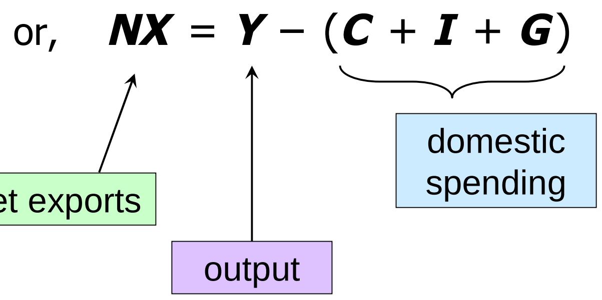
$$= C + I + G + EX - (C^f + I^f + G^f)$$

$$= C + I + G + EX - IM$$

$$= C + I + G + NX$$

The national income identity in an open economy

$$Y = C + I + G + NX$$



or, $NX = Y - \underbrace{(C + I + G)}_{\text{domestic spending}}$

International capital flows

- **Net capital outflow**

  = $S - I$

  = net outflow of "loanable funds"

  = net purchases of foreign assets
  the country's purchases of foreign assets
  minus foreign purchases of domestic assets
- When $S > I$, country is a net lender
- When $S < I$, country is a net borrower

The link between trade & cap. flows

$$NX = Y - (C + I + G)$$

implies

$$NX = (Y - C - G) - I$$
$$= S - I$$

trade balance = net capital outflow

Thus,
a country with a trade deficit ($NX < 0$)
is a net borrower ($S < I$).

Assumptions re: Capital flows

a. domestic & foreign bonds are perfect substitutes (same risk, maturity, *etc*.)

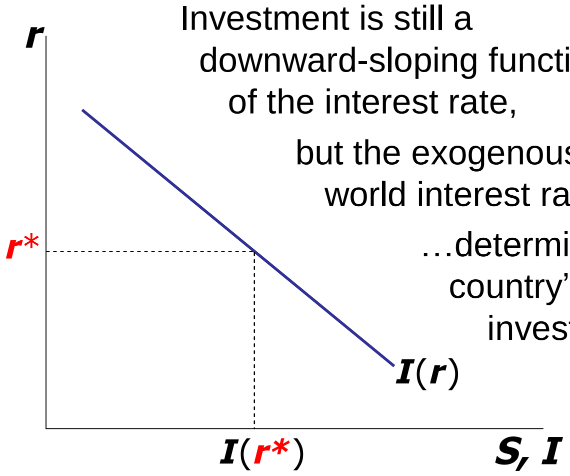
b. **perfect capital mobility**:
no restrictions on international trade in assets

c. economy is **small**:
cannot affect the world interest rate, denoted ***r****

a & b imply ***r*** = ***r****

c implies ***r**** is exogenous

Investment:
The demand for loanable funds



Investment is still a downward-sloping function of the interest rate,

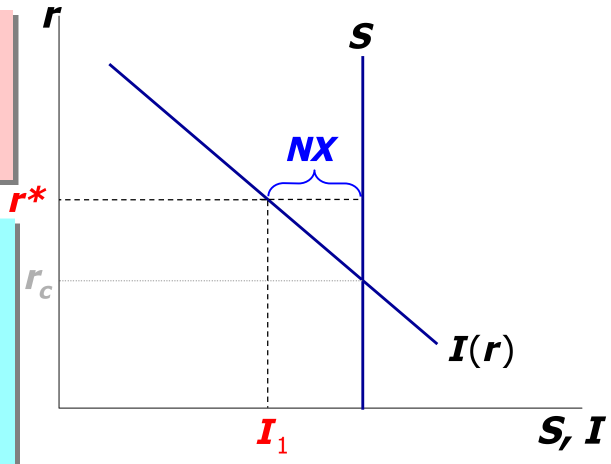
but the exogenous world interest rate…

…determines the country's level of investment.

But in a small open economy…

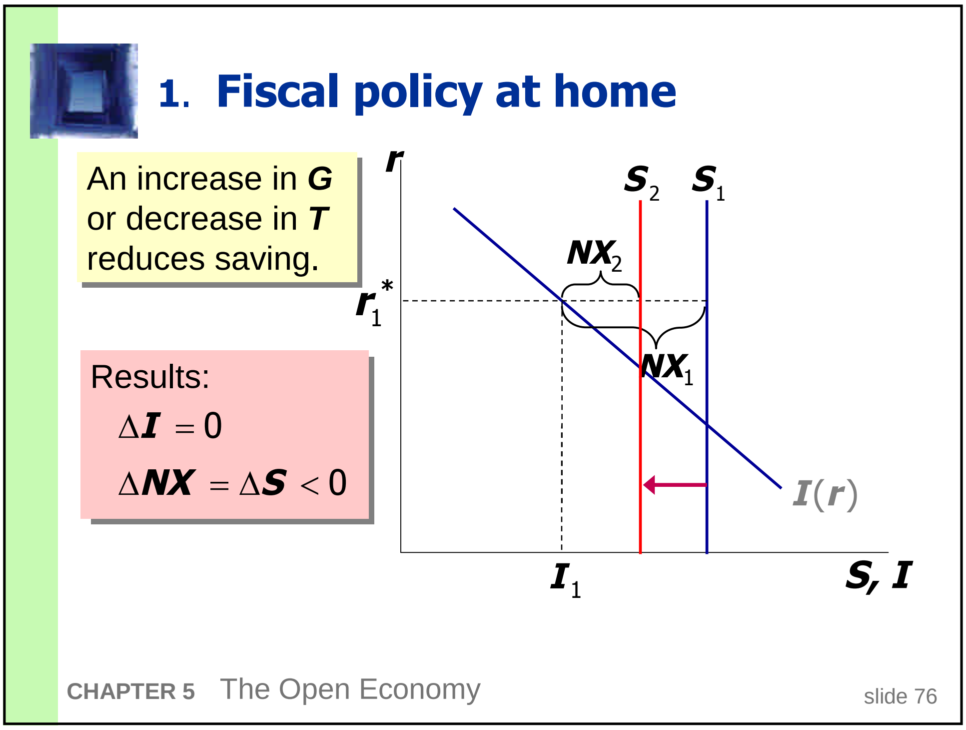
the exogenous world interest rate determines investment…

…and the difference between saving and investment determines net capital outflow and net exports



Next, three experiments:

1. Fiscal policy at home
2. Fiscal policy abroad
3. An increase in investment demand



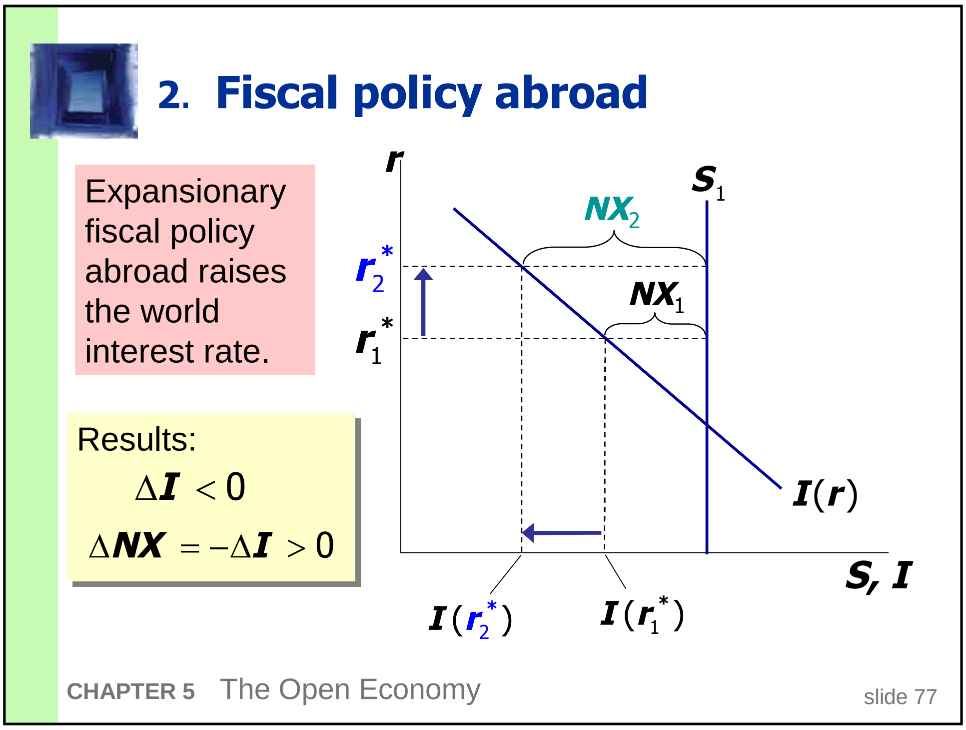
1. Fiscal policy at home

An increase in ***G*** or decrease in ***T*** reduces saving.

Results:

$\Delta I = 0$

$\Delta NX = \Delta S < 0$



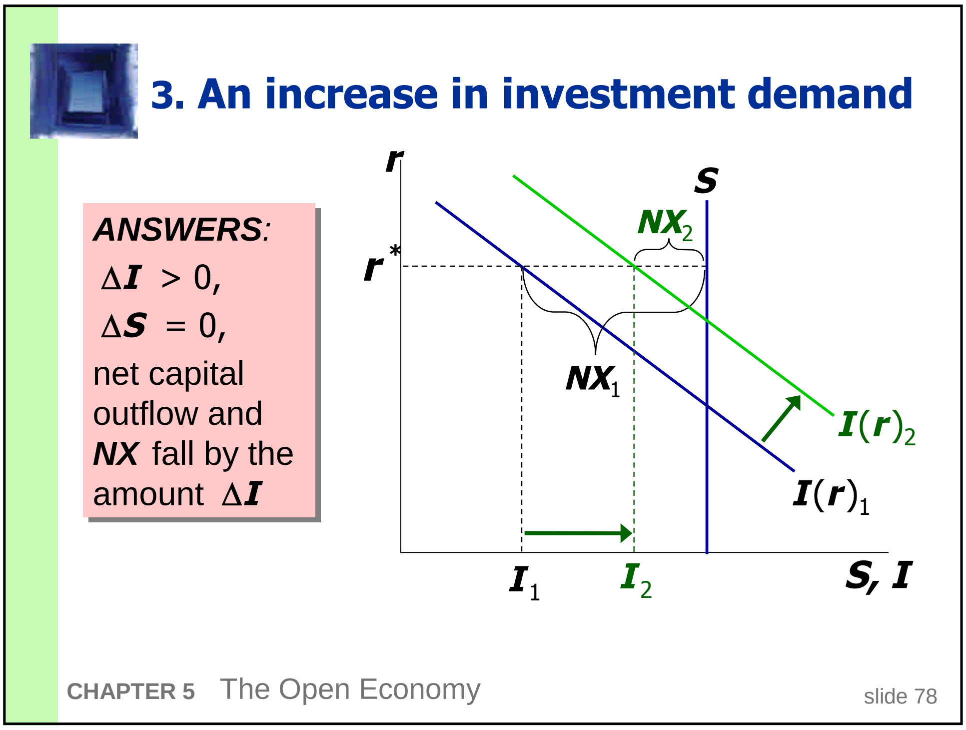
2. Fiscal policy abroad

Expansionary fiscal policy abroad raises the world interest rate.

Results:

$\Delta I < 0$

$\Delta NX = -\Delta I > 0$



3. An increase in investment demand

ANSWERS:

$\Delta I > 0$,

$\Delta S = 0$,

net capital outflow and ***NX*** fall by the amount ΔI

The nominal exchange rate

e = nominal exchange rate,
the relative price of
domestic currency
in terms of foreign currency

(*e.g.* Yen per Dollar)

The real exchange rate

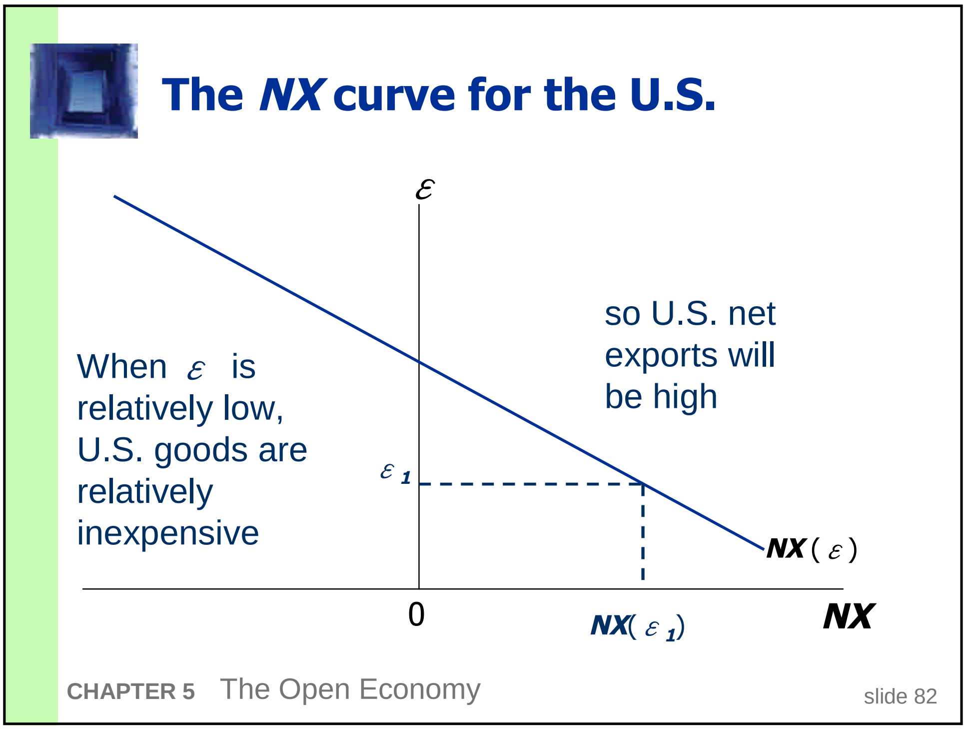
ε = real exchange rate,
the relative price of
domestic goods
in terms of foreign goods

(*e.g.* Japanese Big Macs per
U.S. Big Mac)

The net exports function

- The **net exports function** reflects this inverse relationship between ***NX*** and ε :

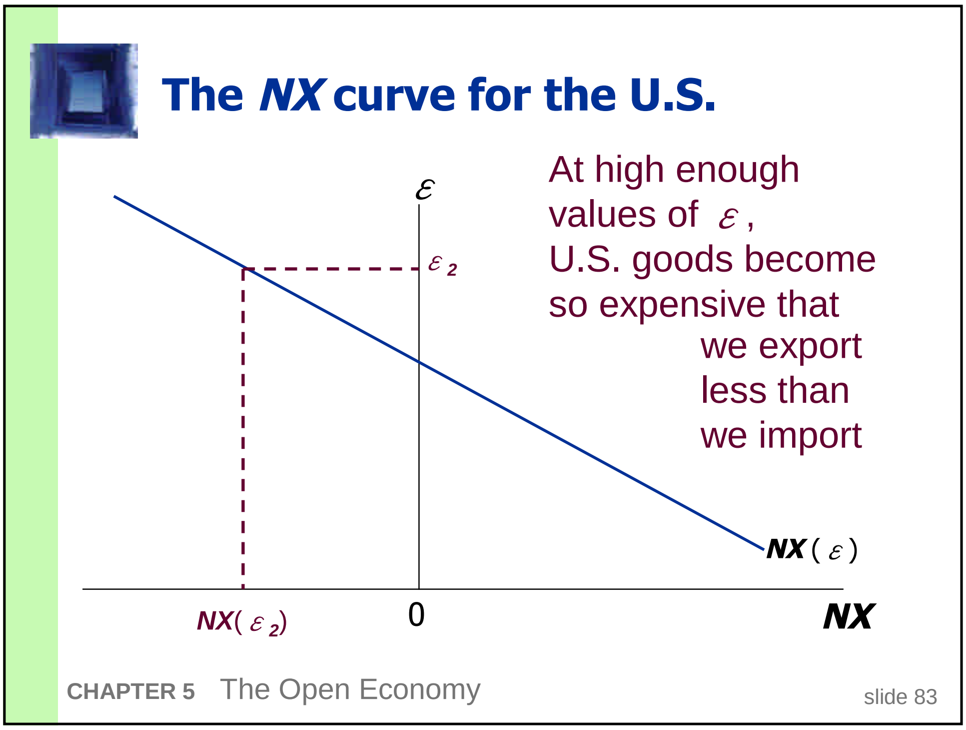
$$NX = NX(\varepsilon)$$



The *NX* curve for the U.S.

When ε is relatively low, U.S. goods are relatively inexpensive

so U.S. net exports will be high



The *NX* curve for the U.S.

At high enough values of ε, U.S. goods become so expensive that we export less than we import

How ε is determined

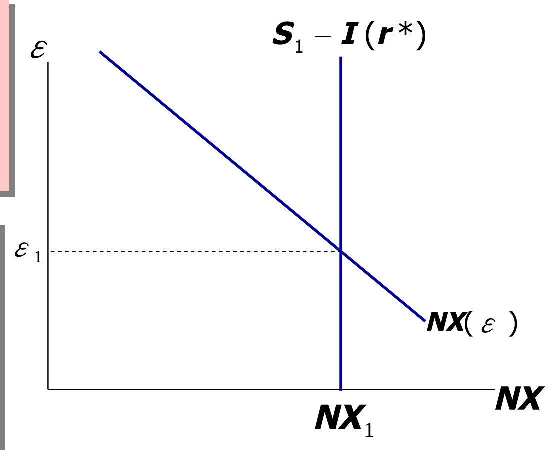
- The accounting identity says $NX = S - I$
- We saw earlier how $S - I$ is determined:
  - S depends on domestic factors (output, fiscal policy variables, *etc*)
  - I is determined by the world interest rate r^*
- So, ε must adjust to ensure

$$NX(\varepsilon) = \overline{S} - I(r^*)$$

Interpretation: Supply and demand in the foreign exchange market

demand:
Foreigners need dollars to buy U.S. net exports.

supply:
Net capital outflow ($S - I$) is the supply of dollars to be invested abroad.



Next, four experiments:

1. Fiscal policy at home
2. Fiscal policy abroad
3. An increase in investment demand
4. Trade policy to restrict imports

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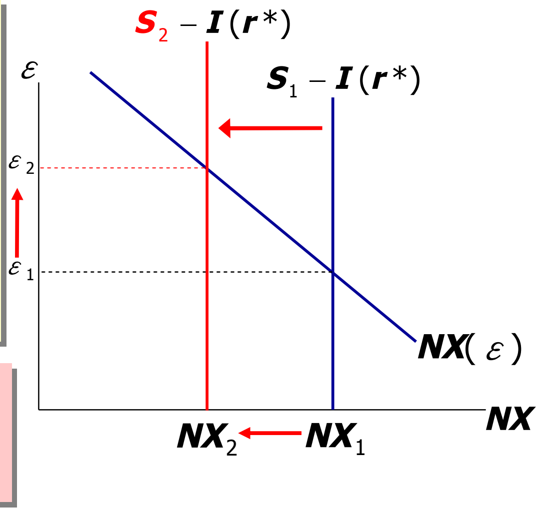
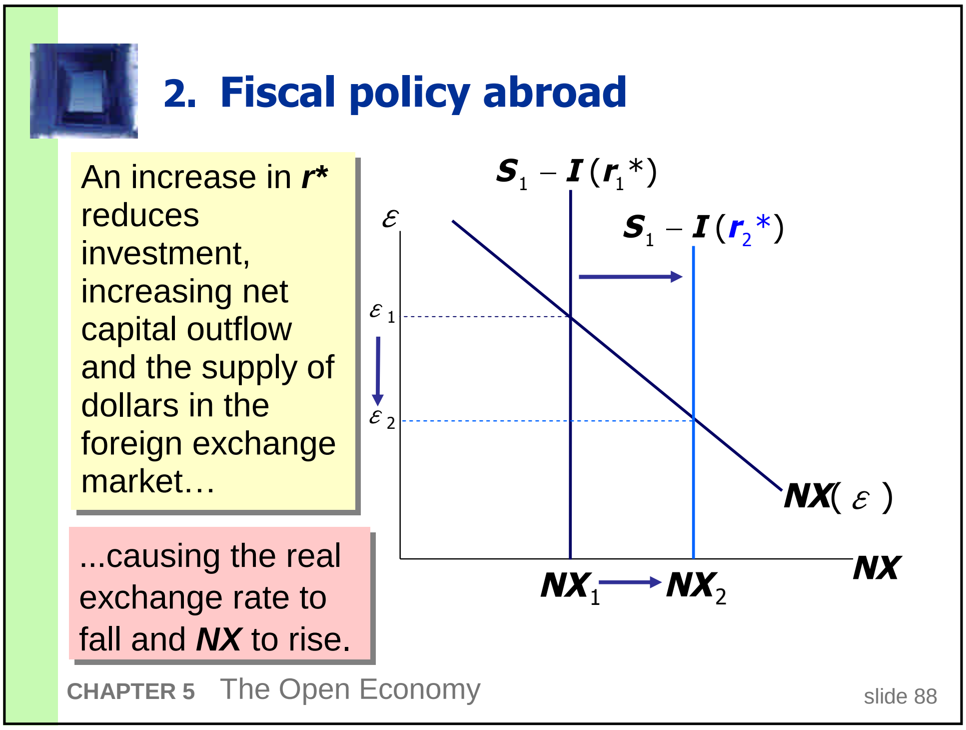
1. Fiscal policy at home

A fiscal expansion reduces national saving, net capital outflow, and the supply of dollars in the foreign exchange market…

...causing the real exchange rate to rise and ***NX*** to fall.

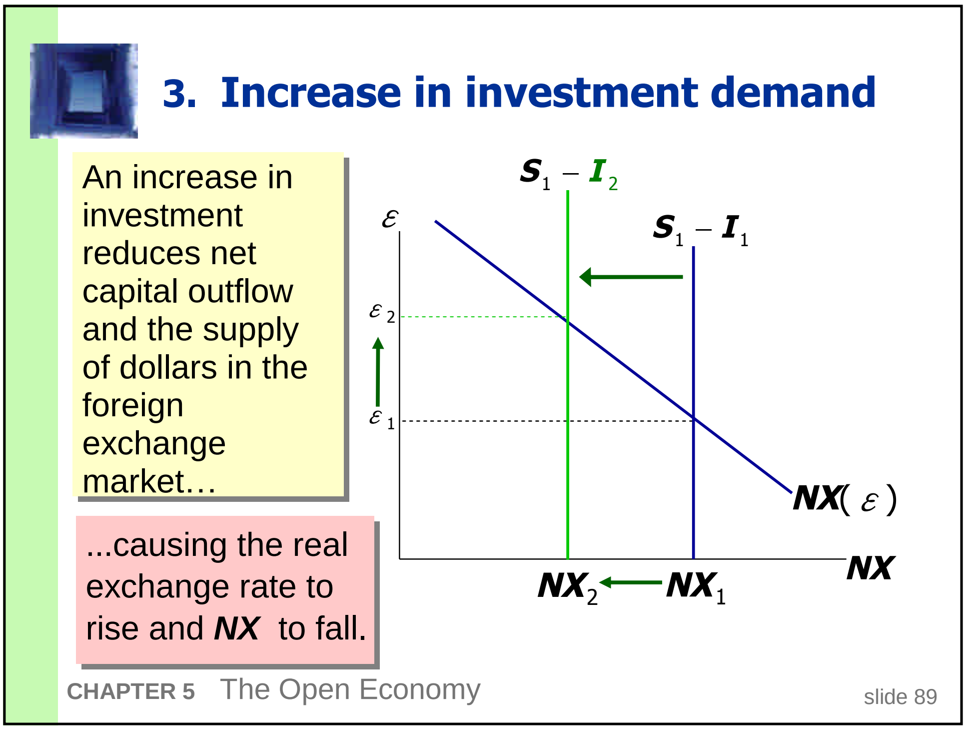




2. Fiscal policy abroad

An increase in ***r**** reduces investment, increasing net capital outflow and the supply of dollars in the foreign exchange market…

...causing the real exchange rate to fall and ***NX*** to rise.



3. Increase in investment demand

An increase in investment reduces net capital outflow and the supply of dollars in the foreign exchange market…

...causing the real exchange rate to rise and ***NX*** to fall.

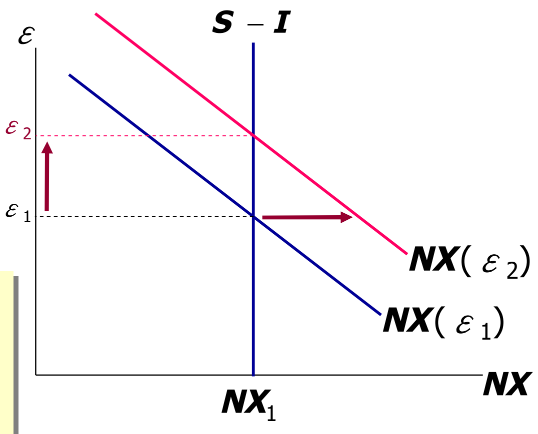
4. Trade policy to restrict imports

At any given value of ε, an import quota

$\Rightarrow \downarrow IM \Rightarrow \uparrow NX$

$\Rightarrow$ demand for dollars shifts right

Trade policy does not affect ***S*** or ***I***, so capital flows and the supply of dollars remain fixed.



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4. Trade policy to restrict imports

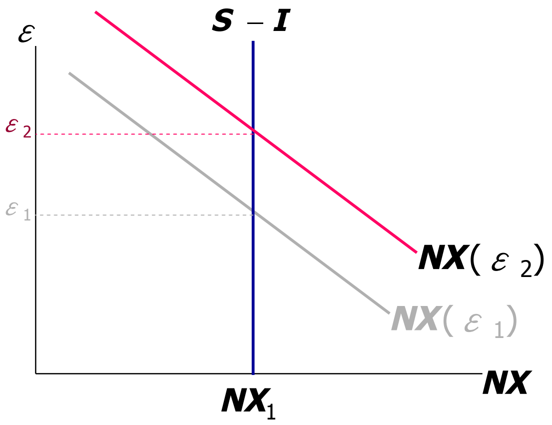
Results:

$\Delta\varepsilon > 0$
(demand increase)

$\Delta NX = 0$
(supply fixed)

$\Delta IM < 0$
(policy)

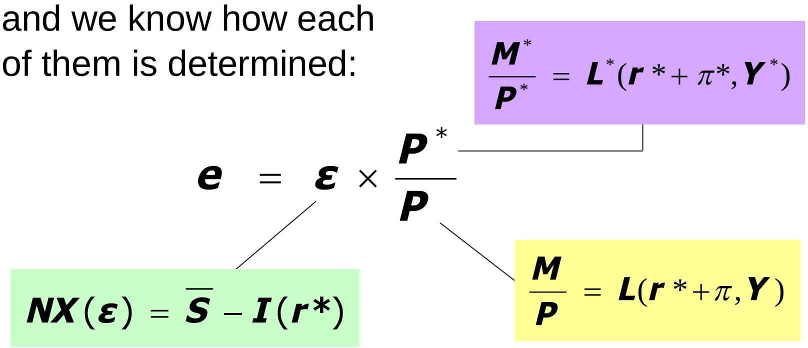
$\Delta EX < 0$
(rise in ε)



The determinants of the nominal exchange rate

- So ***e*** depends on the real exchange rate and the price levels at home and abroad…

…and we know how each of them is determined:



$$e = \varepsilon \times \frac{P^*}{P}$$

$$\frac{M^*}{P^*} = L^*(r^* + \pi^*, Y^*)$$

$$NX(\varepsilon) = \overline{S} - I(r^*)$$

$$\frac{M}{P} = L(r^* + \pi, Y)$$

The determinants of the nominal exchange rate

$$e = \varepsilon \times \frac{P^*}{P}$$

- Rewrite this equation in growth rates
  (*see "arithmetic tricks for working with percentage changes," Chap 2*):

$$\frac{\Delta e}{e} = \frac{\Delta \varepsilon}{\varepsilon} + \frac{\Delta P^*}{P^*} - \frac{\Delta P}{P} = \frac{\Delta \varepsilon}{\varepsilon} + \pi^* - \pi$$

- For a given value of ε ,
  the growth rate of ***e*** equals the difference between foreign and domestic inflation rates.

Purchasing Power Parity (PPP)

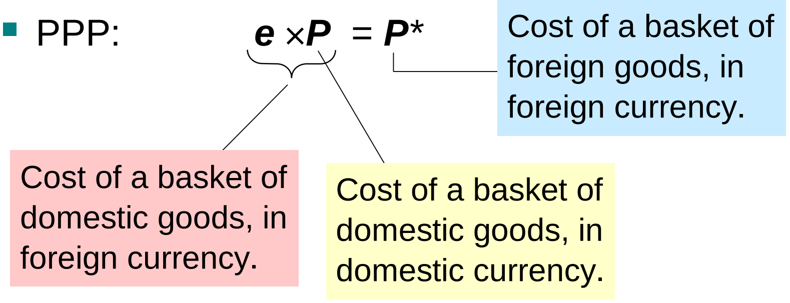
Two definitions:

- A doctrine that states that goods must sell at the same (currency-adjusted) price in all countries.
- The nominal exchange rate adjusts to equalize the cost of a basket of goods across countries.

Reasoning:

- arbitrage, the law of one price

Purchasing Power Parity (PPP)



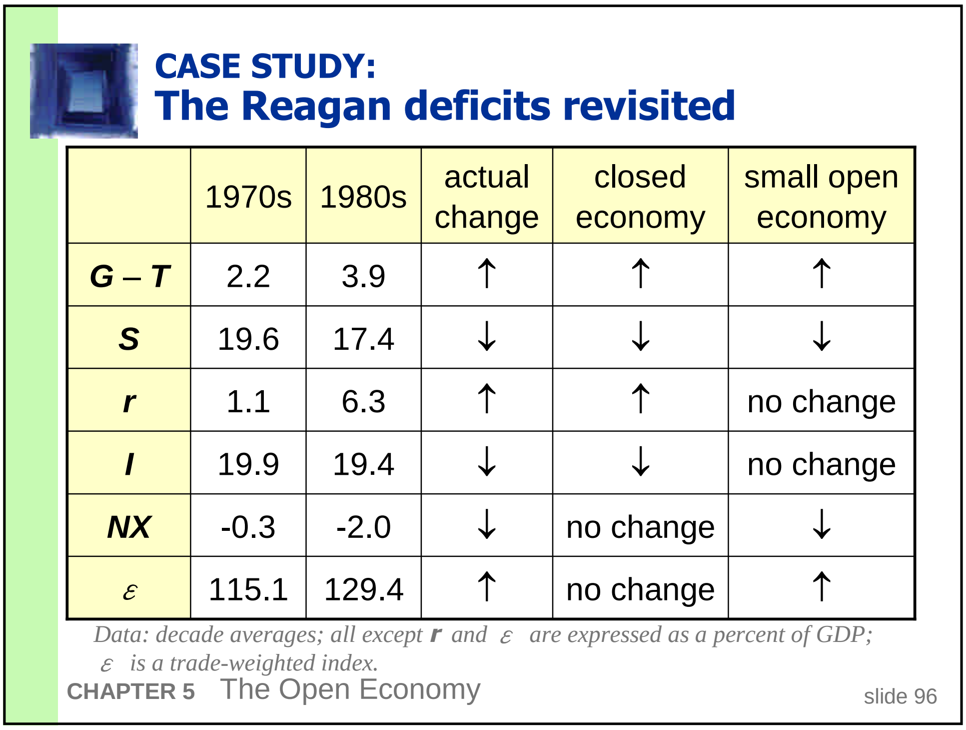
- PPP: $e \times P = P^*$

Cost of a basket of foreign goods, in foreign currency.

Cost of a basket of domestic goods, in foreign currency.

Cost of a basket of domestic goods, in domestic currency.

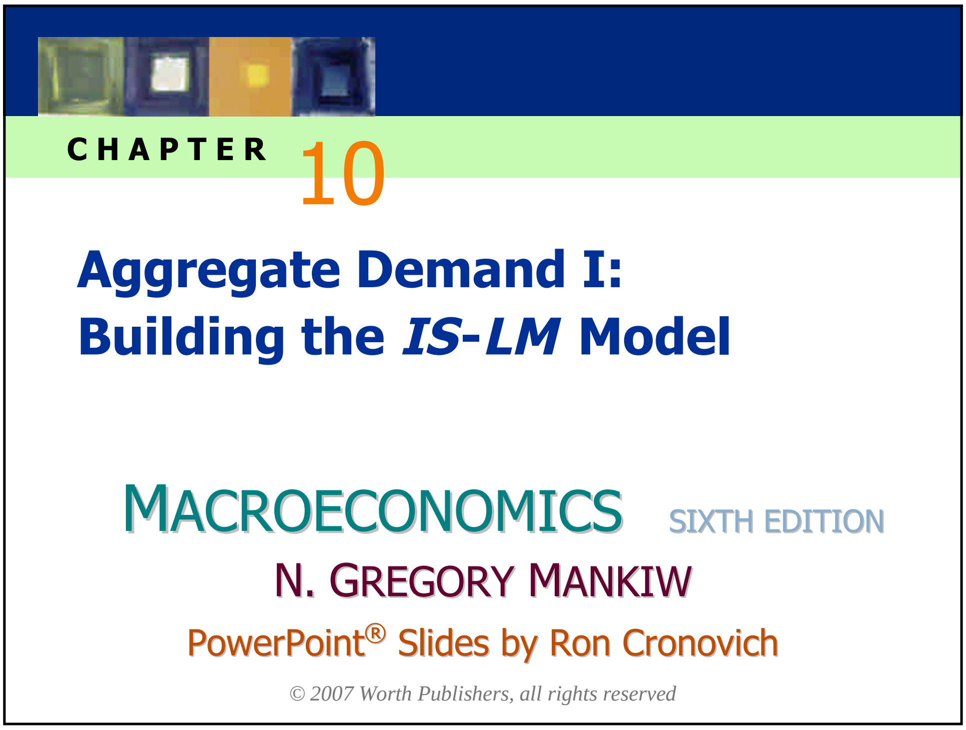
- Solve for ***e*** : $e = P^*/P$
- PPP implies that the nominal exchange rate between two countries equals the ratio of the countries’ price levels.



CASE STUDY:
The Reagan deficits revisited

	1970s	1980s	actual change	closed economy	small open economy
G* – *T	2.2	3.9	↑	↑	↑
S	19.6	17.4	↓	↓	↓
r	1.1	6.3	↑	↑	no change
I	19.9	19.4	↓	↓	no change
NX	-0.3	-2.0	↓	no change	↓
ε	115.1	129.4	↑	no change	↑

*Data: decade averages; all except **r** and ε are expressed as a percent of GDP; ε is a trade-weighted index.*



CHAPTER 10

Aggregate Demand I:
Building the *IS*-*LM* Model

MACROECONOMICS SIXTH EDITION

N. GREGORY MANKIW

PowerPoint® Slides by Ron Cronovich

The Keynesian Cross

- A simple closed economy model in which income is determined by expenditure. *(due to J.M. Keynes)*
- Notation:

  I = planned investment

  $E = C + I + G$ = planned expenditure

  Y = real GDP = actual expenditure
- Difference between actual & planned expenditure = unplanned inventory investment

Elements of the Keynesian Cross

consumption function: $C = C(Y - T)$

govt policy variables: $G = \bar{G}, \quad T = \bar{T}$

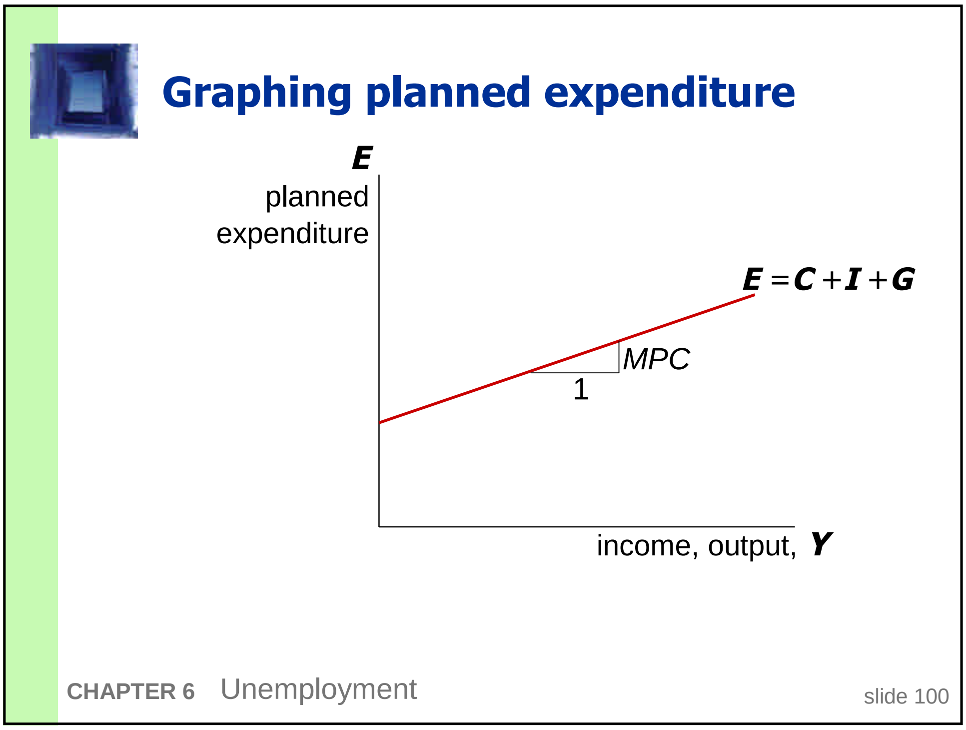
for now, planned investment is exogenous: $I = \bar{I}$

planned expenditure: $E = C(Y - \bar{T}) + \bar{I} + \bar{G}$

equilibrium condition:

actual expenditure = planned expenditure

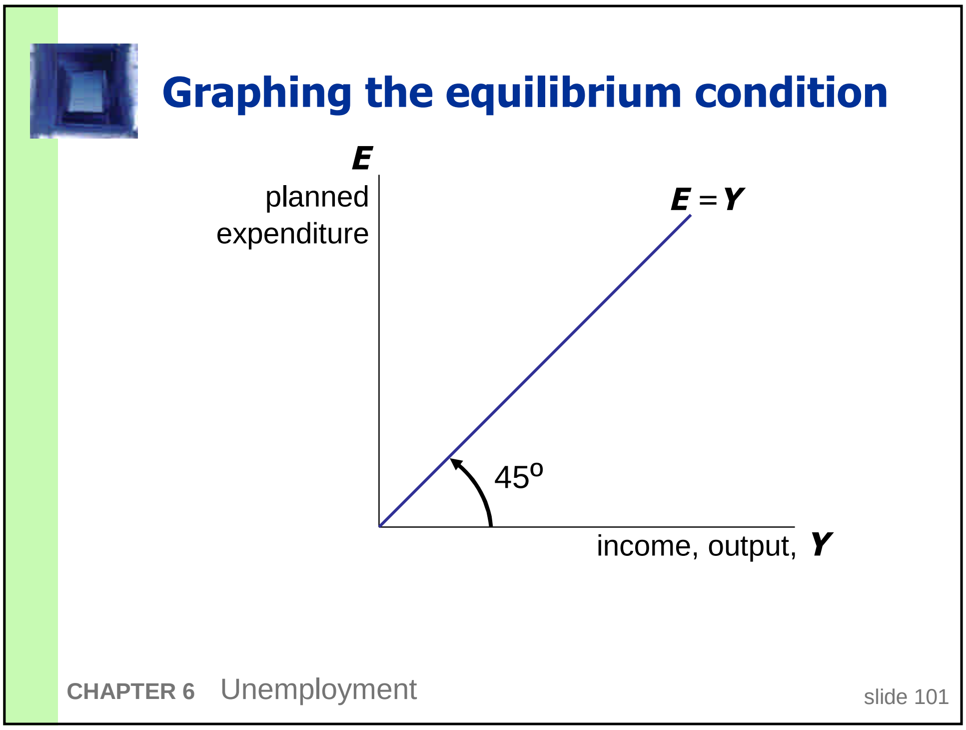
$$Y = E$$



Graphing planned expenditure

CHAPTER 6 Unemployment

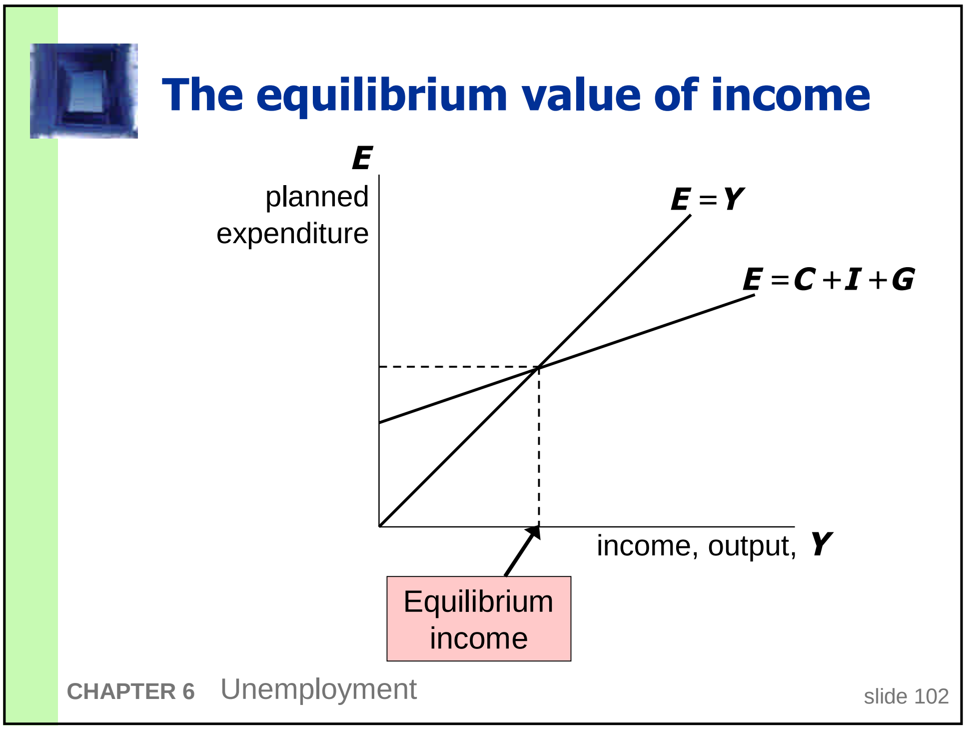
slide 100



Graphing the equilibrium condition

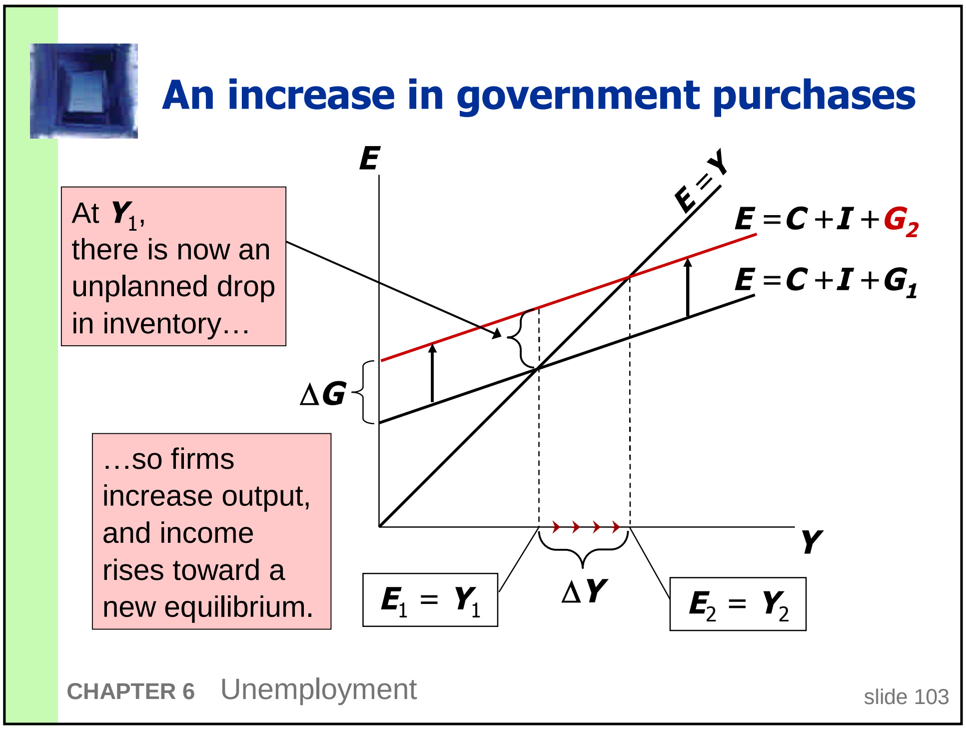
CHAPTER 6 Unemployment

slide 101



The equilibrium value of income

Equilibrium income



An increase in government purchases

At Y_1, there is now an unplanned drop in inventory…

…so firms increase output, and income rises toward a new equilibrium.

$E_1 = Y_1$

$E_2 = Y_2$

Solving for ΔY

$$Y = C + I + G$$ equilibrium condition

$$\Delta Y = \Delta C + \Delta I + \Delta G$$ in changes

$$= \Delta C + \Delta G$$ because I exogenous

$$= \text{MPC} \times \Delta Y + \Delta G$$ because $\Delta C = \text{MPC}\,\Delta Y$

Collect terms with ΔY on the left side of the equals sign:

$$(1 - \text{MPC}) \times \Delta Y = \Delta G$$

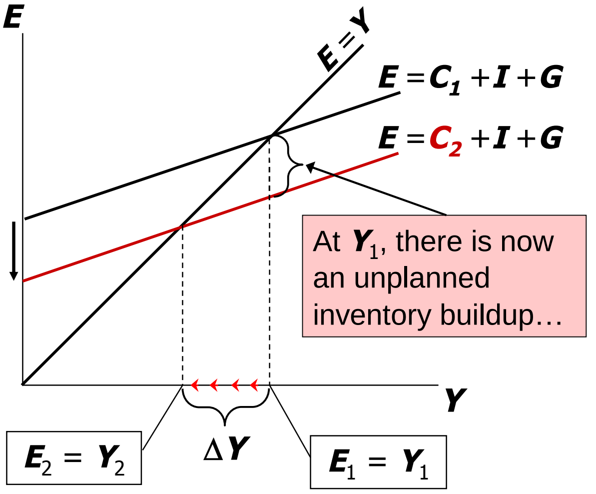
Solve for ΔY:

$$\boxed{\Delta Y = \left(\frac{1}{1 - \text{MPC}}\right) \times \Delta G}$$

An increase in taxes

Initially, the tax increase reduces consumption, and therefore E:

$\Delta C = -\text{MPC}\,\Delta T$



At Y_1, there is now an unplanned inventory buildup…

…so firms reduce output, and income falls toward a new equilibrium

Solving for ΔY

$$\Delta Y = \Delta C + \Delta I + \Delta G$$ eq'm condition in changes

$$= \Delta C$$ I and G exogenous

$$= \text{MPC} \times (\Delta Y - \Delta T)$$

Solving for ΔY: $(1 - \text{MPC}) \times \Delta Y = -\text{MPC} \times \Delta T$

Final result: $$\boxed{\Delta Y = \left(\frac{-\text{MPC}}{1 - \text{MPC}}\right) \times \Delta T}$$

The *IS* curve

def: a graph of all combinations of r and Y that result in goods market equilibrium

i.e. actual expenditure (output)
= planned expenditure

The equation for the *IS* curve is:

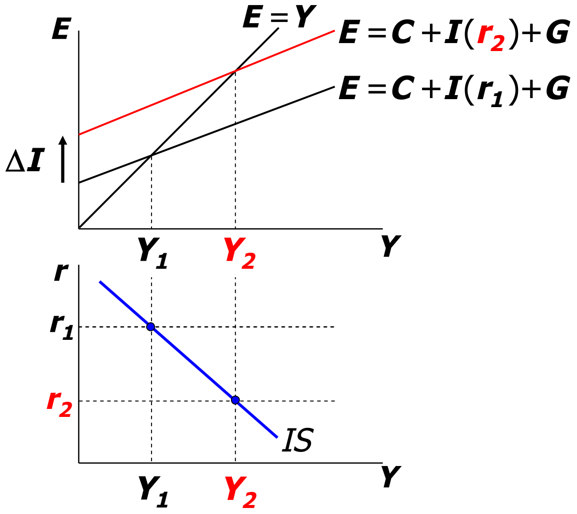
$$\underline{Y = C(Y - \overline{T}) + I(r) + \overline{G}}$$

Deriving the *IS* curve

$\downarrow r \quad \Rightarrow \uparrow I$

$\Rightarrow \uparrow E$

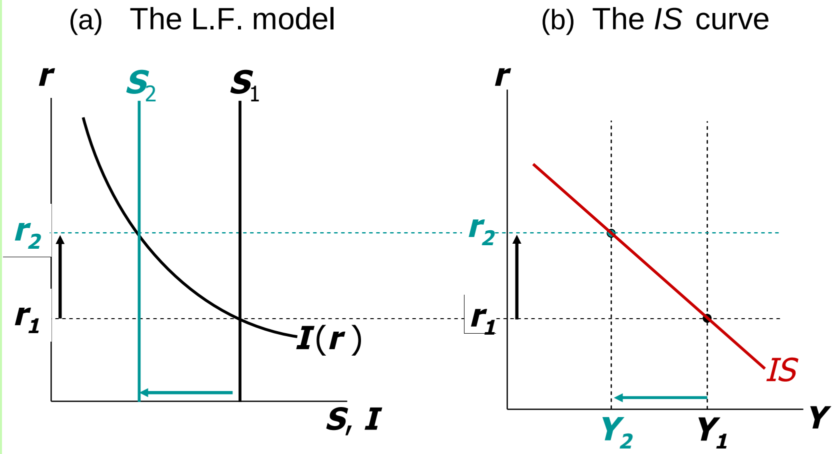
$\Rightarrow \uparrow Y$



Why the *IS* curve is negatively sloped

- A fall in the interest rate motivates firms to increase investment spending, which drives up total planned spending (***E***).
- To restore equilibrium in the goods market, output (*a.k.a.* actual expenditure, ***Y***) must increase.

The *IS* curve and the loanable funds model



Fiscal Policy and the *IS* curve

- We can use the *IS-LM* model to see how fiscal policy (***G*** and ***T***) affects aggregate demand and output.
- Let’s start by using the Keynesian cross to see how fiscal policy shifts the *IS* curve…

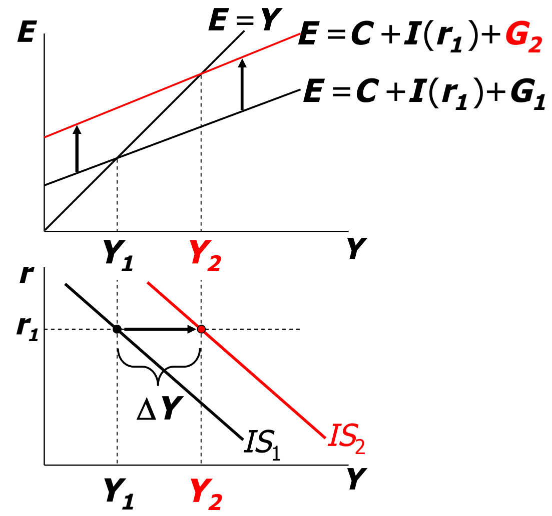
Shifting the *IS* curve: ΔG

At any value of ***r***,
$\uparrow G \Rightarrow \uparrow E \Rightarrow \uparrow Y$

…so the *IS* curve shifts to the right.

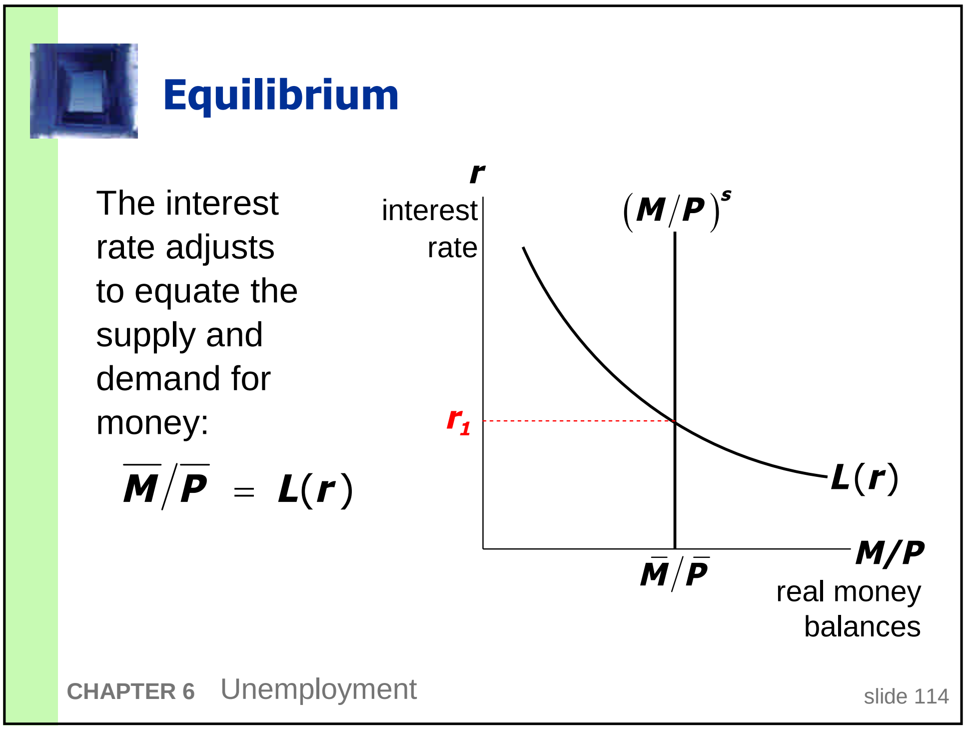
The horizontal distance of the *IS* shift equals

$$\Delta Y = \frac{1}{1-\text{MPC}}\Delta G$$



The Theory of Liquidity Preference

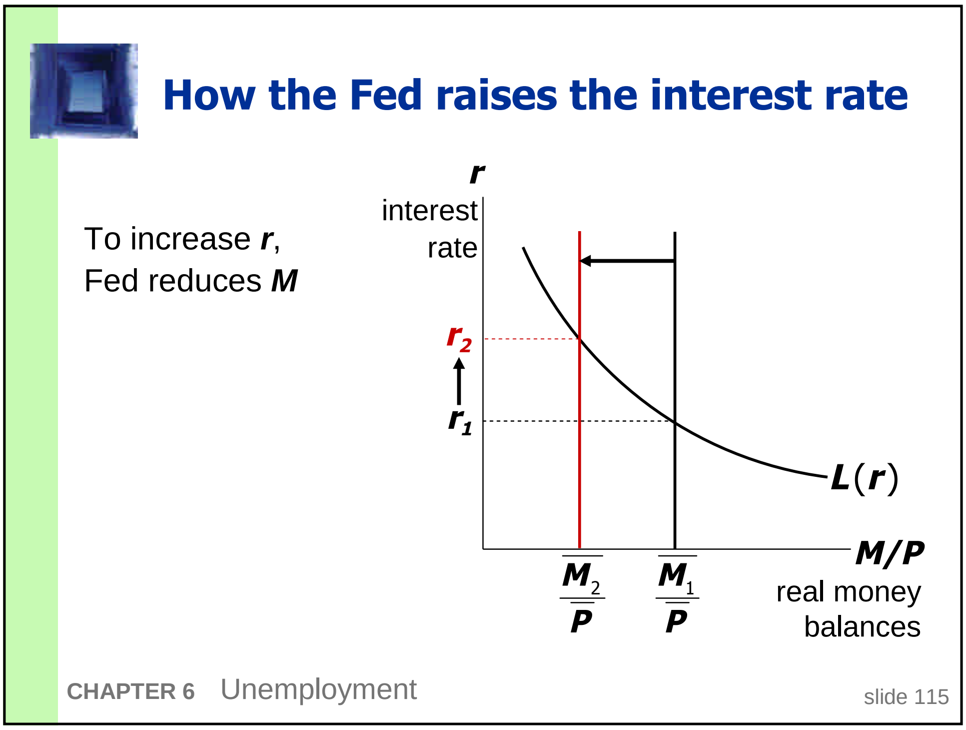
- Due to John Maynard Keynes.
- A simple theory in which the interest rate is determined by money supply and money demand.



Equilibrium

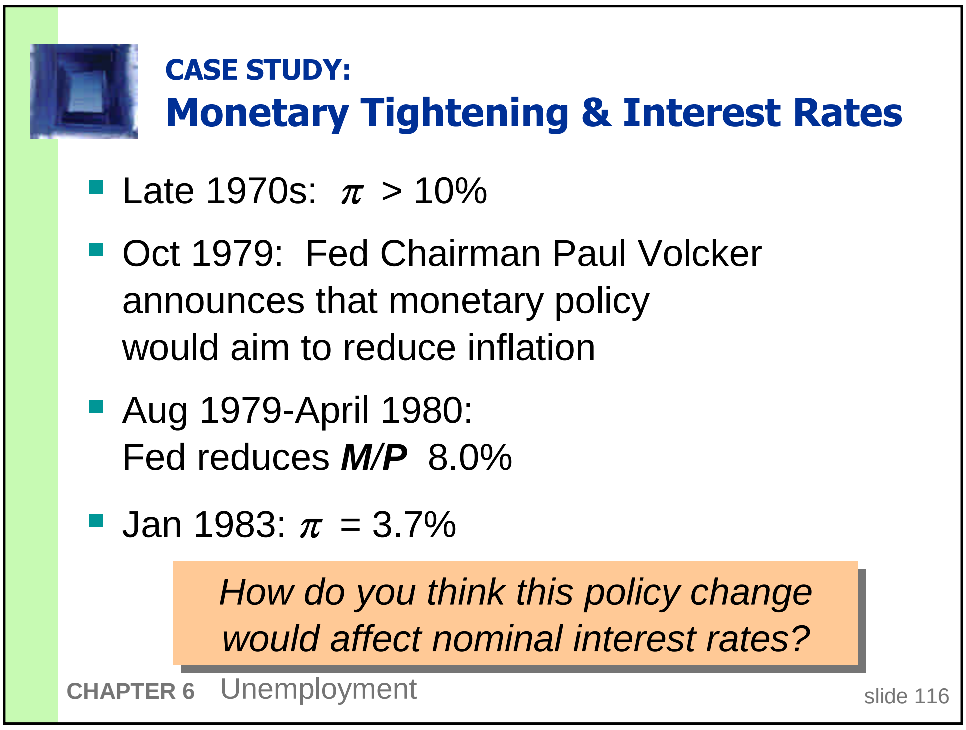
The interest rate adjusts to equate the supply and demand for money:

$$\overline{M}/\overline{P} = L(r)$$



How the Fed raises the interest rate

To increase ***r***,
Fed reduces ***M***

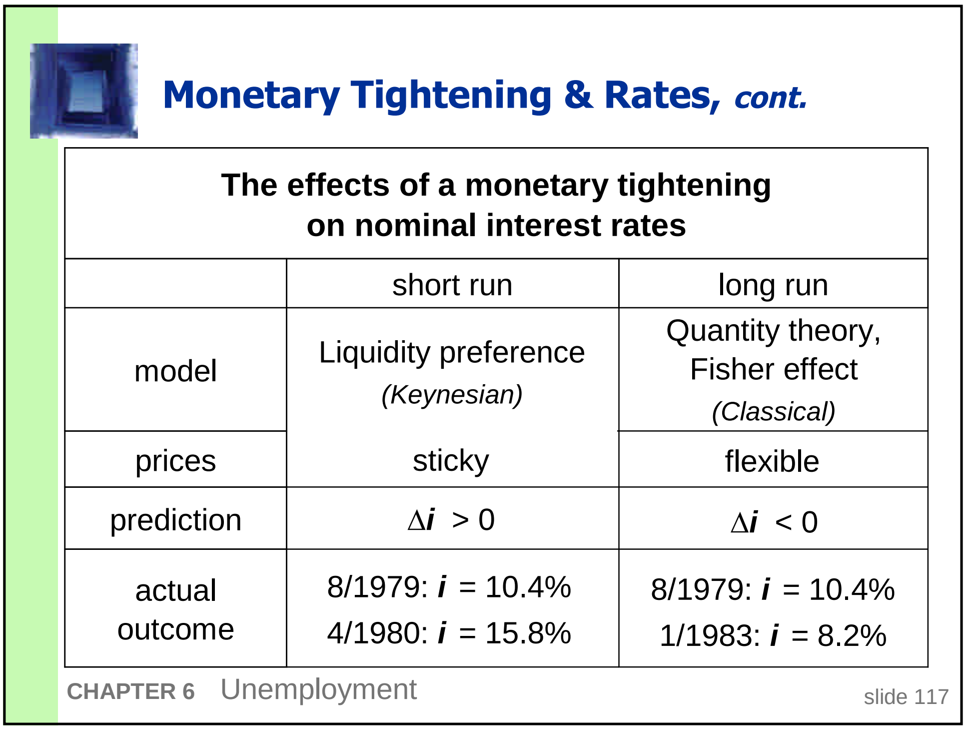


CASE STUDY:

Monetary Tightening & Interest Rates

- Late 1970s: π > 10%
- Oct 1979: Fed Chairman Paul Volcker announces that monetary policy would aim to reduce inflation
- Aug 1979-April 1980:
  Fed reduces ***M/P*** 8.0%
- Jan 1983: π = 3.7%

How do you think this policy change would affect nominal interest rates?



Monetary Tightening & Rates, *cont.*

The effects of a monetary tightening on nominal interest rates

	short run	long run
model	Liquidity preference *(Keynesian)*	Quantity theory, Fisher effect *(Classical)*
prices	sticky	flexible
prediction	Δi > 0	Δi < 0
actual outcome	8/1979: ***i*** = 10.4% 4/1980: ***i*** = 15.8%	8/1979: ***i*** = 10.4% 1/1983: ***i*** = 8.2%

The *LM* curve

Now let's put ***Y*** back into the money demand function:

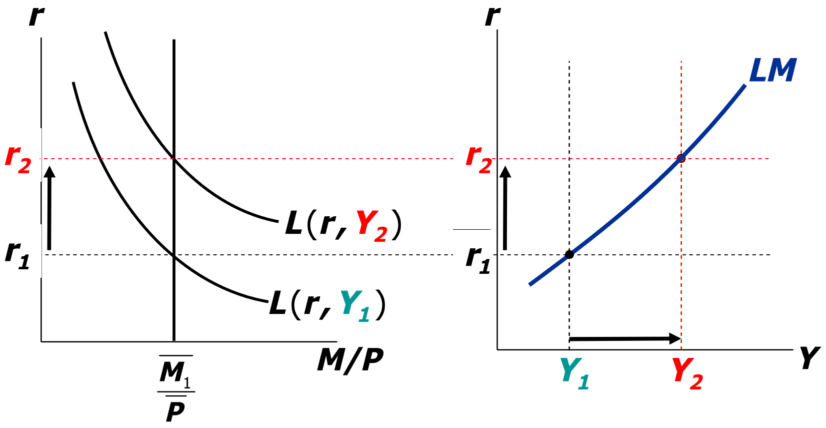
$$\left(M/P\right)^d = L(r,Y)$$

The ***LM* curve** is a graph of all combinations of ***r*** and ***Y*** that equate the supply and demand for real money balances.

The equation for the *LM* curve is:

$$\overline{M}/\overline{P} = L(r,Y)$$

Deriving the *LM* curve



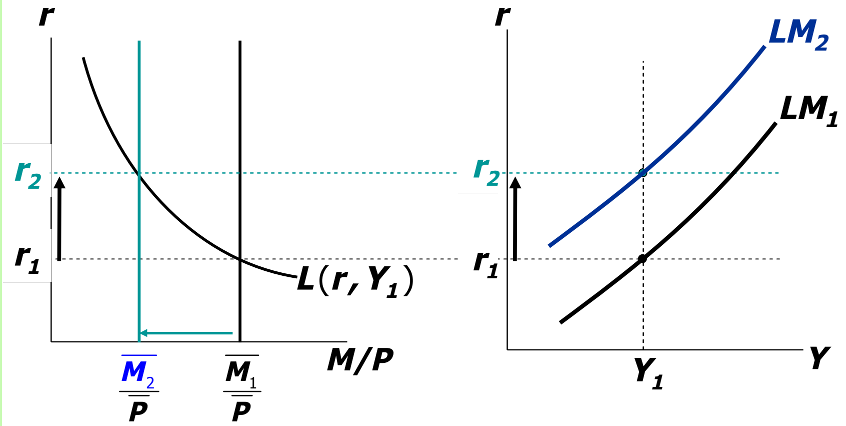
(a) The market for real money balances

(b) The *LM* curve

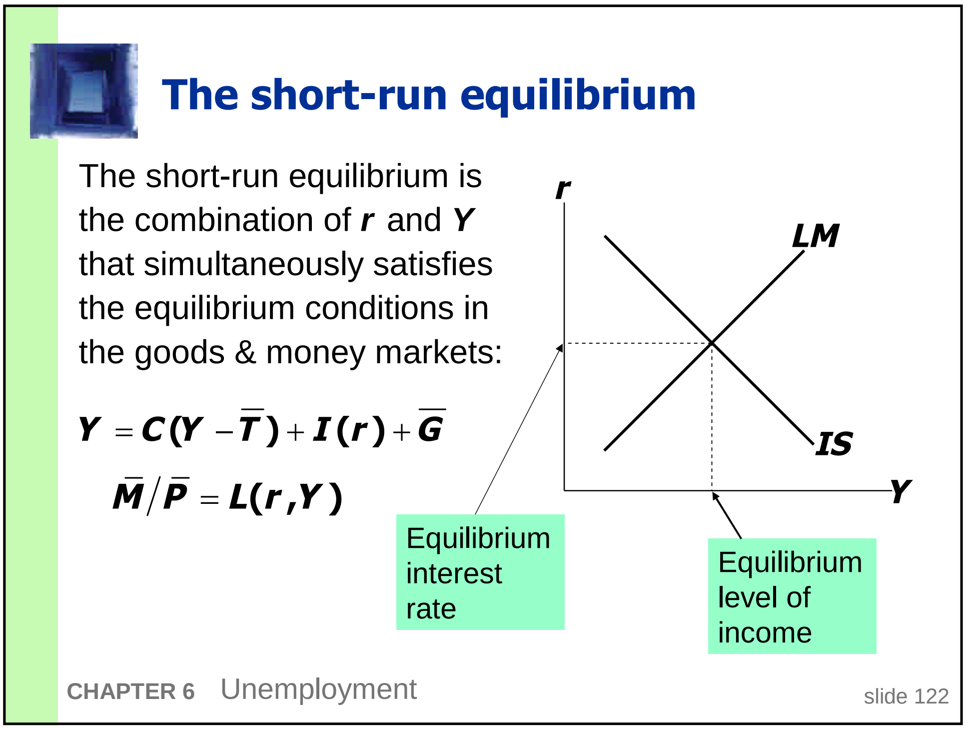
Why the *LM* curve is upward sloping

- An increase in income raises money demand.
- Since the supply of real balances is fixed, there is now excess demand in the money market at the initial interest rate.
- The interest rate must rise to restore equilibrium in the money market.

How ΔM shifts the *LM* curve


(a) The market for real money balances

(b) The *LM* curve



The short-run equilibrium

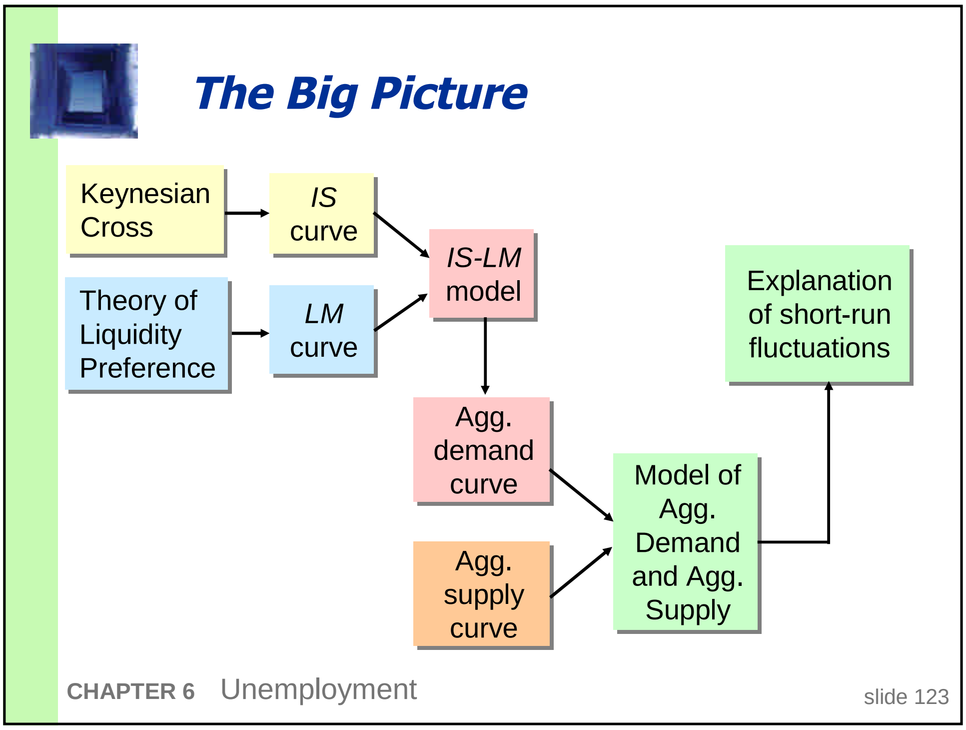
The short-run equilibrium is the combination of ***r*** and ***Y*** that simultaneously satisfies the equilibrium conditions in the goods & money markets:

$$Y = C(Y - \overline{T}) + I(r) + \overline{G}$$

$$\overline{M}/\overline{P} = L(r, Y)$$

Equilibrium interest rate

Equilibrium level of income



The Big Picture

Keynesian Cross

IS curve

Theory of Liquidity Preference

LM curve

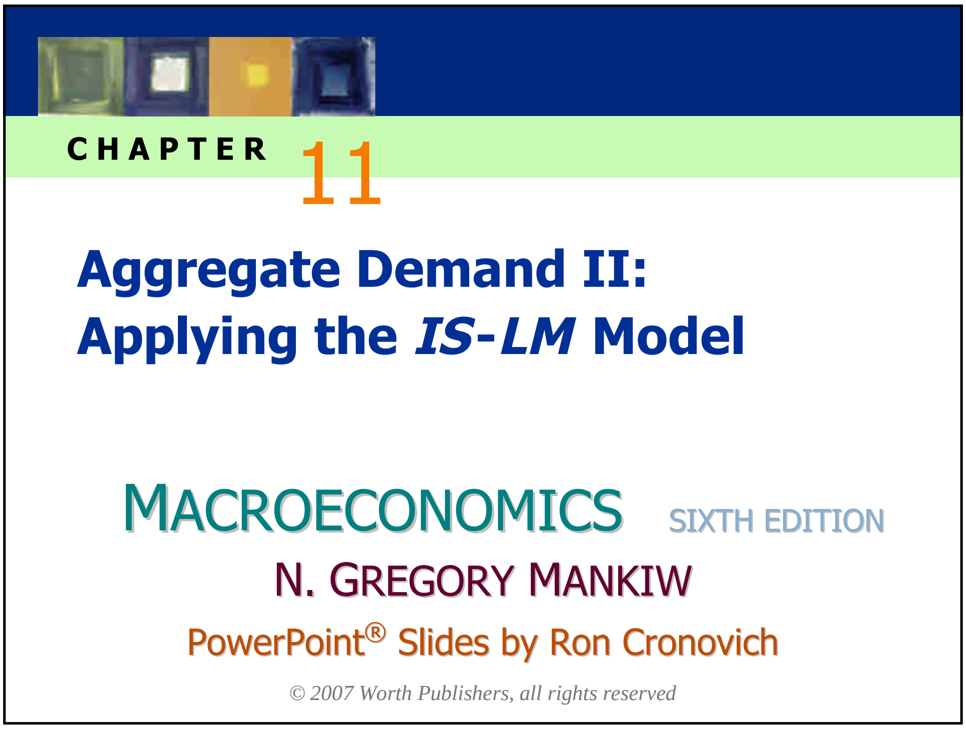
IS-LM model

Agg. demand curve

Agg. supply curve

Model of Agg. Demand and Agg. Supply

Explanation of short-run fluctuations



CHAPTER 11

Aggregate Demand II: Applying the *IS*-*LM* Model

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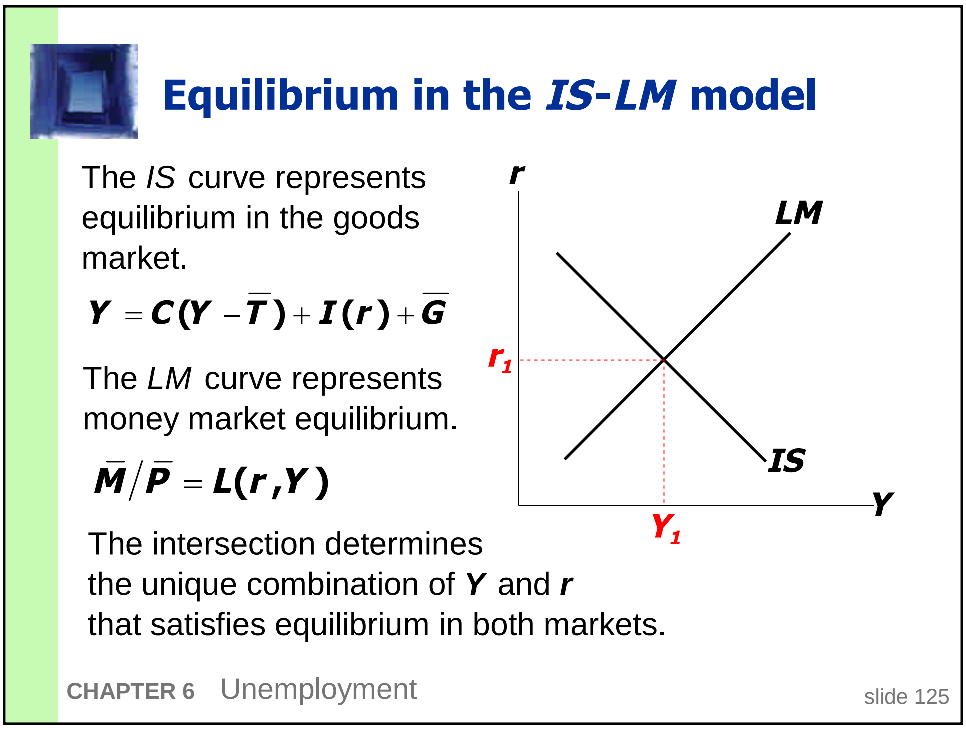


Equilibrium in the *IS*-*LM* model

The *IS* curve represents equilibrium in the goods market.

$$Y = C(Y - \overline{T}) + I(r) + \overline{G}$$

The *LM* curve represents money market equilibrium.

$$\overline{M}/\overline{P} = L(r,Y)$$

The intersection determines the unique combination of *Y* and *r* that satisfies equilibrium in both markets.

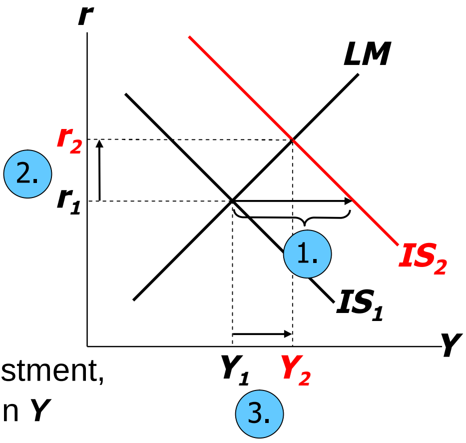
An increase in government purchases

1. *IS* curve shifts right by $\frac{1}{1-\text{MPC}}\Delta \boldsymbol{G}$

   causing output & income to rise.

2. This raises money demand, causing the interest rate to rise…

3. …which reduces investment, so the final increase in ***Y*** is smaller than $\frac{1}{1-\text{MPC}}\Delta \boldsymbol{G}$



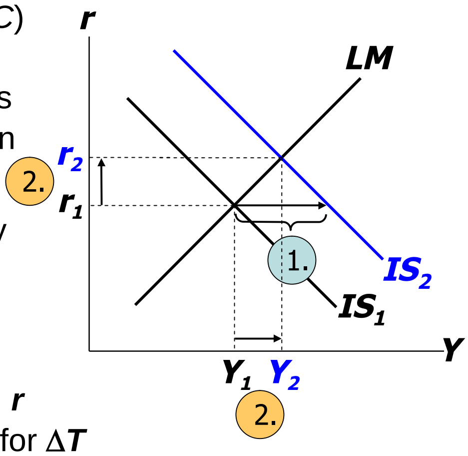
A tax cut

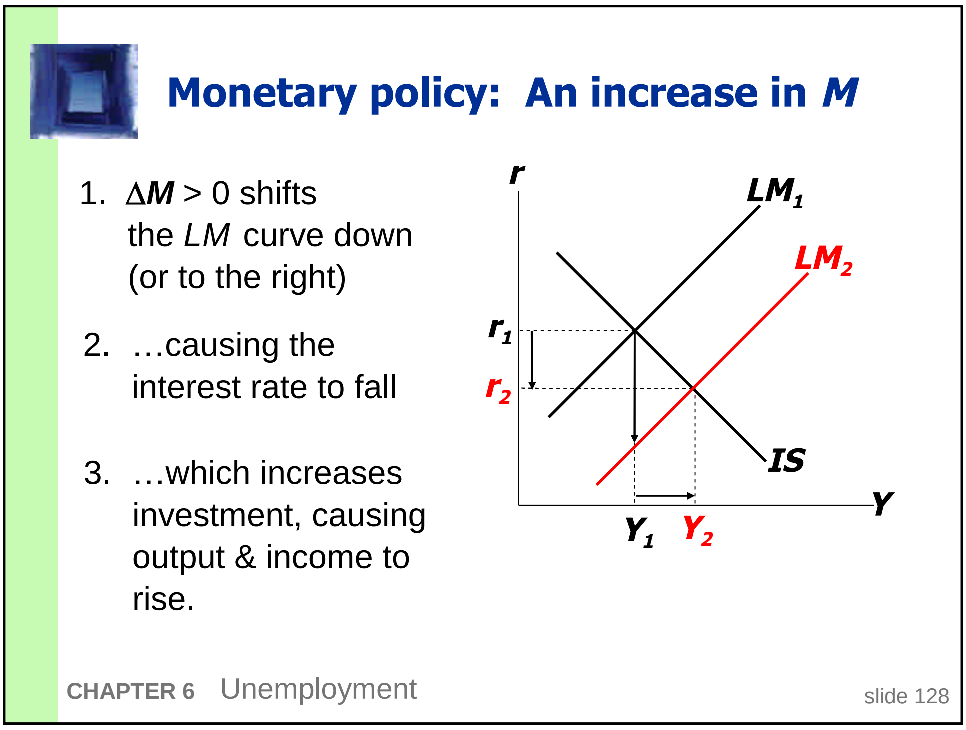
Consumers save (1–*MPC*) of the tax cut, so the initial boost in spending is smaller for Δ***T*** than for an equal Δ***G***…

and the *IS* curve shifts by

① $\frac{-\text{MPC}}{1-\text{MPC}}\Delta \boldsymbol{T}$

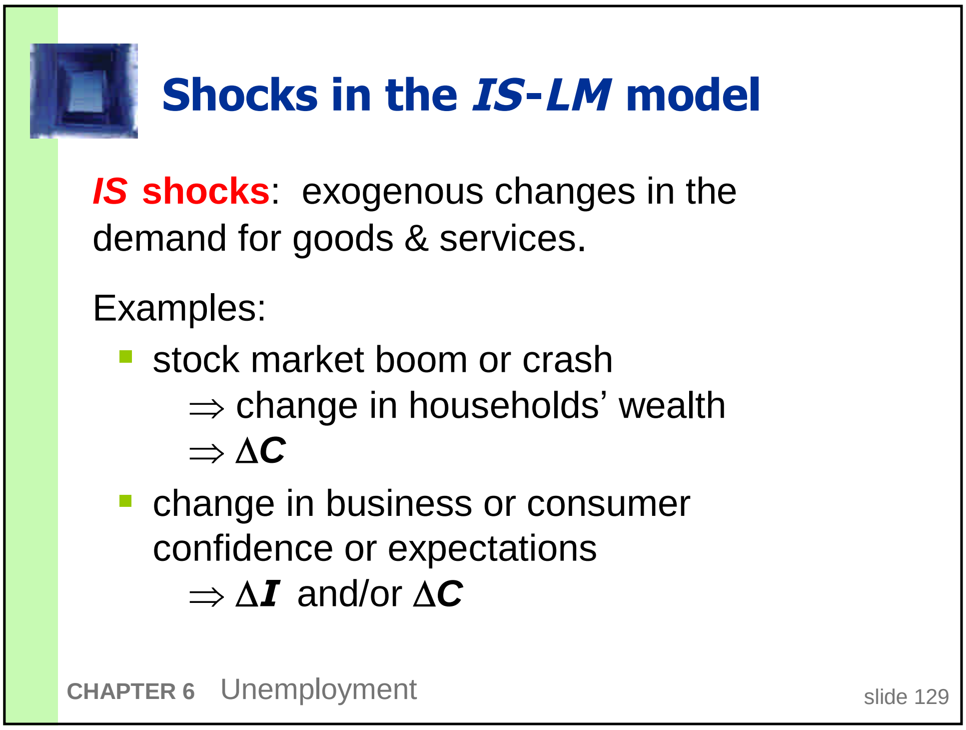
② …so the effects on ***r*** and ***Y*** are smaller for Δ***T*** than for an equal Δ***G***.





Monetary policy: An increase in *M*

1. $\Delta M > 0$ shifts the *LM* curve down (or to the right)
2. …causing the interest rate to fall
3. …which increases investment, causing output & income to rise.



Shocks in the *IS*-*LM* model

***IS* shocks**: exogenous changes in the demand for goods & services.

Examples:

- stock market boom or crash
  $\Rightarrow$ change in households' wealth
  $\Rightarrow \Delta C$
- change in business or consumer confidence or expectations
  $\Rightarrow \Delta I$ and/or ΔC

Shocks in the *IS*-*LM* model

***LM* shocks**: exogenous changes in the demand for money.

Examples:

- a wave of credit card fraud increases demand for money.
- more ATMs or the Internet reduce money demand.

EXERCISE:
Analyze shocks with the IS-LM model

Use the *IS*-*LM* model to analyze the effects of

1. a boom in the stock market that makes consumers wealthier.
2. after a wave of credit card fraud, consumers using cash more frequently in transactions.

For each shock,

a. use the *IS*-*LM* diagram to show the effects of the shock on ***Y*** and ***r*.**

b. determine what happens to ***C***, ***I***, and the unemployment rate.

IS-LM and aggregate demand

- So far, we've been using the *IS-LM* model to analyze the short run, when the price level is assumed fixed.
- However, a change in ***P*** would shift *LM* and therefore affect ***Y*.**
- The **aggregate demand curve** captures this relationship between ***P*** and ***Y*.**

Deriving the *AD* curve

Intuition for slope of *AD* curve:

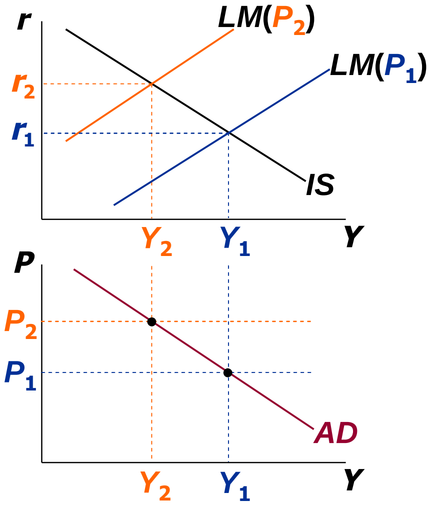
$\uparrow \boldsymbol{P} \;\Rightarrow \downarrow (\boldsymbol{M/P})$

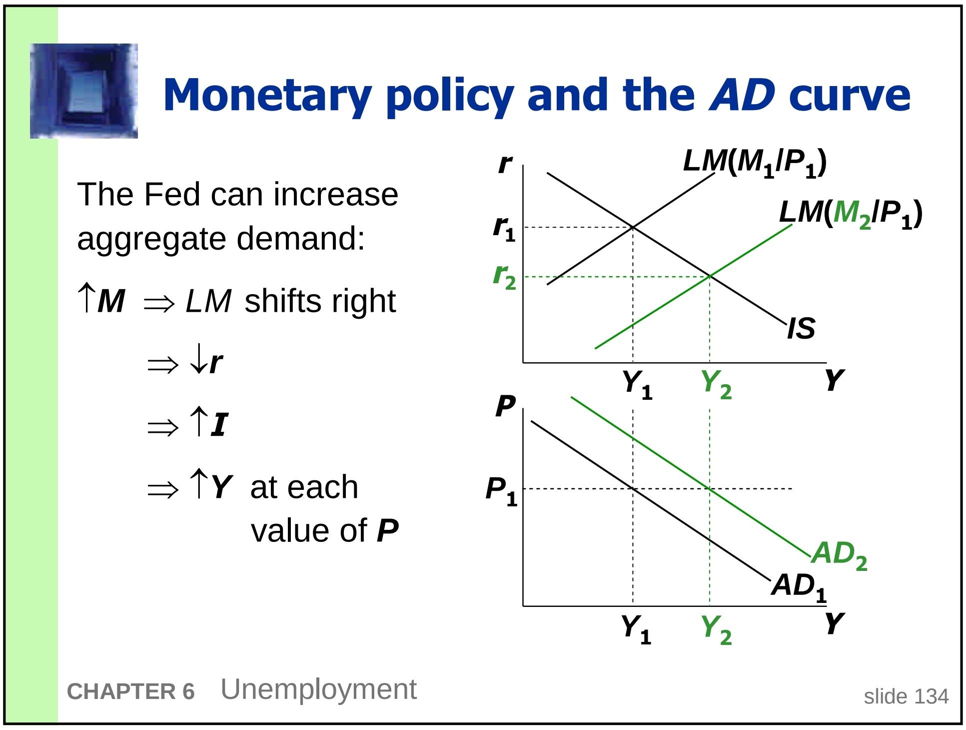
$\Rightarrow$ *LM* shifts left

$\Rightarrow \uparrow \boldsymbol{r}$

$\Rightarrow \downarrow \boldsymbol{I}$

$\Rightarrow \downarrow \boldsymbol{Y}$





Monetary policy and the *AD* curve

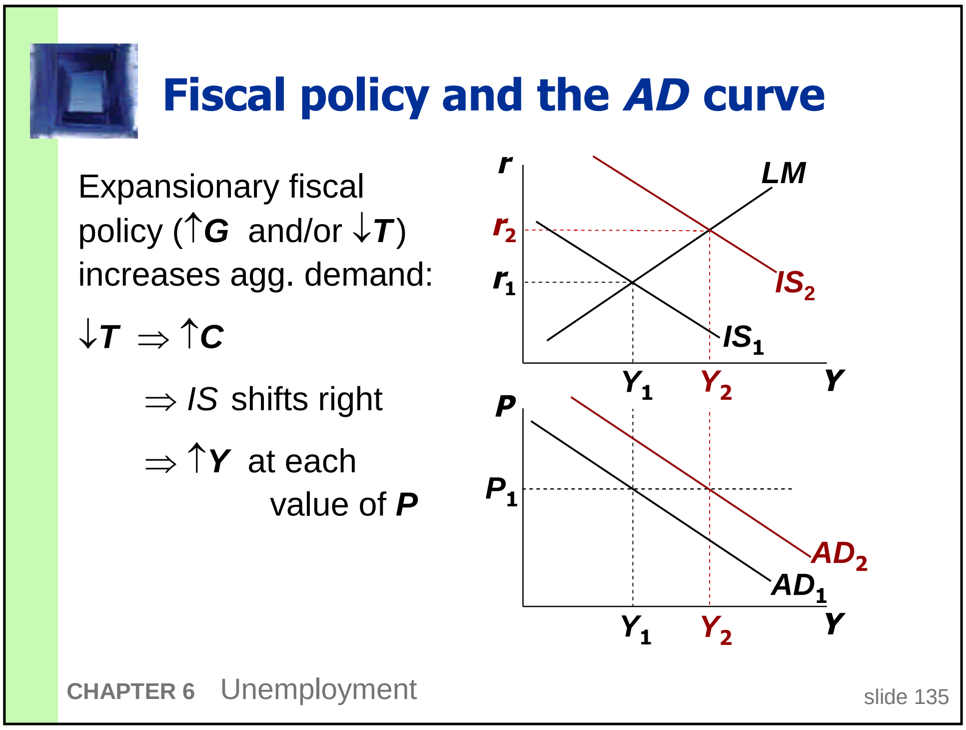
The Fed can increase aggregate demand:

$\uparrow M \Rightarrow LM$ shifts right

$\Rightarrow \downarrow r$

$\Rightarrow \uparrow I$

$\Rightarrow \uparrow Y$ at each value of P



Fiscal policy and the *AD* curve

Expansionary fiscal policy ($\uparrow G$ and/or $\downarrow T$) increases agg. demand:

$\downarrow T \Rightarrow \uparrow C$

$\Rightarrow IS$ shifts right

$\Rightarrow \uparrow Y$ at each value of P

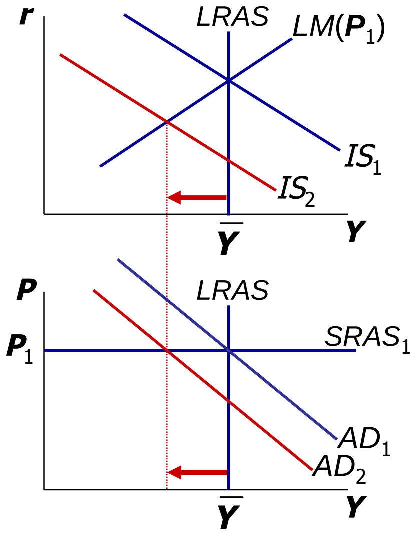
IS-LM and *AD-AS* in the short run & long run

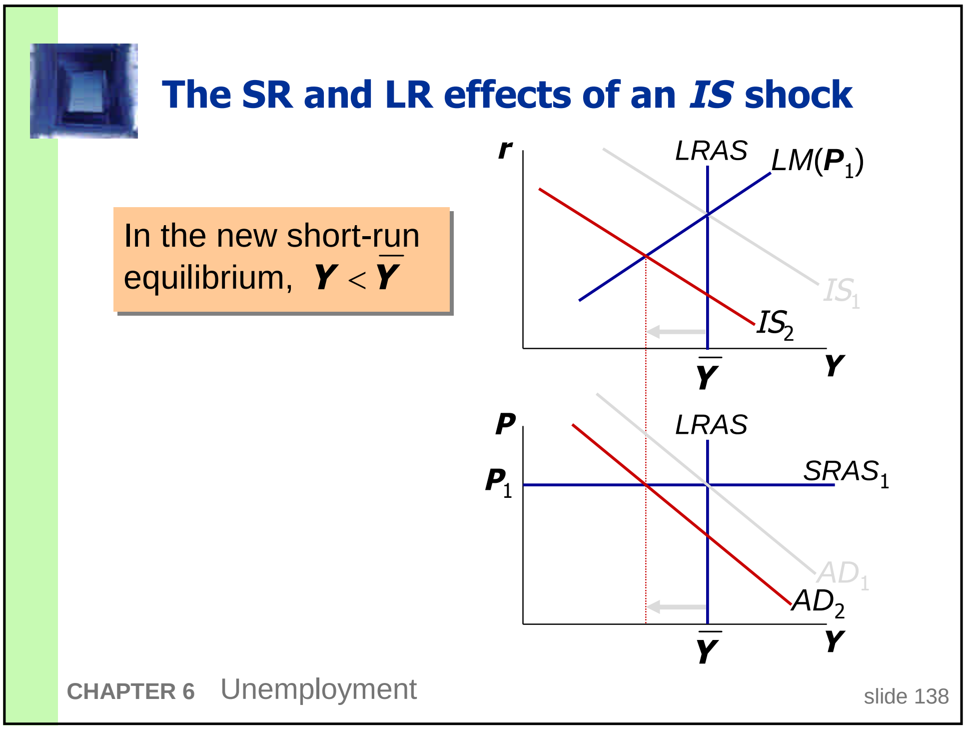
The force that moves the economy from the short run to the long run is the gradual adjustment of prices.

In the short-run equilibrium, if	then over time, the price level will
$Y > \bar{Y}$	rise
$Y < \bar{Y}$	fall
$Y = \bar{Y}$	remain constant

The SR and LR effects of an *IS* shock

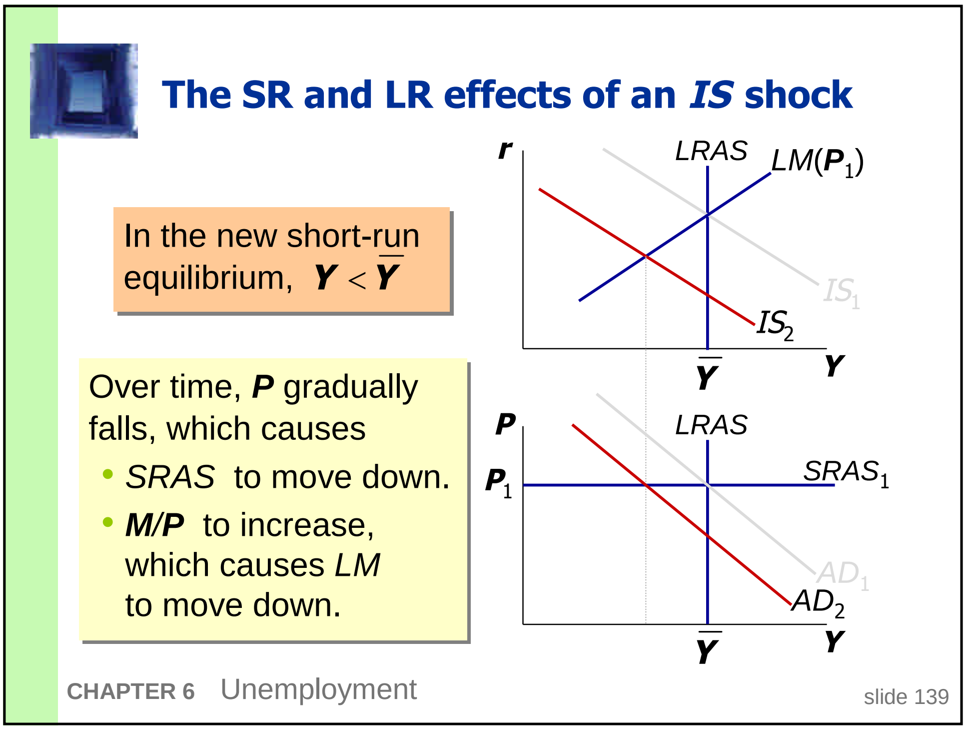
A negative *IS* shock shifts *IS* and *AD* left, causing Y to fall.





The SR and LR effects of an *IS* shock

In the new short-run equilibrium, $\boldsymbol{Y} < \bar{\boldsymbol{Y}}$

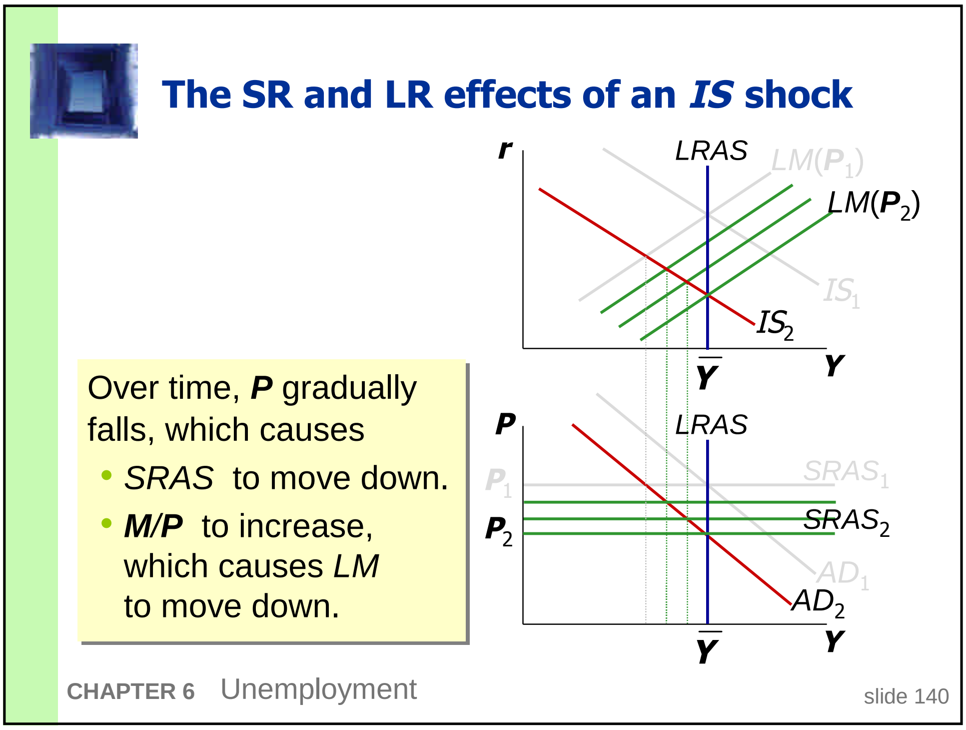


The SR and LR effects of an *IS* shock

In the new short-run equilibrium, $\boldsymbol{Y} < \bar{\boldsymbol{Y}}$

Over time, ***P*** gradually falls, which causes

- *SRAS* to move down.
- ***M/P*** to increase, which causes *LM* to move down.



The SR and LR effects of an *IS* shock

Over time, ***P*** gradually falls, which causes

- *SRAS* to move down.
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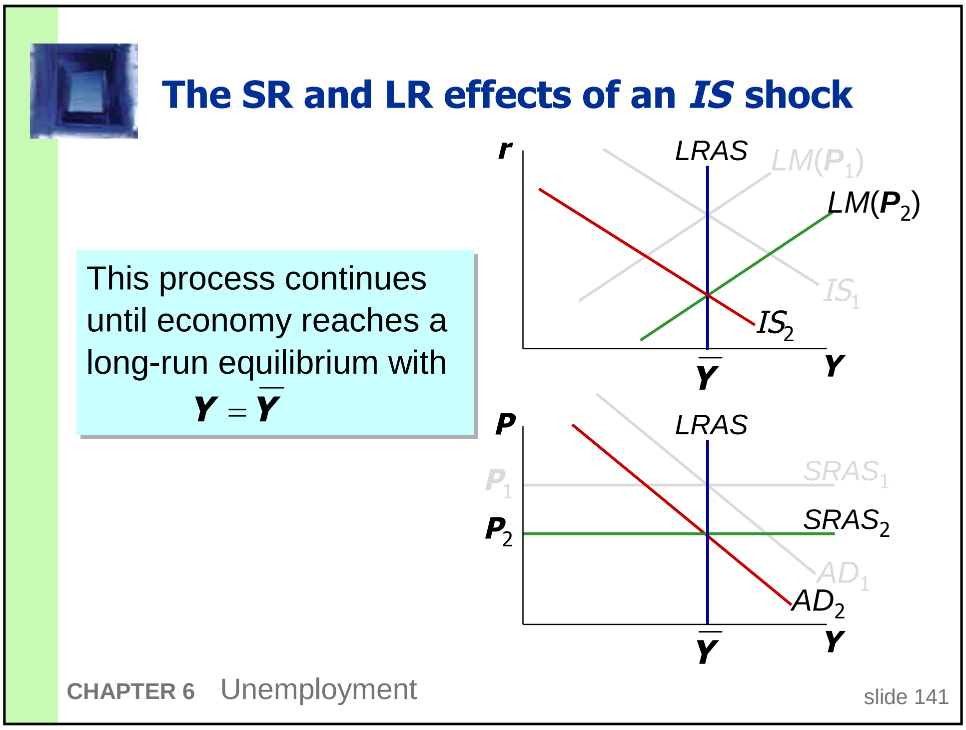
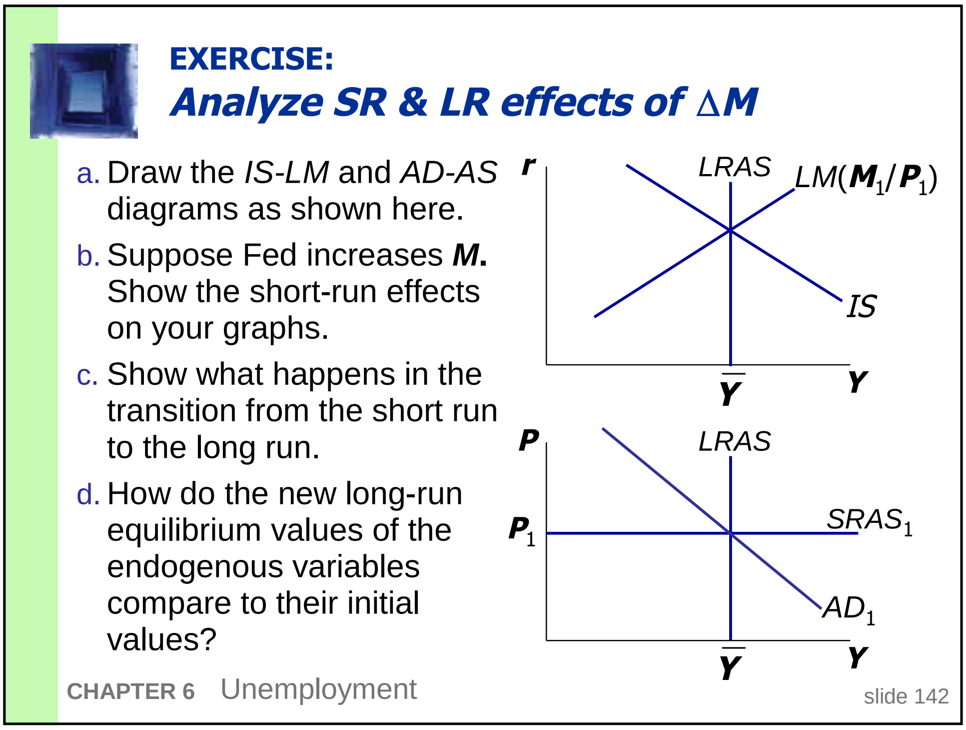


The SR and LR effects of an *IS* shock

This process continues until economy reaches a long-run equilibrium with

$$\boldsymbol{Y} = \overline{\boldsymbol{Y}}$$



EXERCISE:

Analyze SR & LR effects of ΔM

a. Draw the *IS-LM* and *AD-AS* diagrams as shown here.

b. Suppose Fed increases ***M.*** Show the short-run effects on your graphs.

c. Show what happens in the transition from the short run to the long run.

d. How do the new long-run equilibrium values of the endogenous variables compare to their initial values?

CHAPTER 6 Unemployment

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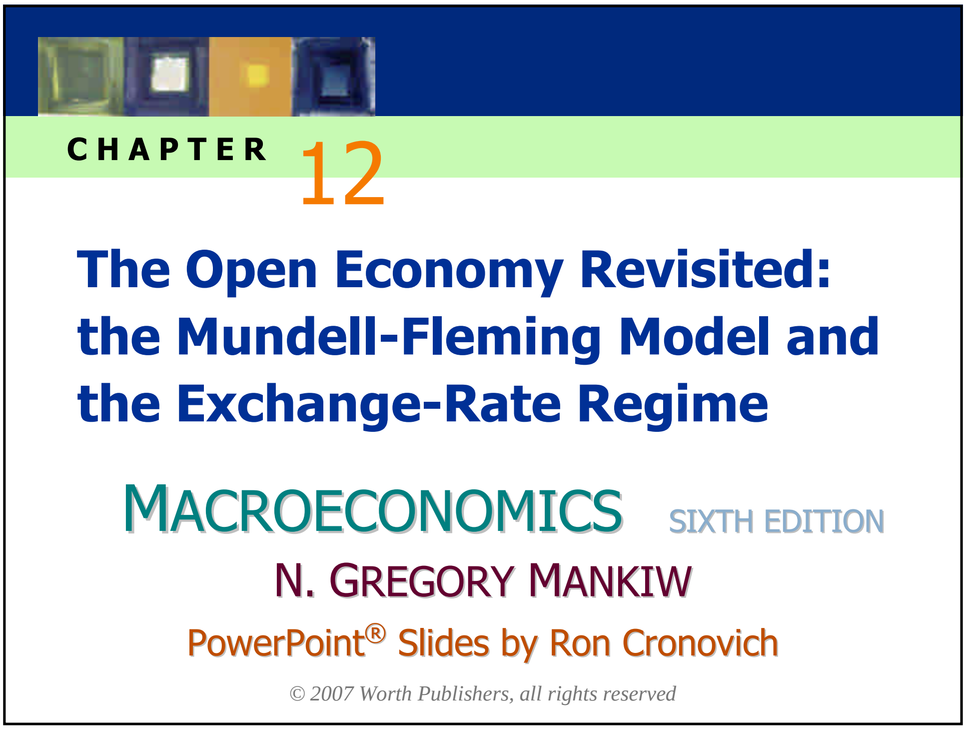


CHAPTER 12

The Open Economy Revisited: the Mundell-Fleming Model and the Exchange-Rate Regime

MACROECONOMICS SIXTH EDITION

N. GREGORY MANKIW

PowerPoint® Slides by Ron Cronovich

The Mundell-Fleming model

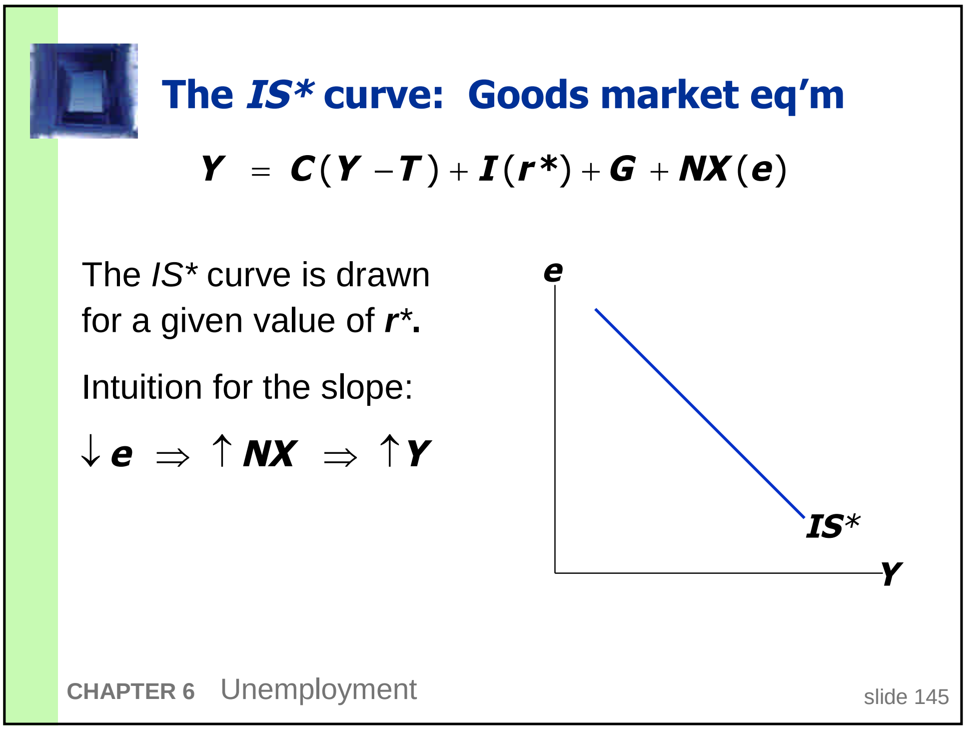
- *Key assumption:*
  Small open economy with perfect capital mobility.

$$r = r^*$$

- Goods market equilibrium – the *IS** curve:

$$Y = C(Y - T) + I(r^*) + G + NX(e)$$

where
e = nominal exchange rate
= foreign currency per unit domestic currency



The *IS** curve: Goods market eq'm

$$Y = C(Y - T) + I(r^*) + G + NX(e)$$

The *IS** curve is drawn for a given value of r^*.

Intuition for the slope:

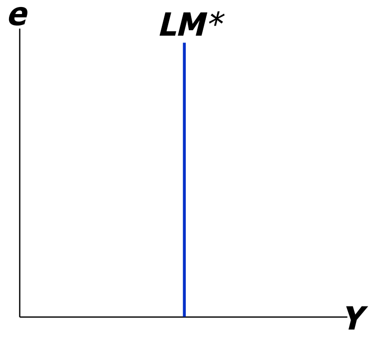
$$\downarrow e \Rightarrow \uparrow NX \Rightarrow \uparrow Y$$

The *LM** curve: Money market eq'm

$$M/P = L(r^*, Y)$$

The *LM** curve

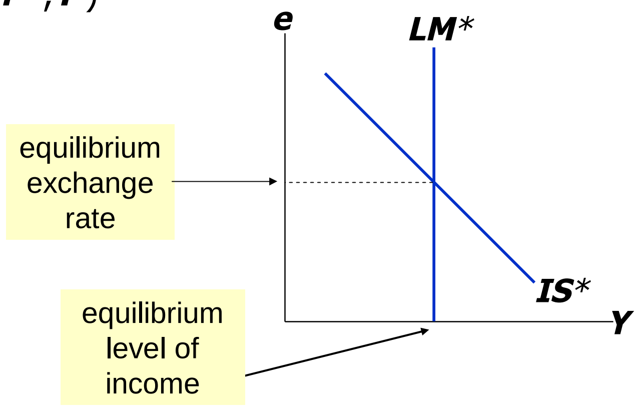
- is drawn for a given value of ***r*.***
- is vertical because: given ***r****, there is only one value of ***Y*** that equates money demand with supply, regardless of ***e***.



Equilibrium in the Mundell-Fleming model

$$Y = C(Y - T) + I(r^*) + G + NX(e)$$

$$M/P = L(r^*, Y)$$



equilibrium exchange rate

equilibrium level of income

Floating & fixed exchange rates

- In a system of **floating exchange rates**, ***e*** is allowed to fluctuate in response to changing economic conditions.
- In contrast, under **fixed exchange rates**, the central bank trades domestic for foreign currency at a predetermined price.
- Next, policy analysis –
  - first, in a floating exchange rate system
  - then, in a fixed exchange rate system

Fiscal policy under floating exchange rates

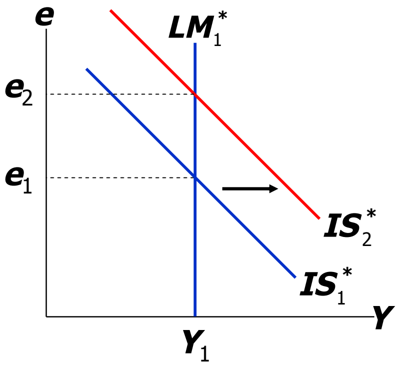
$$Y = C(Y - T) + I(r^*) + G + NX(e)$$

$$M/P = L(r^*, Y)$$

At any given value of ***e*,** a fiscal expansion increases ***Y***, shifting *IS** to the right.

Results:

$\Delta e > 0, \ \Delta Y = 0$



Lessons about fiscal policy

- In a small open economy with perfect capital mobility, fiscal policy cannot affect real GDP.
- “Crowding out”
  - *closed economy:*
    Fiscal policy crowds out investment by causing the interest rate to rise.
  - *small open economy:*
    Fiscal policy crowds out net exports by causing the exchange rate to appreciate.

Monetary policy under floating exchange rates

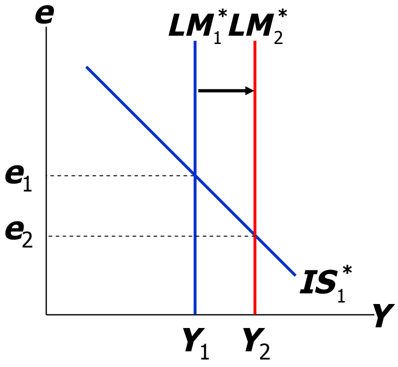
$$Y = C(Y - T) + I(r^*) + G + NX(e)$$

$$M/P = L(r^*, Y)$$

An increase in ***M*** shifts *LM** right because ***Y*** must rise to restore eq’m in the money market.

Results:

$\Delta e < 0, \; \Delta Y > 0$



Lessons about monetary policy

- Monetary policy affects output by affecting the components of aggregate demand:

  closed economy: $\uparrow M \Rightarrow \downarrow r \Rightarrow \uparrow I \Rightarrow \uparrow Y$

  small open economy: $\uparrow M \Rightarrow \downarrow e \Rightarrow \uparrow NX \Rightarrow \uparrow Y$

- Expansionary mon. policy does not raise world agg. demand, it merely shifts demand from foreign to domestic products.

  So, the increases in domestic income and employment are at the expense of losses abroad.

Trade policy under floating exchange rates

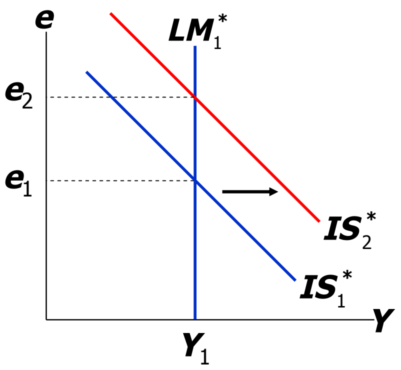
$$Y = C(Y - T) + I(r^*) + G + NX(e)$$

$$M/P = L(r^*, Y)$$

At any given value of ***e***, a tariff or quota reduces imports, increases ***NX***, and shifts *IS** to the right.

Results:

$\Delta e > 0, \ \Delta Y = 0$



Lessons about trade policy

- Import restrictions cannot reduce a trade deficit.
- Even though ***NX*** is unchanged, there is less trade:
  - the trade restriction reduces imports.
  - the exchange rate appreciation reduces exports.
- Less trade means fewer “gains from trade.”

Lessons about trade policy, *cont.*

- Import restrictions on specific products save jobs in the domestic industries that produce those products, but destroy jobs in export-producing sectors.
- Hence, import restrictions fail to increase total employment.
- Also, import restrictions create “sectoral shifts,” which cause frictional unemployment.

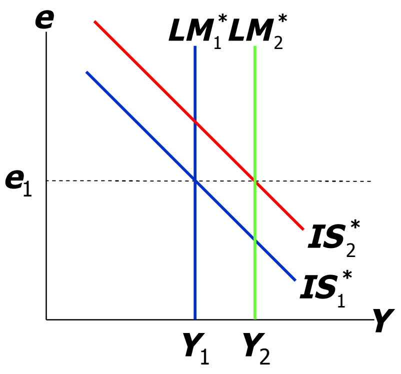
Fixed exchange rates

- Under fixed exchange rates, the central bank stands ready to buy or sell the domestic currency for foreign currency at a predetermined rate.
- In the Mundell-Fleming model, the central bank shifts the *LM** curve as required to keep ***e*** at its preannounced rate.
- This system fixes the nominal exchange rate.
  In the long run, when prices are flexible,
  the real exchange rate can move even if the nominal rate is fixed.

Fiscal policy under fixed exchange rates

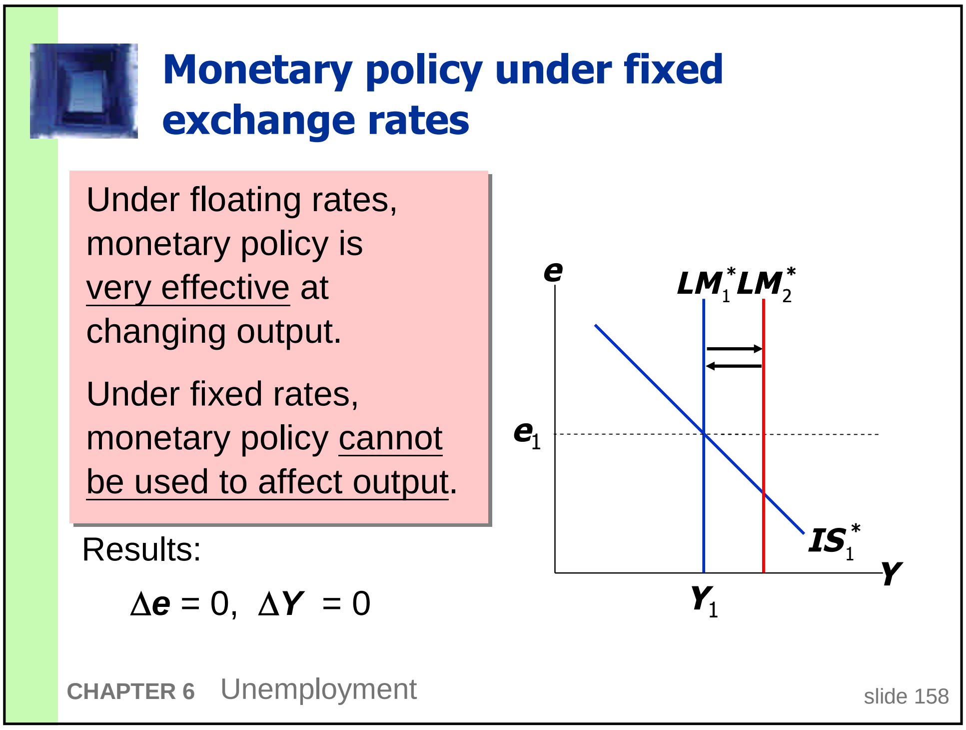
Under floating rates,
fiscal policy is ineffective
at changing output.

Under fixed rates,
fiscal policy is very
effective at changing
output.



Results:

$\Delta e = 0$, $\Delta Y > 0$



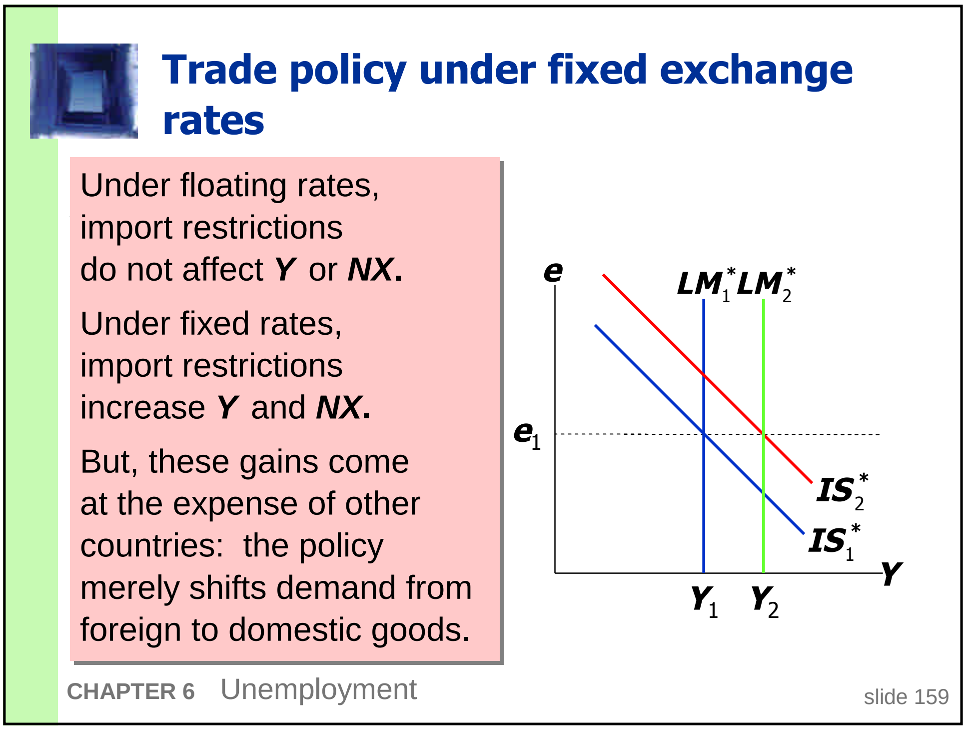
Monetary policy under fixed exchange rates

Under floating rates, monetary policy is very effective at changing output.

Under fixed rates, monetary policy cannot be used to affect output.

Results:

$\Delta e = 0$, $\Delta Y = 0$

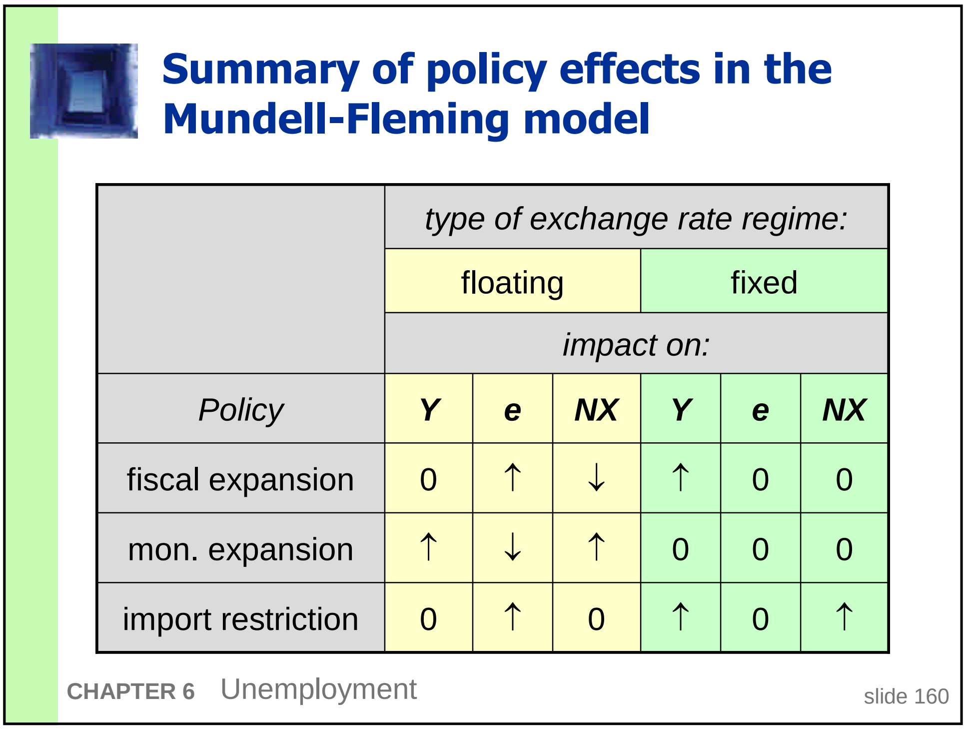


Trade policy under fixed exchange rates

Under floating rates, import restrictions do not affect *Y* or ***NX*.**

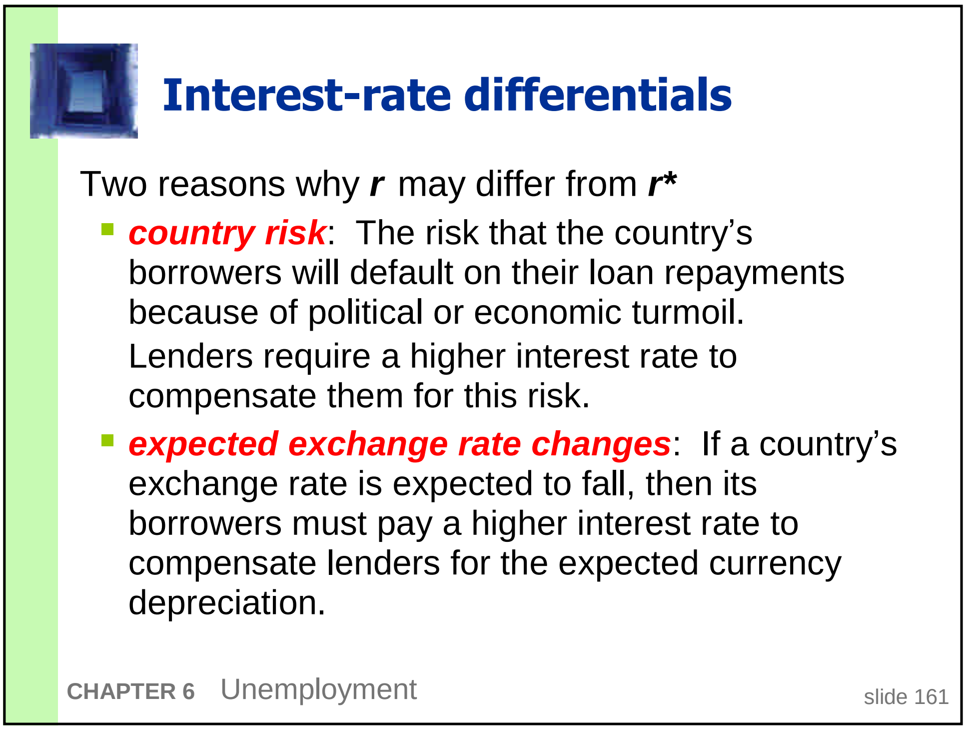
Under fixed rates, import restrictions increase *Y* and ***NX*.**

But, these gains come at the expense of other countries: the policy merely shifts demand from foreign to domestic goods.



Summary of policy effects in the Mundell-Fleming model

	type of exchange rate regime:					
	floating			fixed		
	impact on:					
Policy	***Y***	***e***	***NX***	***Y***	***e***	***NX***
fiscal expansion	0	↑	↓	↑	0	0
mon. expansion	↑	↓	↑	0	0	0
import restriction	0	↑	0	↑	0	↑



Interest-rate differentials

Two reasons why ***r*** may differ from ***r****

- ***country risk***: The risk that the country's borrowers will default on their loan repayments because of political or economic turmoil.
  Lenders require a higher interest rate to compensate them for this risk.
- ***expected exchange rate changes***: If a country's exchange rate is expected to fall, then its borrowers must pay a higher interest rate to compensate lenders for the expected currency depreciation.

Differentials in the M-F model

$$r = r^* + \theta$$

where θ (Greek letter "theta") is a risk premium, assumed exogenous.

Substitute the expression for r into the *IS** and *LM** equations:

$$Y = C(Y - T) + I(r^* + \theta) + G + NX(e)$$

$$M/P = L(r^* + \theta, Y)$$

The effects of an increase in θ

*IS** shifts left, because

$\uparrow\theta \Rightarrow \uparrow r \Rightarrow \downarrow I$

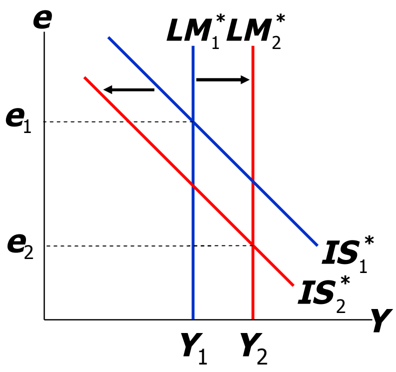
*LM** shifts right, because

$\uparrow\theta \Rightarrow \uparrow r \Rightarrow \downarrow(M/P)^d$,

so Y must rise to restore money market eq'm.

Results:

$\Delta e < 0$, $\Delta Y > 0$



The effects of an increase in θ

- The fall in ***e*** is intuitive:
  An increase in country risk or an expected depreciation makes holding the country's currency less attractive.
- The increase in ***Y*** occurs because

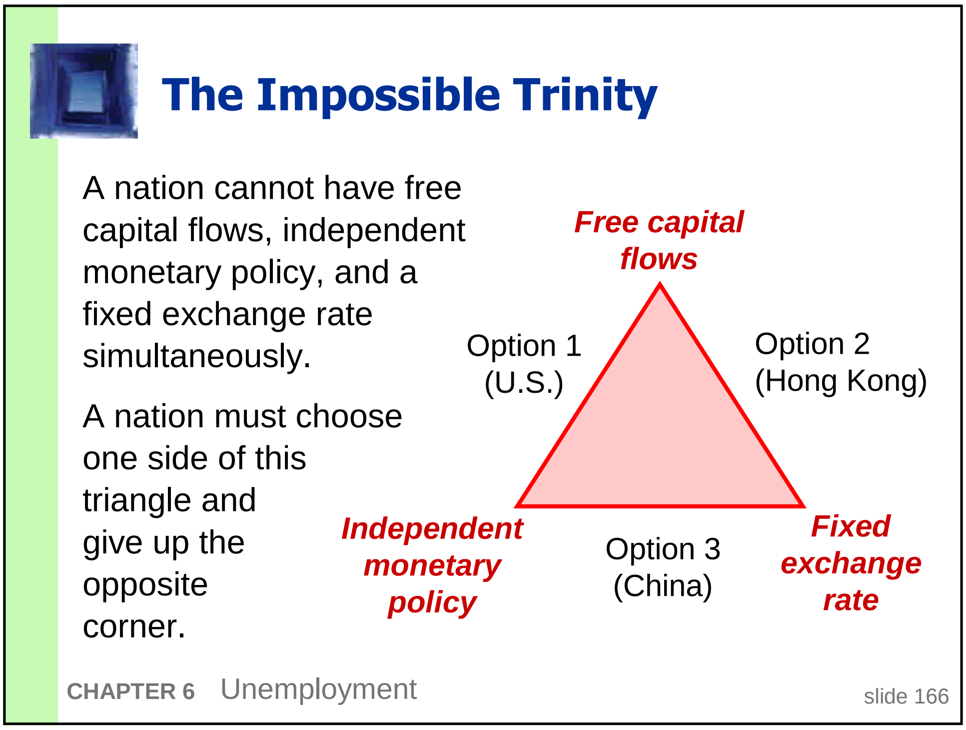
  the boost in ***NX*** (from the depreciation)

  is greater than the fall in ***I*** (from the rise in ***r***).

Why income might not rise

- The central bank may try to prevent the depreciation by reducing the money supply.
- The depreciation might boost the price of imports enough to increase the price level (which would reduce the real money supply).
- Consumers might respond to the increased risk by holding more money.

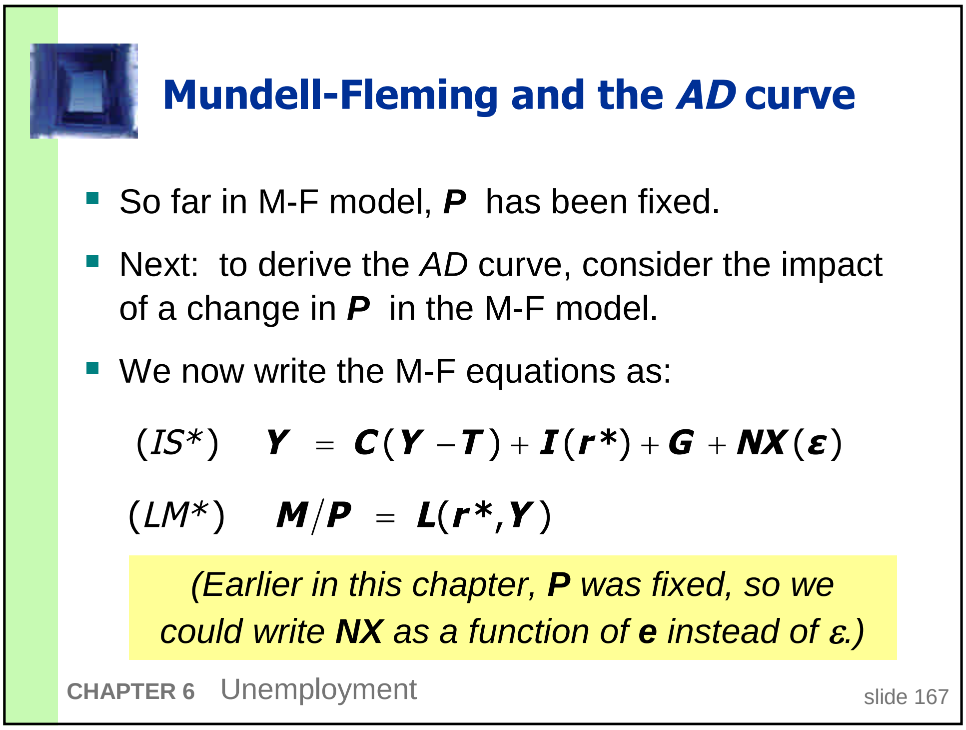
Each of the above would shift *LM** leftward.



The Impossible Trinity

A nation cannot have free capital flows, independent monetary policy, and a fixed exchange rate simultaneously.

A nation must choose one side of this triangle and give up the opposite corner.



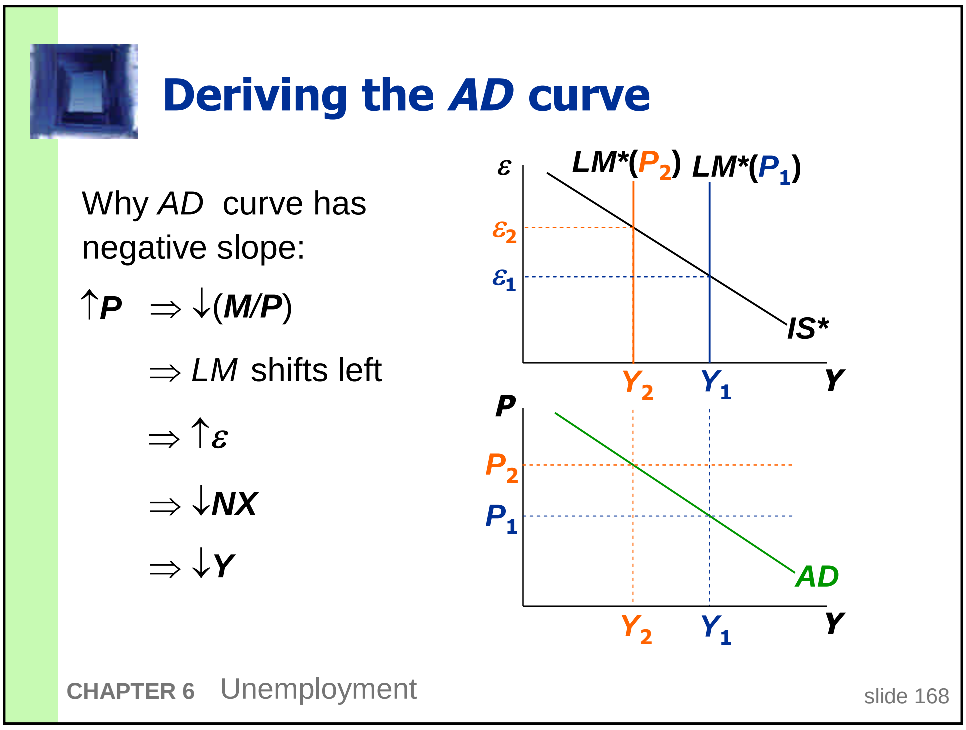
Mundell-Fleming and the *AD* curve

- So far in M-F model, ***P*** has been fixed.
- Next: to derive the *AD* curve, consider the impact of a change in ***P*** in the M-F model.
- We now write the M-F equations as:

$$(IS^*) \quad \boldsymbol{Y} = \boldsymbol{C}(\boldsymbol{Y} - \boldsymbol{T}) + \boldsymbol{I}(\boldsymbol{r}^*) + \boldsymbol{G} + \boldsymbol{NX}(\boldsymbol{\varepsilon})$$

$$(LM^*) \quad \boldsymbol{M}/\boldsymbol{P} = \boldsymbol{L}(\boldsymbol{r}^*, \boldsymbol{Y})$$

*(Earlier in this chapter, **P** was fixed, so we could write **NX** as a function of **e** instead of ε.)*



Deriving the *AD* curve

Why *AD* curve has negative slope:

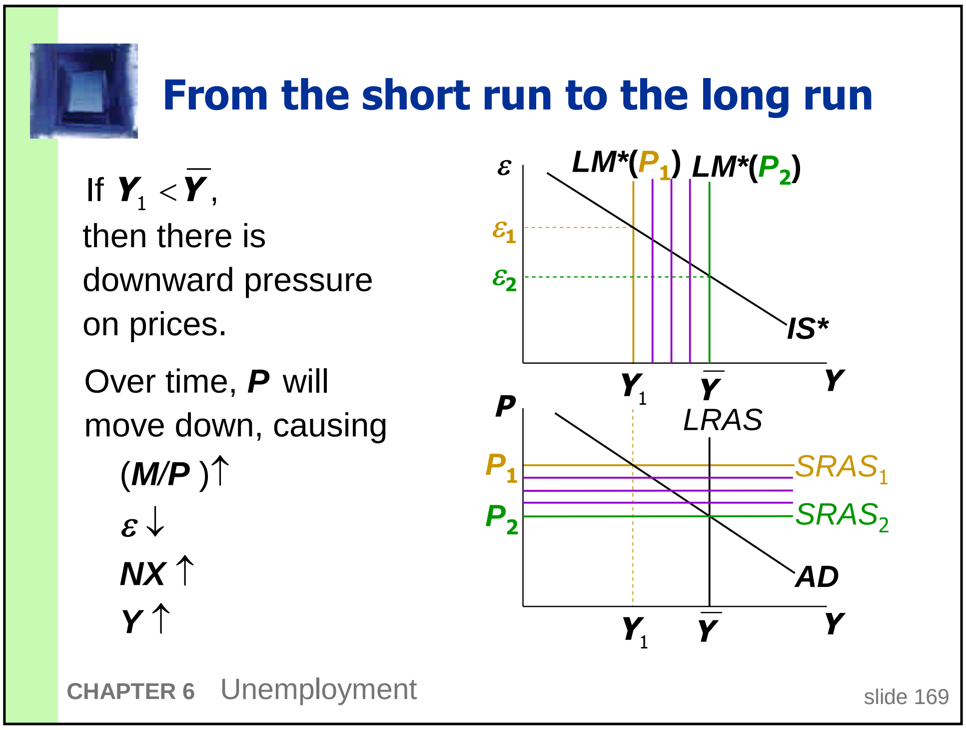
↑***P*** ⇒ ↓(***M/P***)

⇒ *LM* shifts left

⇒ ↑ε

⇒ ↓***NX***

⇒ ↓***Y***



From the short run to the long run

If $\boldsymbol{Y}_1 < \overline{\boldsymbol{Y}}$, then there is downward pressure on prices.

Over time, ***P*** will move down, causing

(***M/P***)↑

ε↓

NX↑

Y↑

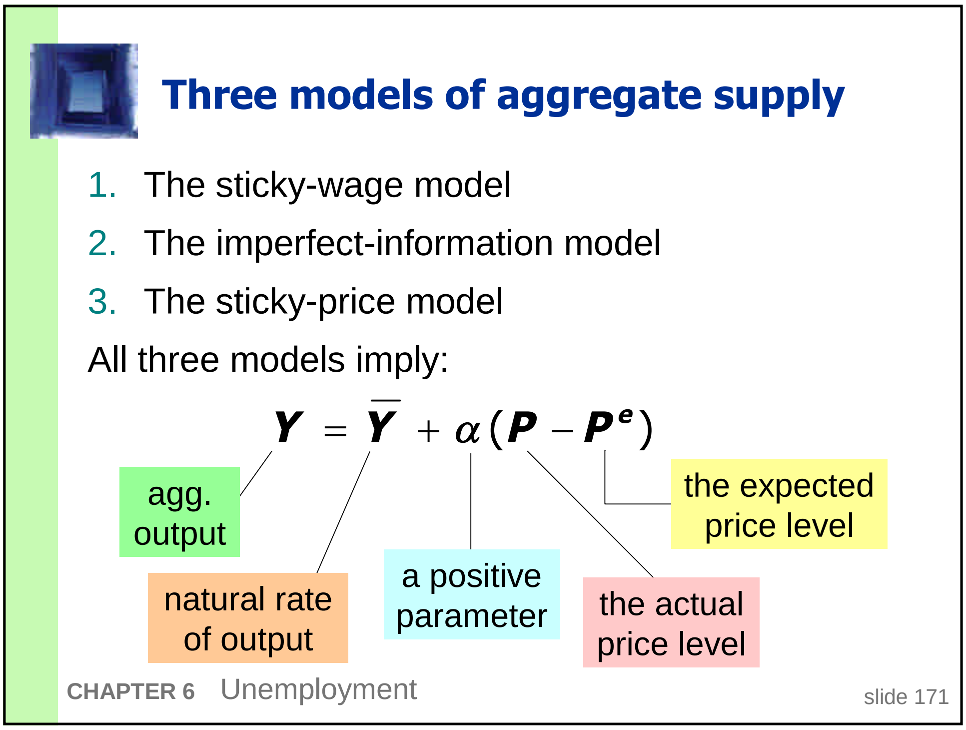
CHAPTER 13

Aggregate Supply and the Short-run Tradeoff Between Inflation and Unemployment

MACROECONOMICS SIXTH EDITION

N. GREGORY MANKIW

PowerPoint® Slides by Ron Cronovich



Three models of aggregate supply

1. The sticky-wage model
2. The imperfect-information model
3. The sticky-price model

All three models imply:

$$Y = \bar{Y} + \alpha(P - P^e)$$

The sticky-wage model

- Assumes that firms and workers negotiate contracts and fix the nominal wage before they know what the price level will turn out to be.
- The nominal wage they set is the product of a target real wage and the expected price level:

$$W = \omega \times P^e$$

Target real wage

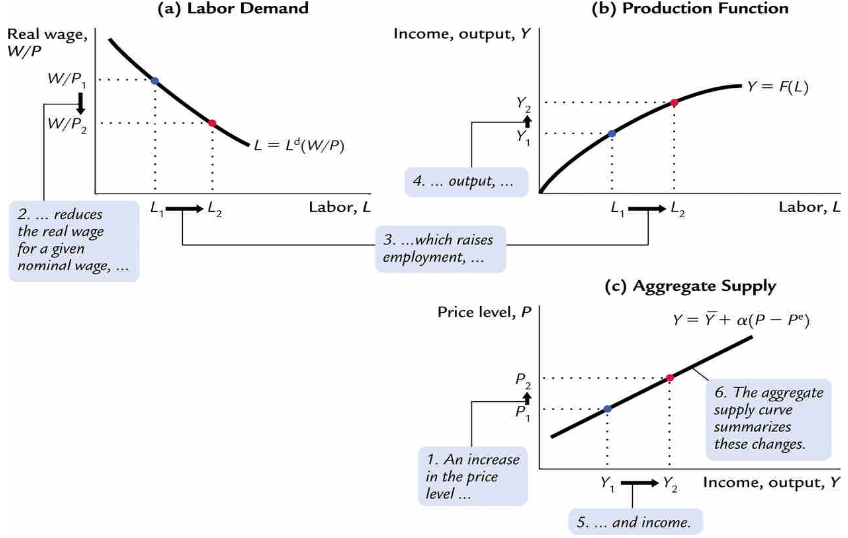
$$\Rightarrow \frac{W}{P} = \omega \times \frac{P^e}{P}$$

The sticky-wage model

$$\frac{W}{P} = \omega \times \frac{P^e}{P}$$

If it turns out that	then
$P = P^e$	Unemployment and output are at their natural rates.
$P > P^e$	Real wage is less than its target, so firms hire more workers and output rises above its natural rate.
$P < P^e$	Real wage exceeds its target, so firms hire fewer workers and output falls below its natural rate.

The sticky-wage model



The sticky-wage model

- Implies that the real wage should be ***counter-cyclical***, should move in the opposite direction as output during business cycles:
    - In booms, when ***P*** typically rises, real wage should fall.
    - In recessions, when ***P*** typically falls, real wage should rise.
- This prediction does not come true in the real world:

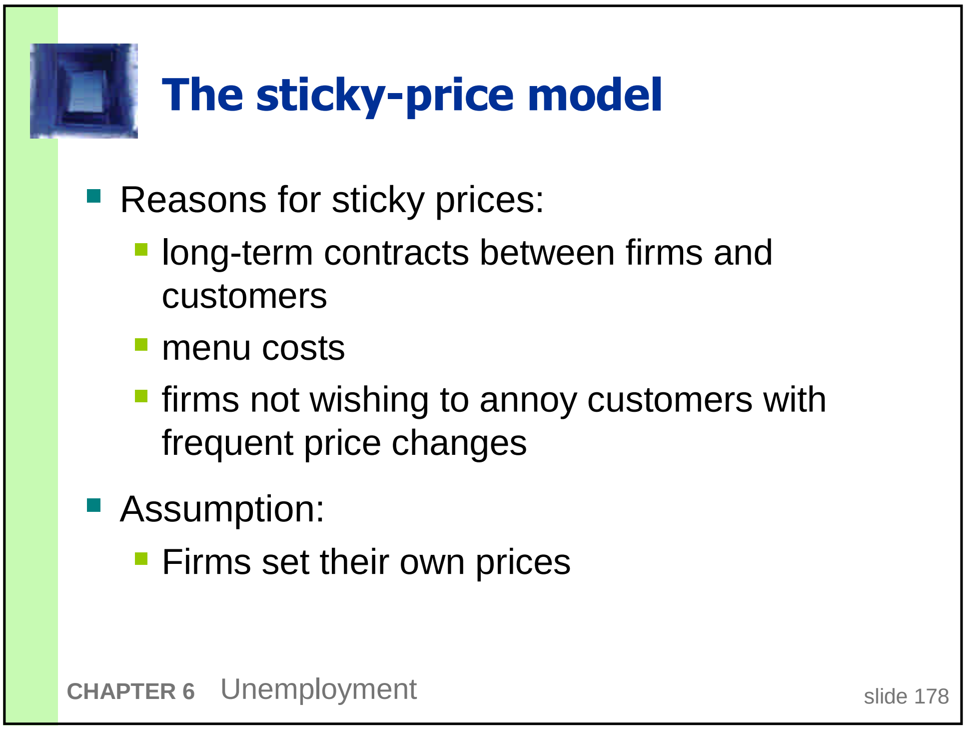
The imperfect-information model

Assumptions:

- All wages and prices are perfectly flexible, all markets are clear.
- Each supplier produces one good, consumes many goods.
- Each supplier knows the nominal price of the good she produces, but does not know the overall price level.

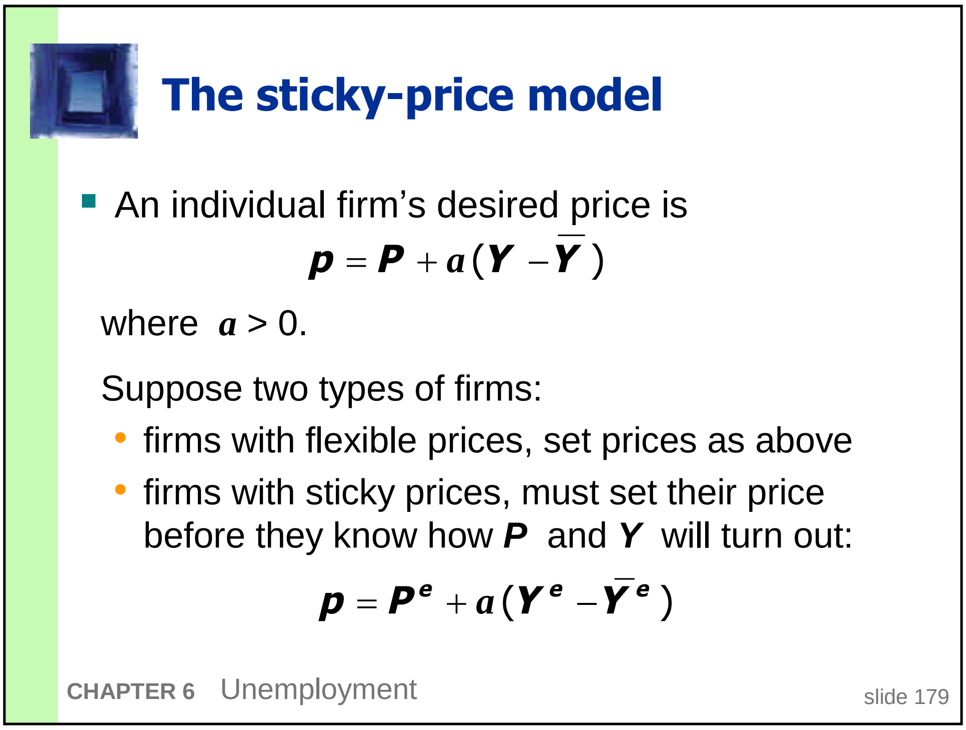
The imperfect-information model

- Supply of each good depends on its relative price: the nominal price of the good divided by the overall price level.
- Supplier does not know price level at the time she makes her production decision, so uses the expected price level, P^e.
- Suppose P rises but P^e does not.
  - Supplier thinks her relative price has risen, so she produces more.
  - With many producers thinking this way, Y will rise whenever P rises above P^e.



The sticky-price model

- Reasons for sticky prices:
  - long-term contracts between firms and customers
  - menu costs
  - firms not wishing to annoy customers with frequent price changes
- Assumption:
  - Firms set their own prices



The sticky-price model

- An individual firm's desired price is

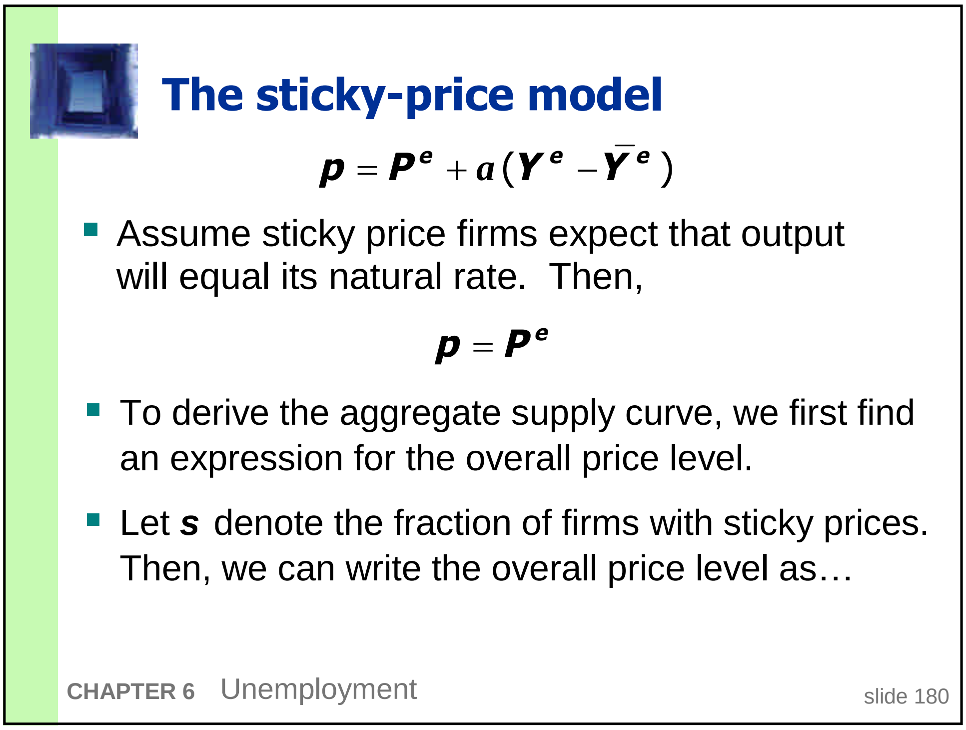
$$\boldsymbol{p} = \boldsymbol{P} + a(\boldsymbol{Y} - \bar{\boldsymbol{Y}})$$

where $a > 0$.

Suppose two types of firms:

- firms with flexible prices, set prices as above
- firms with sticky prices, must set their price before they know how $\boldsymbol{P}$ and $\boldsymbol{Y}$ will turn out:

$$\boldsymbol{p} = \boldsymbol{P}^{\boldsymbol{e}} + a(\boldsymbol{Y}^{\boldsymbol{e}} - \bar{\boldsymbol{Y}}^{\boldsymbol{e}})$$



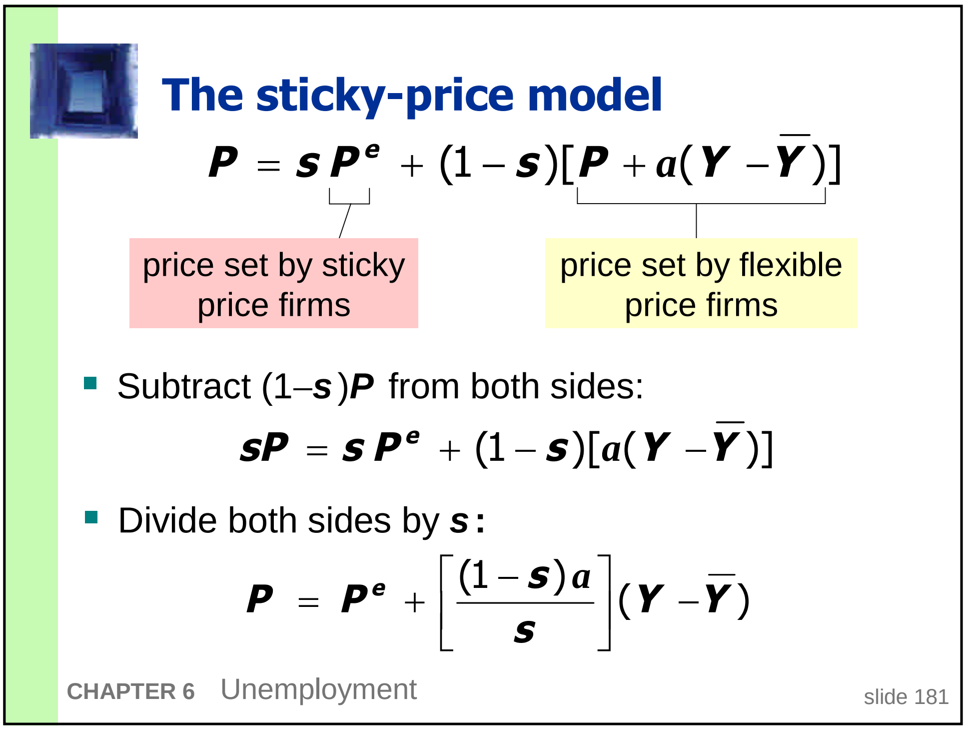
The sticky-price model

$$p = P^e + a(Y^e - \bar{Y}^e)$$

- Assume sticky price firms expect that output will equal its natural rate. Then,

$$p = P^e$$

- To derive the aggregate supply curve, we first find an expression for the overall price level.
- Let s denote the fraction of firms with sticky prices. Then, we can write the overall price level as…



The sticky-price model

$$P = \underbrace{sP^e}_{\text{price set by sticky price firms}} + (1-s)\underbrace{[P + a(Y - \bar{Y})]}_{\text{price set by flexible price firms}}$$

- Subtract $(1–s)P$ from both sides:

$$sP = sP^e + (1-s)[a(Y - \bar{Y})]$$

- Divide both sides by s:

$$P = P^e + \left[\frac{(1-s)a}{s}\right](Y - \bar{Y})$$

The sticky-price model

$$\boldsymbol{P} = \boldsymbol{P}^{e} + \left[\frac{(1-\boldsymbol{s})\boldsymbol{a}}{\boldsymbol{s}}\right](\boldsymbol{Y} - \overline{\boldsymbol{Y}})$$

- High $\boldsymbol{P}^{e}$ ⇒ High $\boldsymbol{P}$
  If firms expect high prices, then firms that must set prices in advance will set them high.
  Other firms respond by setting high prices.
- High $\boldsymbol{Y}$ ⇒ High $\boldsymbol{P}$
  When income is high, the demand for goods is high. Firms with flexible prices set high prices.
  The greater the fraction of flexible price firms, the smaller is $\boldsymbol{s}$ and the bigger is the effect of $\Delta \boldsymbol{Y}$ on $\boldsymbol{P}$.

The sticky-price model

$$\boldsymbol{P} = \boldsymbol{P}^{e} + \left[\frac{(1-\boldsymbol{s})\boldsymbol{a}}{\boldsymbol{s}}\right](\boldsymbol{Y} - \overline{\boldsymbol{Y}})$$

- Finally, derive *AS* equation by solving for $\boldsymbol{Y}$:

$$\boldsymbol{Y} = \overline{\boldsymbol{Y}} + \alpha(\boldsymbol{P} - \boldsymbol{P}^{e}),$$

$$\text{where} \quad \alpha = \frac{\boldsymbol{s}}{(1-\boldsymbol{s})\boldsymbol{a}}$$

The sticky-price model

- In contrast to the sticky-wage model, the sticky-price model implies a pro-cyclical real wage:

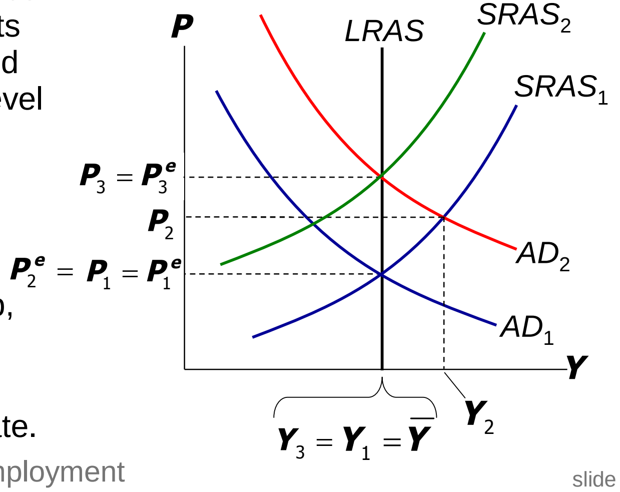
  Suppose aggregate output/income falls. Then,
  - Firms see a fall in demand for their products.
  - Firms with sticky prices reduce production, and hence reduce their demand for labor.
  - The leftward shift in labor demand causes the real wage to fall.

Summary & implications

SRAS equation: $Y = \overline{Y} + \alpha (P - P^e)$

Suppose a positive *AD* shock moves output above its natural rate and ***P*** above the level people had expected.

Over time, P^e rises, *SRAS* shifts up, and output returns to its natural rate.



Inflation, Unemployment, and the Phillips Curve

The **Phillips curve** states that π depends on

- expected inflation, π^{e}.
- **cyclical unemployment**: the deviation of the actual rate of unemployment from the natural rate
- supply shocks, ν (Greek letter “nu”).

$$\pi = \pi^{e} - \beta(u - u^{n}) + \nu$$

where $\beta > 0$ is an exogenous constant.

Deriving the Phillips Curve from *SRAS*

(1) $Y = \overline{Y} + \alpha(P - P^{e})$

(2) $P = P^{e} + (1/\alpha)(Y - \overline{Y})$

(3) $P = P^{e} + (1/\alpha)(Y - \overline{Y}) + \nu$

(4) $(P - P_{-1}) = (P^{e} - P_{-1}) + (1/\alpha)(Y - \overline{Y}) + \nu$

(5) $\pi = \pi^{e} + (1/\alpha)(Y - \overline{Y}) + \nu$

(6) $(1/\alpha)(Y - \overline{Y}) = -\beta(u - u^{n})$

(7) $\pi = \pi^{e} - \beta(u - u^{n}) + \nu$

The Phillips Curve and *SRAS*

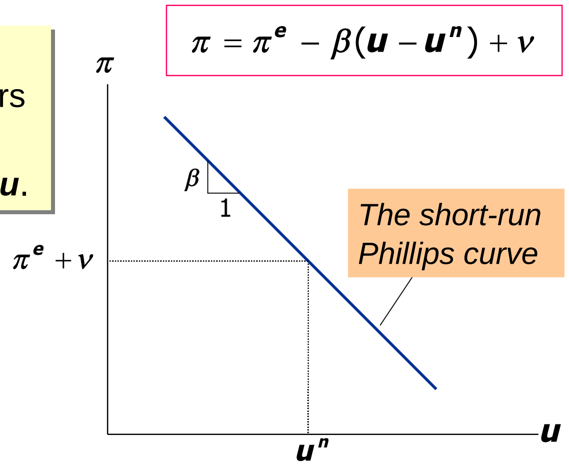
SRAS: $Y = \overline{Y} + \alpha(P - P^e)$

Phillips curve: $\pi = \pi^e - \beta(u - u^n) + \nu$

- *SRAS* curve:
  Output is related to
  unexpected movements in the price level.
- Phillips curve:
  Unemployment is related to
  unexpected movements in the inflation rate.

Graphing the Phillips curve

In the short run, policymakers face a tradeoff between π and u.



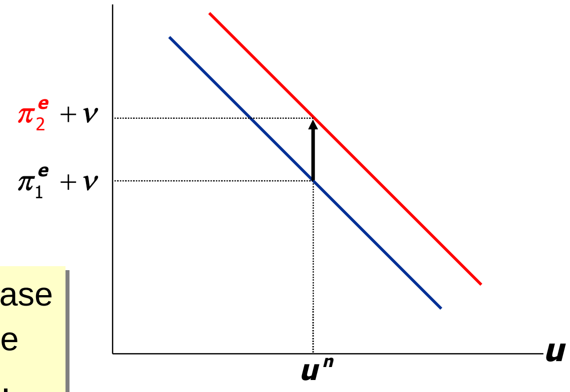
The short-run Phillips curve

Shifting the Phillips curve

People adjust their expectations over time, so the tradeoff only holds in the short run.

E.g., an increase in π^e shifts the short-run P.C. upward.

$$\pi = \pi^e - \beta(u - u^n) + v$$



The sacrifice ratio

- To reduce inflation, policymakers can contract agg. demand, causing unemployment to rise above the natural rate.
- The **sacrifice ratio** measures the percentage of a year’s real GDP that must be foregone to reduce inflation by 1 percentage point.
- A typical estimate of the ratio is 5.

The sacrifice ratio

- Example: To reduce inflation from 6 to 2 percent, must sacrifice 20 percent of one year's GDP:

  GDP loss = (inflation reduction) x (sacrifice ratio)
  = 4 x 5

- This loss could be incurred in one year or spread over several, *e.g.*, 5% loss for each of four years.
- The cost of disinflation is lost GDP.
  One could use Okun's law to translate this cost into unemployment.

Rational expectations

Ways of modeling the formation of expectations:

- **adaptive expectations**:
  People base their expectations of future inflation on recently observed inflation.
- **rational expectations**:
  People base their expectations on all available information, including information about current and prospective future policies.

Adaptive expectations

- **Adaptive expectations**: an approach that assumes people form their expectations of future inflation based on recently observed inflation.
- A simple example:
  Expected inflation = last year's actual inflation

$$\pi^{e} = \pi_{-1}$$

- Then, the P.C. becomes

$$\pi = \pi_{-1} - \beta(u - u^{n}) + v$$

Painless disinflation?

- Proponents of rational expectations believe that the sacrifice ratio may be very small:
- Suppose $u = u^{n}$ and $\pi = \pi^{e} = 6\%$,
  and suppose the Fed announces that it will do whatever is necessary to reduce inflation from 6 to 2 percent as soon as possible.
- If the announcement is credible,
  then π^{e} will fall, perhaps by the full 4 points.
- Then, π can fall without an increase in u.

CHAPTER 7

Economic Growth I: Capital Accumulation and Population Growth

MACROECONOMICS SIXTH EDITION

N. GREGORY MANKIW

PowerPoint® Slides by Ron Cronovich

The Solow model

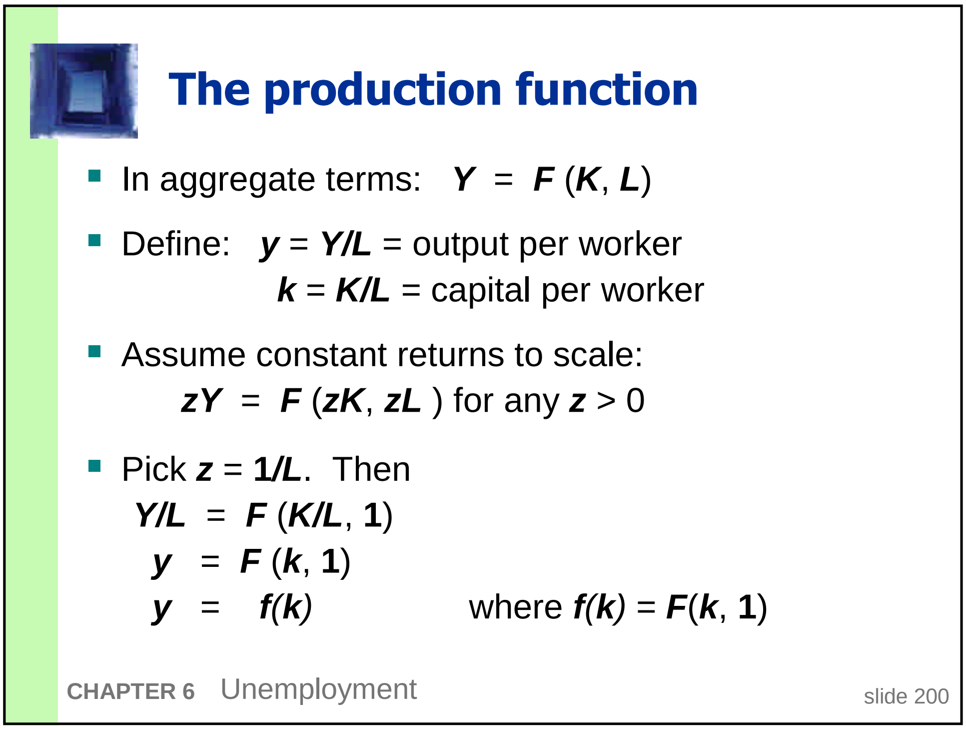
- due to Robert Solow,
  won Nobel Prize for contributions to
  the study of economic growth
- a major paradigm:
  - widely used in policy making
  - benchmark against which most recent growth theories are compared
- looks at the determinants of economic growth and the standard of living in the long run

How Solow model is different from Chapter 3's model

1. ***K*** is no longer fixed:
   investment causes it to grow,
   depreciation causes it to shrink
2. ***L*** is no longer fixed:
   population growth causes it to grow
3. the consumption function is simpler

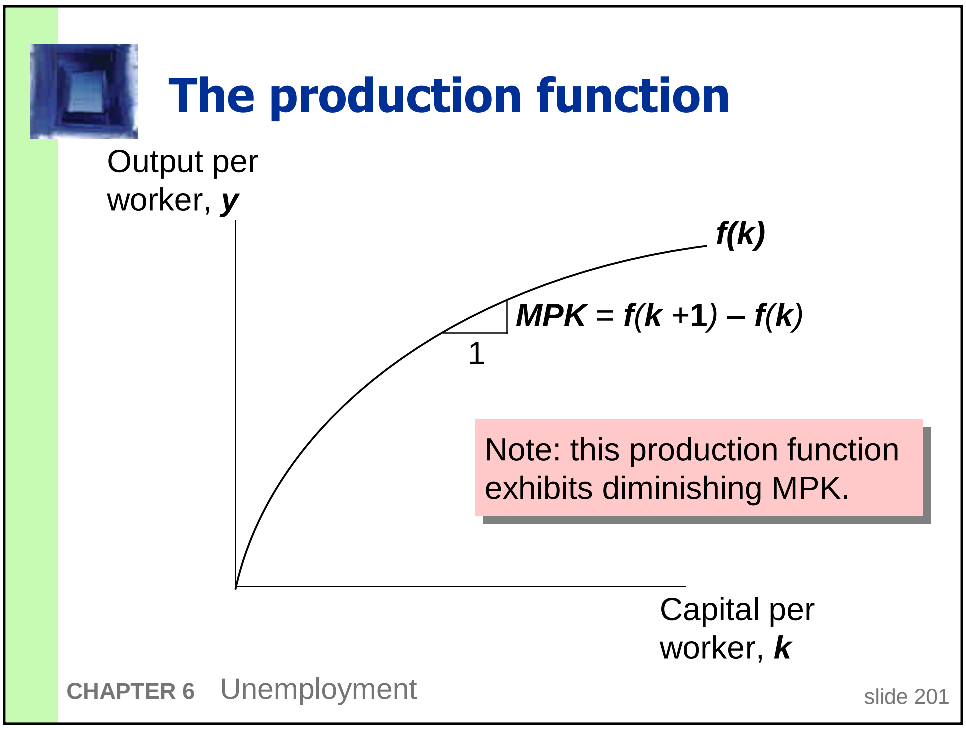
How Solow model is different from Chapter 3's model

4. no ***G*** or ***T***
   (only to simplify presentation;
   we can still do fiscal policy experiments)
5. cosmetic differences



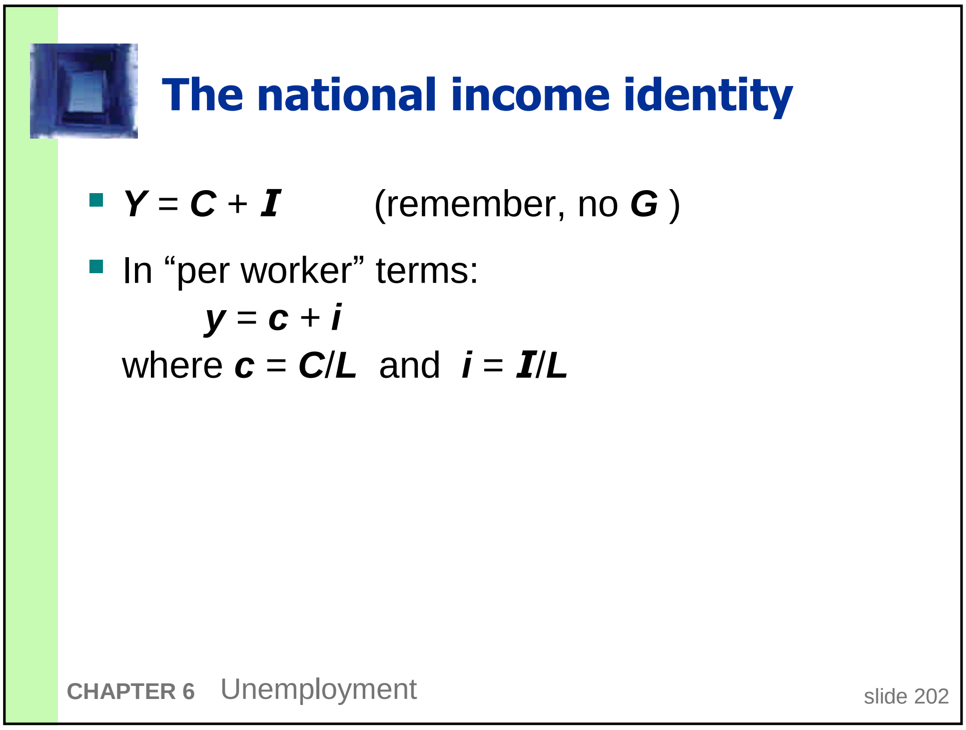
The production function

- In aggregate terms: **$Y = F(K, L)$**
- Define: **$y = Y/L$** = output per worker
  $k = K/L$ = capital per worker
- Assume constant returns to scale:
  $zY = F(zK, zL)$ for any **z** > 0
- Pick **$z = 1/L$**. Then
  $Y/L = F(K/L, 1)$
  $y = F(k, 1)$
  $y = f(k)$ where **$f(k) = F(k, 1)$**



The production function

Note: this production function exhibits diminishing MPK.

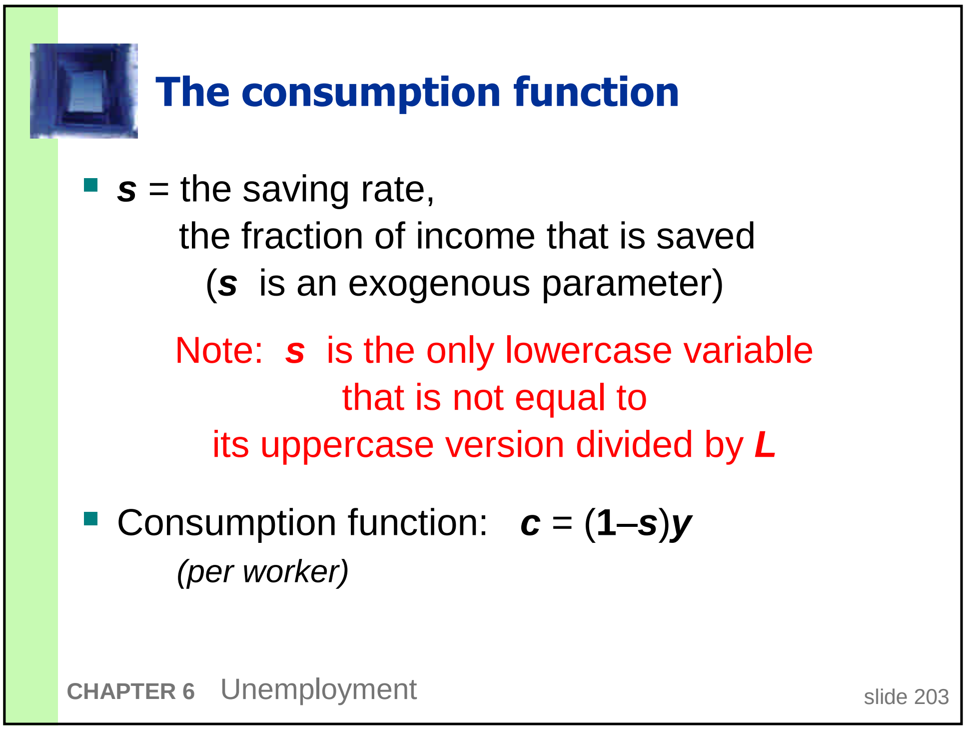


The national income identity

- $Y = C + I$ (remember, no G)
- In "per worker" terms:

  $y = c + i$

  where $c = C/L$ and $i = I/L$



The consumption function

- s = the saving rate,

  the fraction of income that is saved

  (s is an exogenous parameter)

  Note: s is the only lowercase variable
  that is not equal to
  its uppercase version divided by L

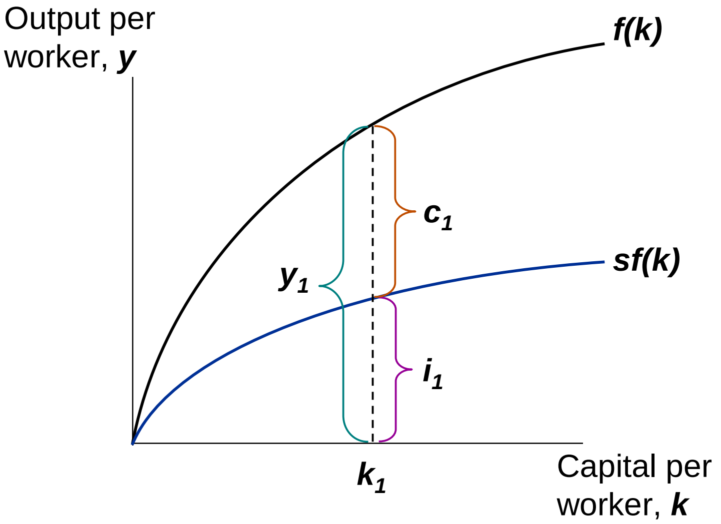
- Consumption function: $c = (1–s)y$

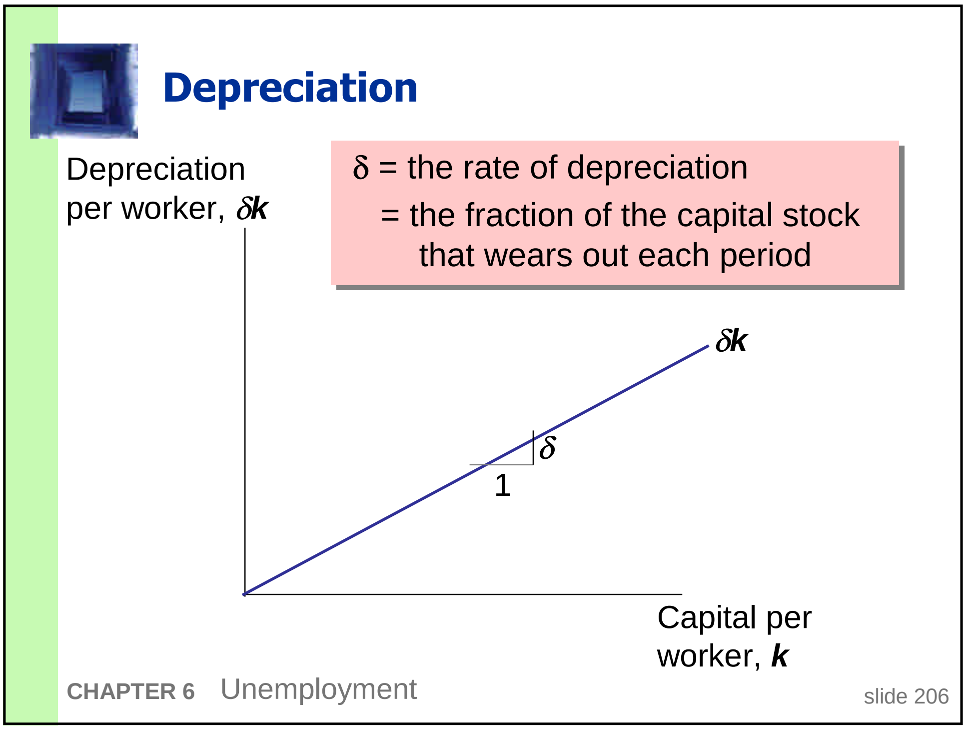
  (per worker)

Saving and investment

- saving (per worker) $= y - c$
  $= y - (1-s)y$
  $= sy$
- National income identity is $y = c + i$
  Rearrange to get: $i = y - c = sy$
  (investment = saving, like in chap. 3!)
- Using the results above,
  $i = sy = sf(k)$

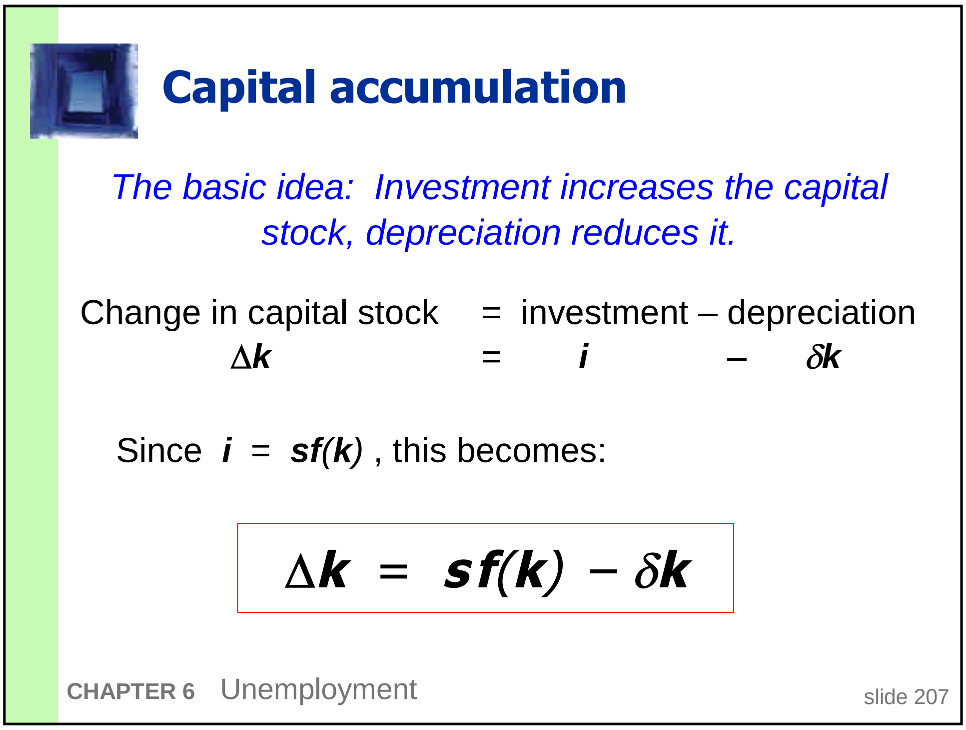
Output, consumption, and investment





Depreciation

δ = the rate of depreciation
= the fraction of the capital stock that wears out each period



Capital accumulation

The basic idea: Investment increases the capital stock, depreciation reduces it.

Change in capital stock = investment – depreciation

$$\Delta k = i - \delta k$$

Since $i = sf(k)$, this becomes:

$$\boxed{\Delta k = sf(k) - \delta k}$$

The equation of motion for *k*

$$\boxed{\Delta k = s f(k) - \delta k}$$

- The Solow model's central equation
- Determines behavior of capital over time…
- …which, in turn, determines behavior of all of the other endogenous variables because they all depend on ***k***. *E.g.*,

  income per person: $y = f(k)$

  consumption per person: $c = (1-s) f(k)$

The steady state

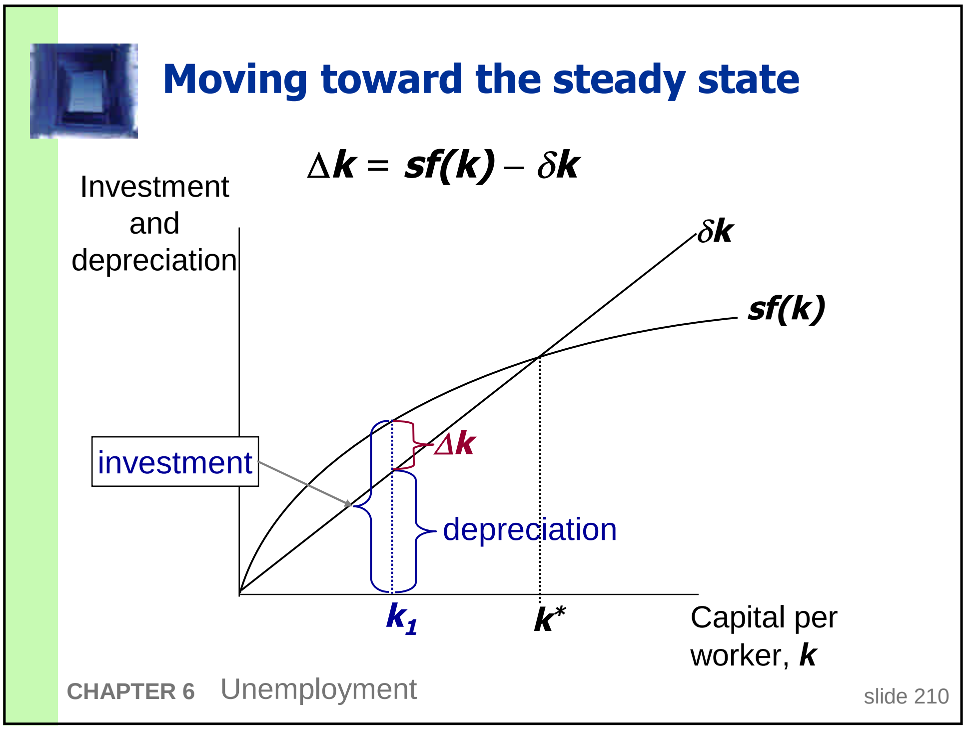
$$\boxed{\Delta k = s f(k) - \delta k}$$

If investment is just enough to cover depreciation $[sf(k) = \delta k]$,

then capital per worker will remain constant:

$$\Delta k = 0.$$

This occurs at one value of ***k***, denoted k^*, called the ***steady state capital stock***.

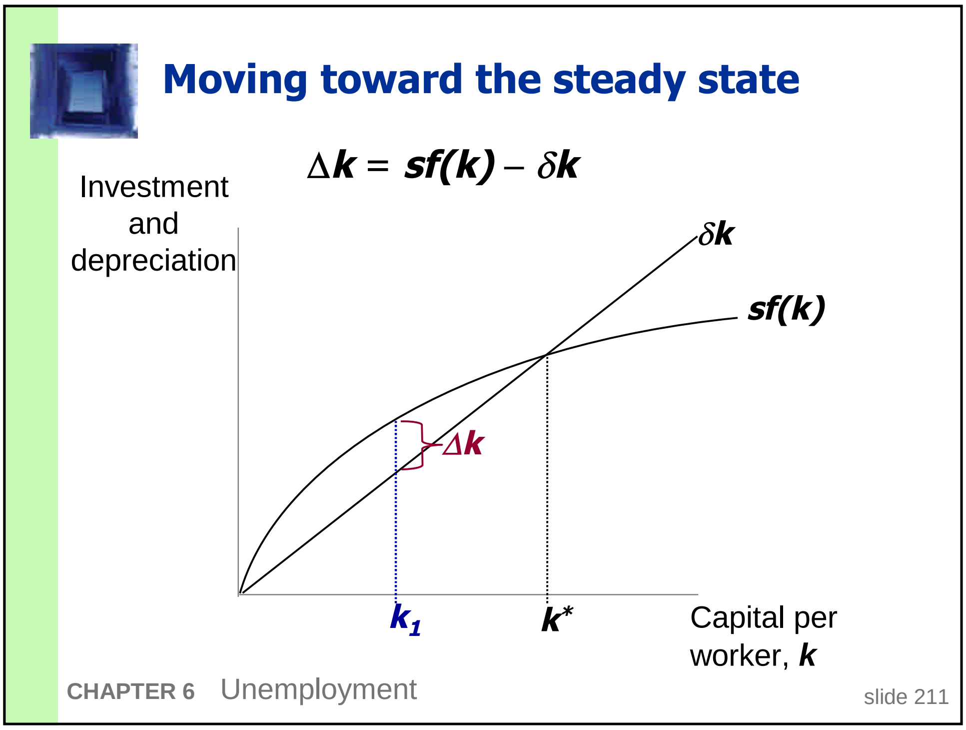


Moving toward the steady state

$$\Delta k = sf(k) - \delta k$$

CHAPTER 6 Unemployment

slide 210



Moving toward the steady state

$$\Delta k = sf(k) - \delta k$$

CHAPTER 6 Unemployment

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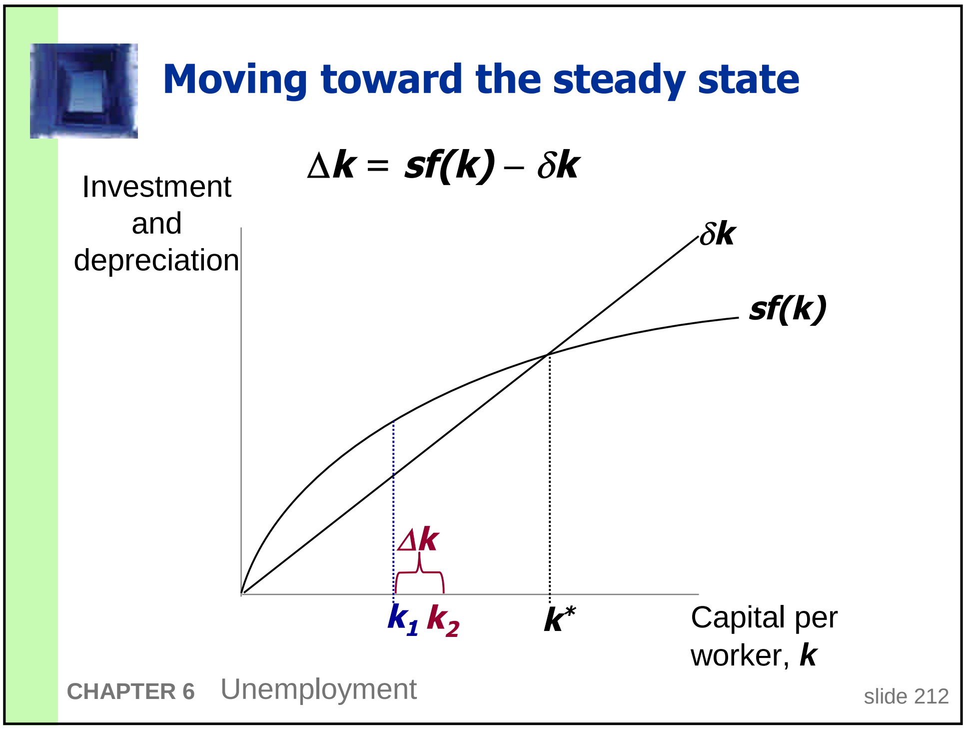
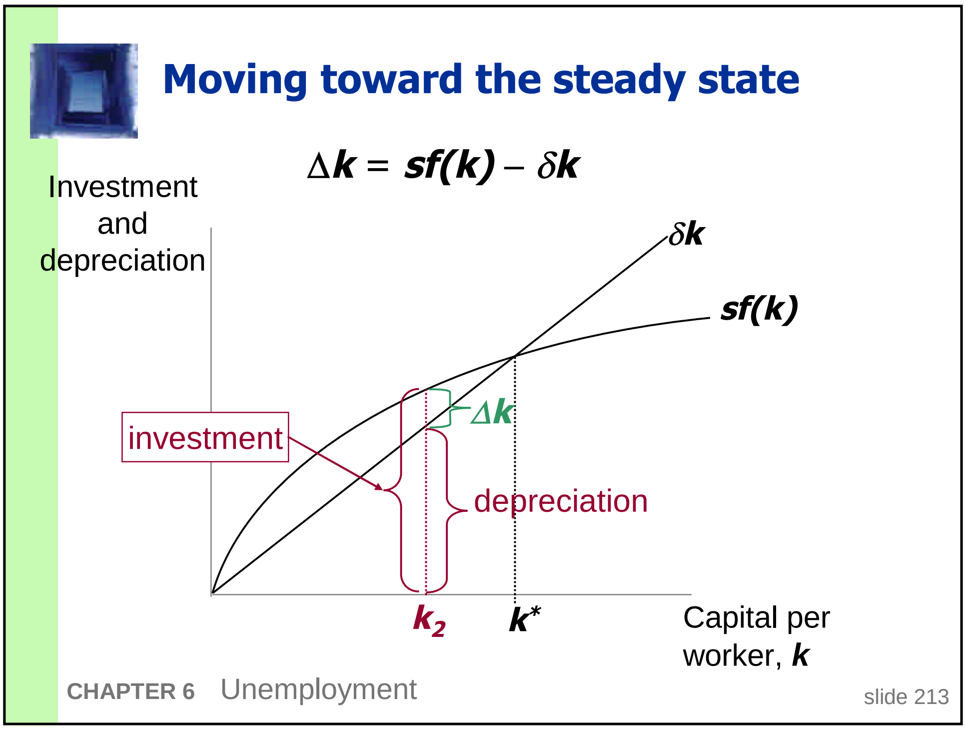


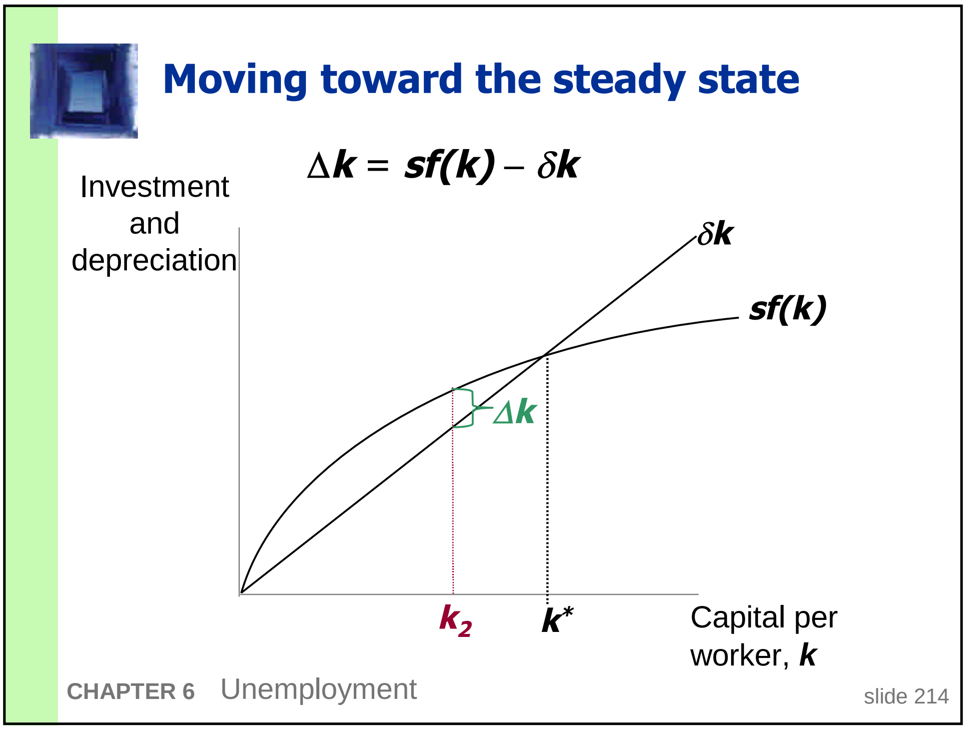
Moving toward the steady state

$$\Delta k = sf(k) - \delta k$$



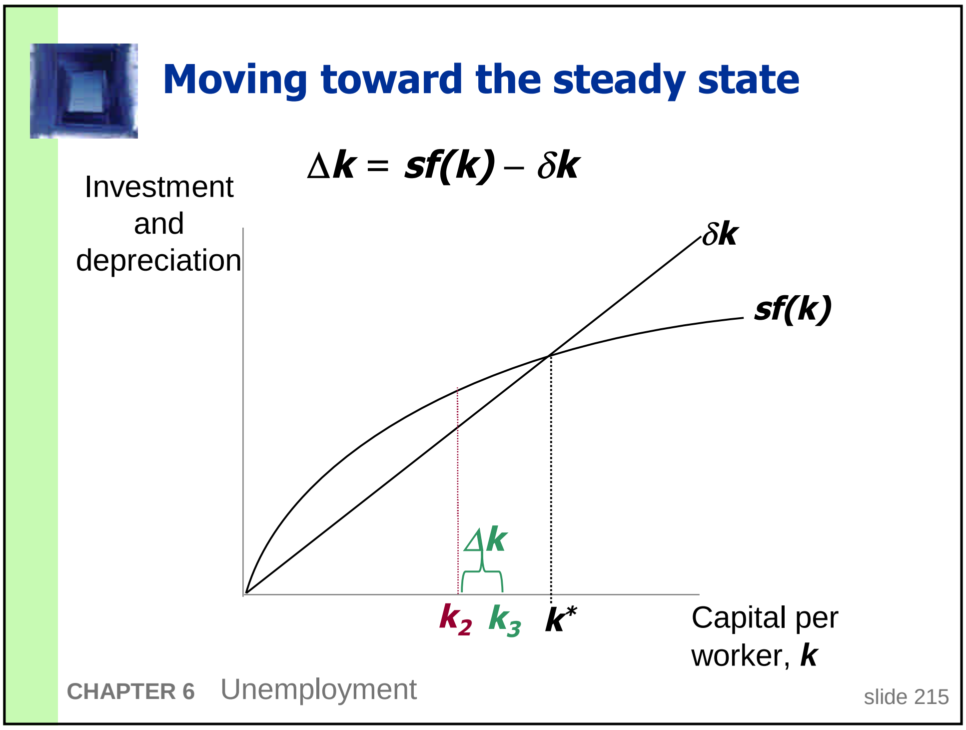
Moving toward the steady state

$$\Delta k = sf(k) - \delta k$$



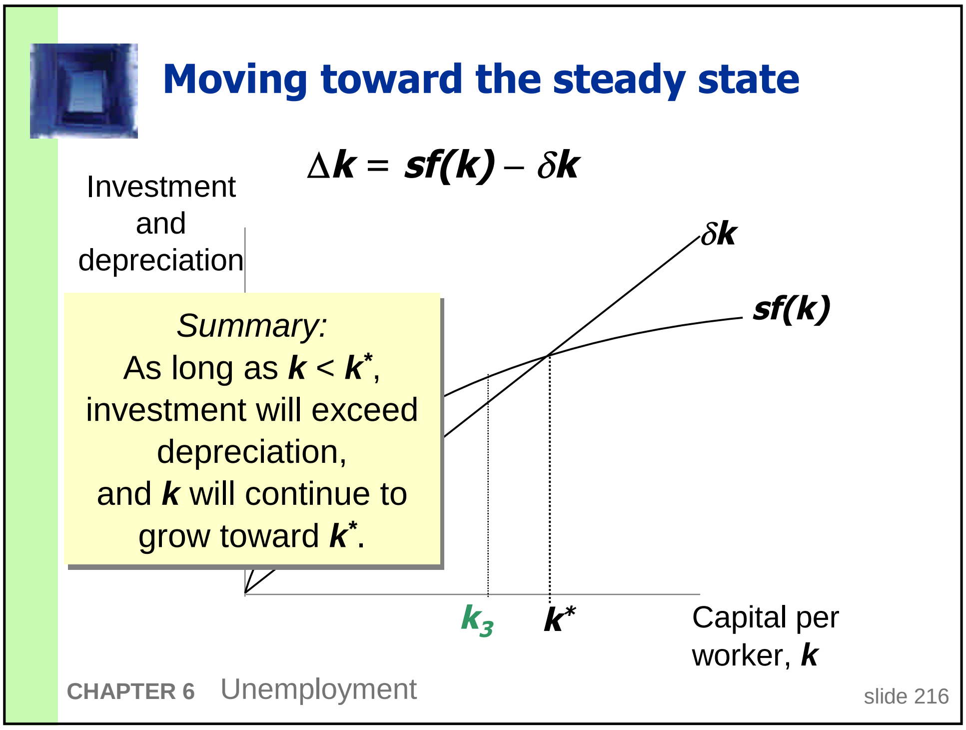
Moving toward the steady state

$$\Delta k = sf(k) - \delta k$$



Moving toward the steady state

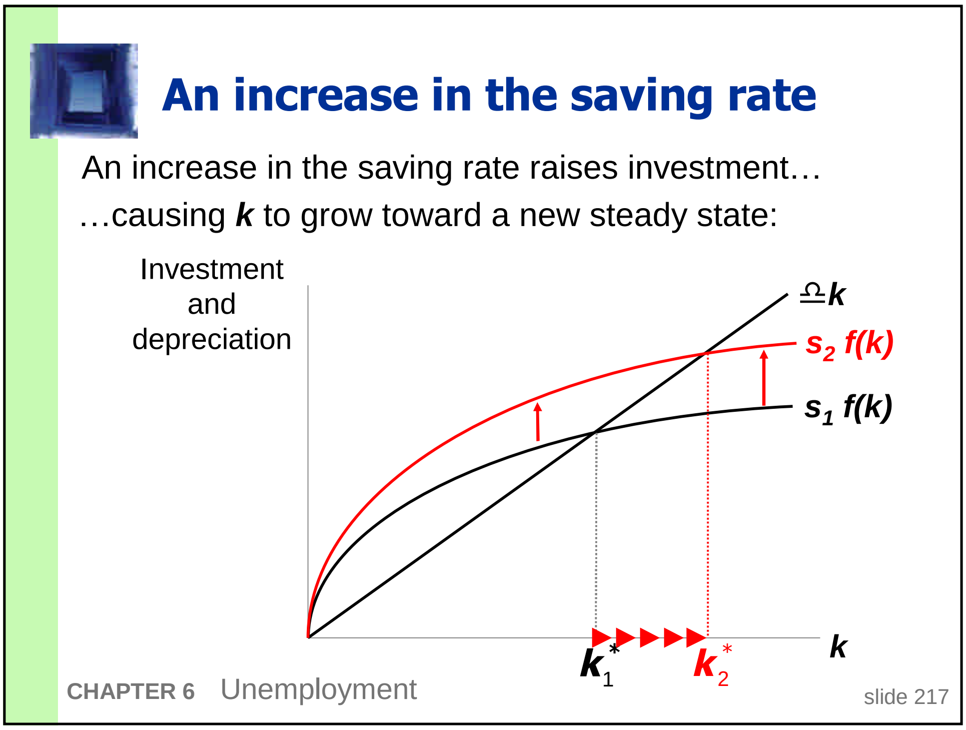
$$\Delta k = sf(k) - \delta k$$



Moving toward the steady state

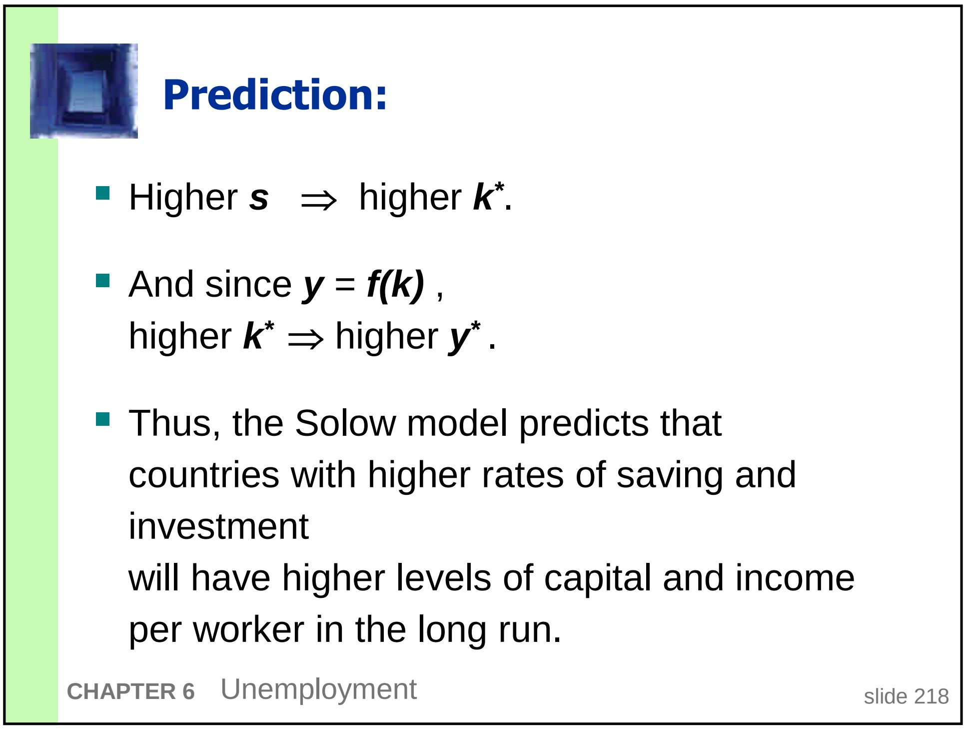
$$\Delta k = sf(k) - \delta k$$

Summary:
As long as $k < k^*$,
investment will exceed
depreciation,
and k will continue to
grow toward k^*.



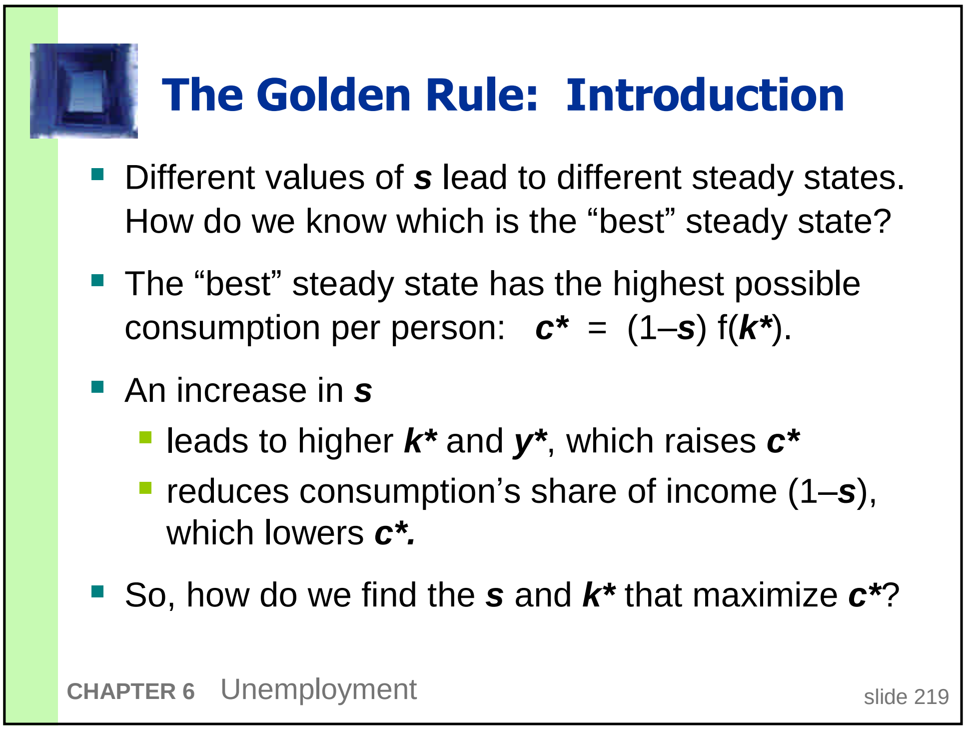
An increase in the saving rate

An increase in the saving rate raises investment…
…causing k to grow toward a new steady state:



Prediction:

- Higher ***s*** $\Rightarrow$ higher $\boldsymbol{k}^*$.
- And since $\boldsymbol{y} = \boldsymbol{f(k)}$,
  higher $\boldsymbol{k}^*$ $\Rightarrow$ higher $\boldsymbol{y}^*$.
- Thus, the Solow model predicts that
  countries with higher rates of saving and investment
  will have higher levels of capital and income per worker in the long run.



The Golden Rule: Introduction

- Different values of ***s*** lead to different steady states. How do we know which is the "best" steady state?
- The "best" steady state has the highest possible consumption per person: $\boldsymbol{c^*} = (1–\boldsymbol{s})\ f(\boldsymbol{k^*})$.
- An increase in ***s***
  - leads to higher ***k**** and ***y****, which raises ***c****
  - reduces consumption's share of income (1–***s***), which lowers ***c*.***
- So, how do we find the ***s*** and ***k**** that maximize ***c****?

The Golden Rule capital stock

k^*_{gold} = the **Golden Rule level of capital**,
the steady state value of k
that maximizes consumption.

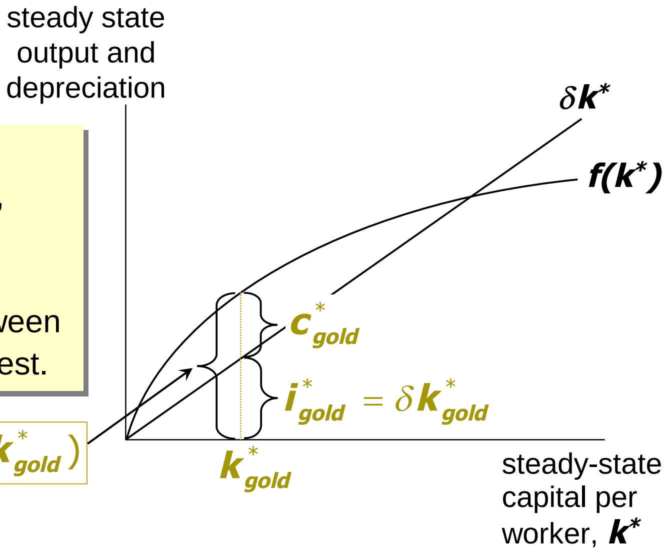
To find it, first express c^* in terms of k^*:

$$c^* = y^* - i^*$$
$$= f(k^*) - i^*$$
$$= f(k^*) - \delta k^*$$

In the steady state:
$i^* = \delta k^*$
because $\Delta k = 0$.

The Golden Rule capital stock

Then, graph $f(k^*)$ and δk^*, look for the point where the gap between them is biggest.

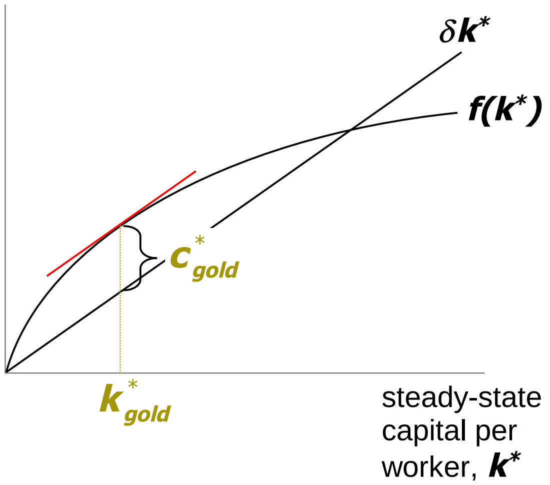


$y^*_{gold} = f(k^*_{gold})$

The Golden Rule capital stock

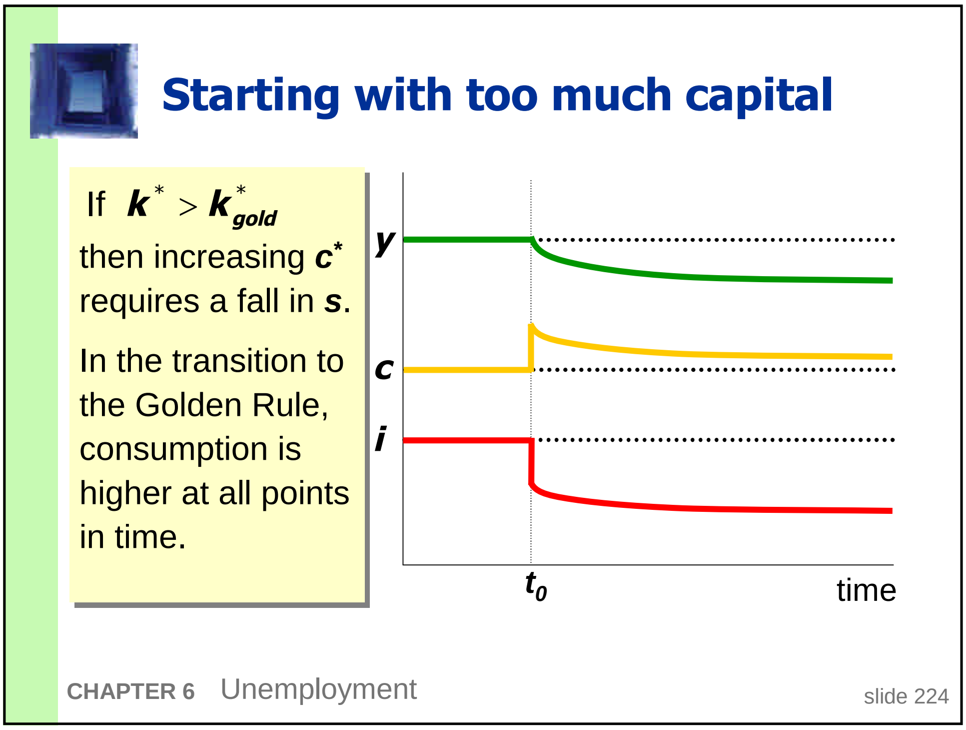
$c^* = f(k^*) - \delta k^*$
is biggest where
the slope of the
production function
equals
the slope of the
depreciation line:

$\text{MPK} = \delta$



The transition to the Golden Rule steady state

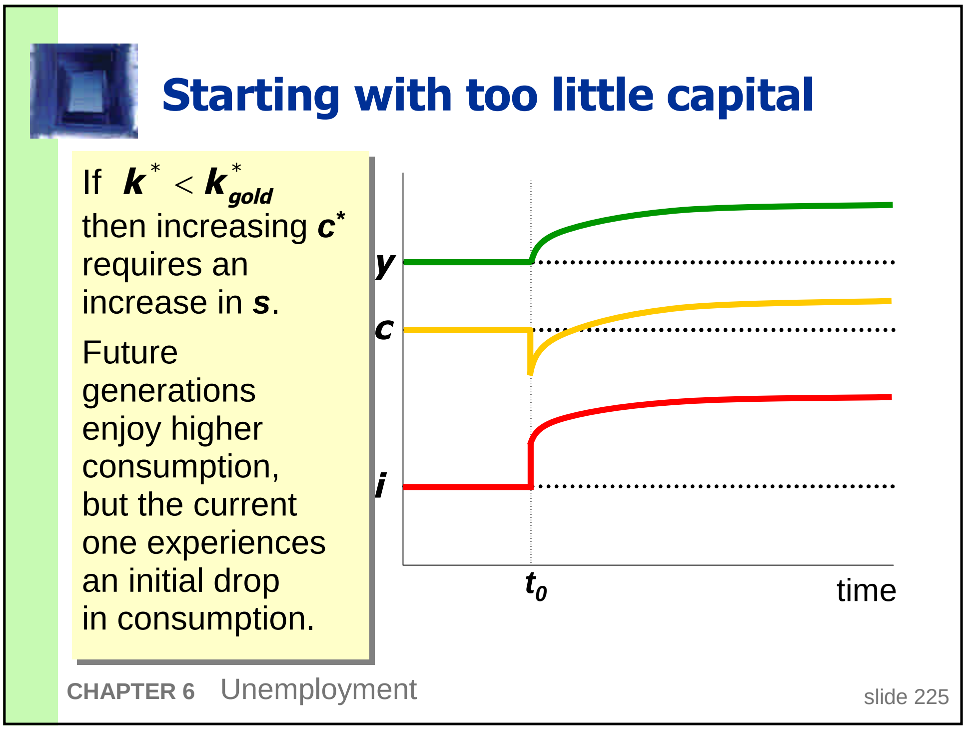
- The economy does NOT have a tendency to move toward the Golden Rule steady state.
- Achieving the Golden Rule requires that policymakers adjust ***s***.
- This adjustment leads to a new steady state with higher consumption.
- But what happens to consumption during the transition to the Golden Rule?



Starting with too much capital

If $k^* > k^*_{gold}$
then increasing c^* requires a fall in s.

In the transition to the Golden Rule, consumption is higher at all points in time.



Starting with too little capital

If $k^* < k^*_{gold}$
then increasing c^* requires an increase in s.

Future generations enjoy higher consumption, but the current one experiences an initial drop in consumption.

Population growth

- Assume that the population (and labor force) grow at rate ***n***. (***n*** is exogenous.)

$$\frac{\Delta L}{L} = n$$

- EX: Suppose ***L*** = 1,000 in year 1 and the population is growing at 2% per year (***n*** = 0.02).
- Then $\Delta L = nL = 0.02 \times 1{,}000 = 20$, so ***L*** = 1,020 in year 2.

Break-even investment

- $(\delta + n)k$ = **break-even investment**, the amount of investment necessary to keep ***k*** constant.
- Break-even investment includes:
  - δk to replace capital as it wears out
  - nk to equip new workers with capital

    (Otherwise, ***k*** would fall as the existing capital stock would be spread more thinly over a larger population of workers.)

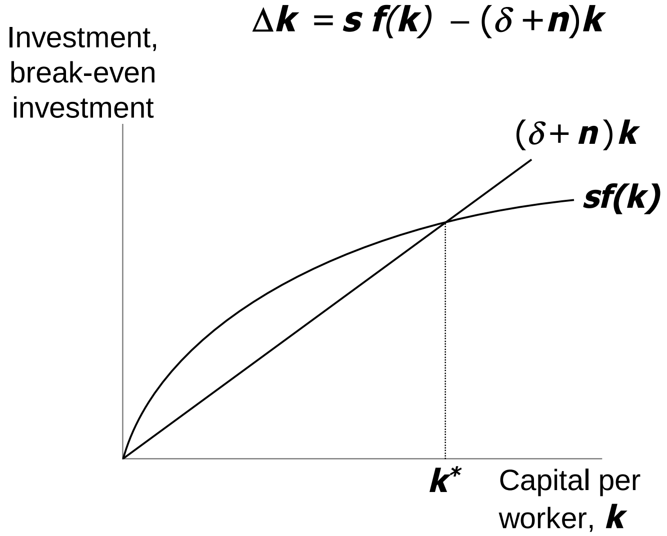
The equation of motion for *k*

- With population growth,
  the equation of motion for ***k*** is

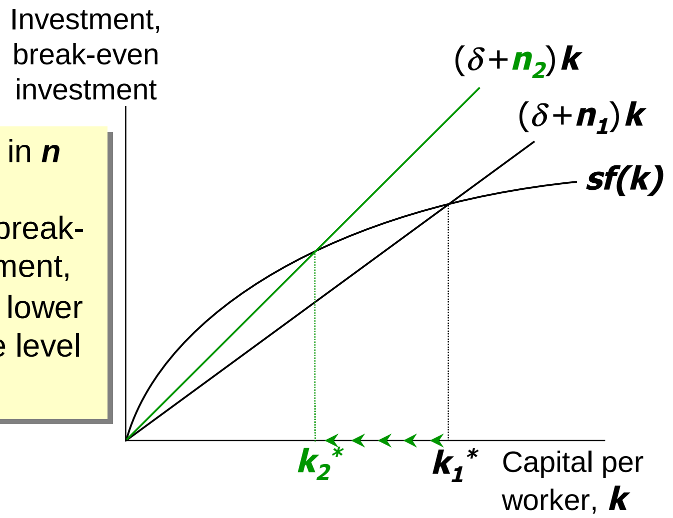
$$\Delta k = \underbrace{s f(k)}_{\text{actual investment}} - \underbrace{(\delta + n)\, k}_{\text{break-even investment}}$$

The Solow model diagram

$$\Delta k = s\, f(k) - (\delta + n) k$$



The impact of population growth



An increase in ***n*** causes an increase in break-even investment, leading to a lower steady-state level of ***k***.

Prediction:

- Higher ***n*** ⇒ lower ***k****.
- And since ***y*** = f(***k***) ,
  lower ***k**** ⇒ lower ***y****.
- Thus, the Solow model predicts that countries with higher population growth rates will have lower levels of capital and income per worker in the long run.

The Golden Rule with population growth

To find the Golden Rule capital stock, express c^* in terms of k^*:

$$\begin{aligned} c^* &= y^* - i^* \\ &= f(k^*) - (\delta + n)\,k^* \end{aligned}$$

c^* is maximized when

$$\text{MPK} = \delta + n$$

or equivalently,

$$\boxed{\text{MPK} - \delta = n}$$

In the Golden Rule steady state, the marginal product of capital net of depreciation equals the population growth rate.

CHAPTER 8

Economic Growth II: Technology, Empirics, and Policy

MACROECONOMICS SIXTH EDITION

N. GREGORY MANKIW

PowerPoint® Slides by Ron Cronovich

Technological progress in the Solow model

- A new variable: ***E*** = labor efficiency
- Assume:
  Technological progress is **labor-augmenting**: it increases labor efficiency at the exogenous rate ***g***:

$$g = \frac{\Delta E}{E}$$

Technological progress in the Solow model

- We now write the production function as:

$$Y = F(K, L \times E)$$

- where $L \times E$ = the number of effective workers.
  - Increases in labor efficiency have the same effect on output as increases in the labor force.

Technological progress in the Solow model

- Notation:

  $y = Y/LE$ = output per effective worker

  $k = K/LE$ = capital per effective worker

- Production function per effective worker:

  $y = f(k)$

- Saving and investment per effective worker:

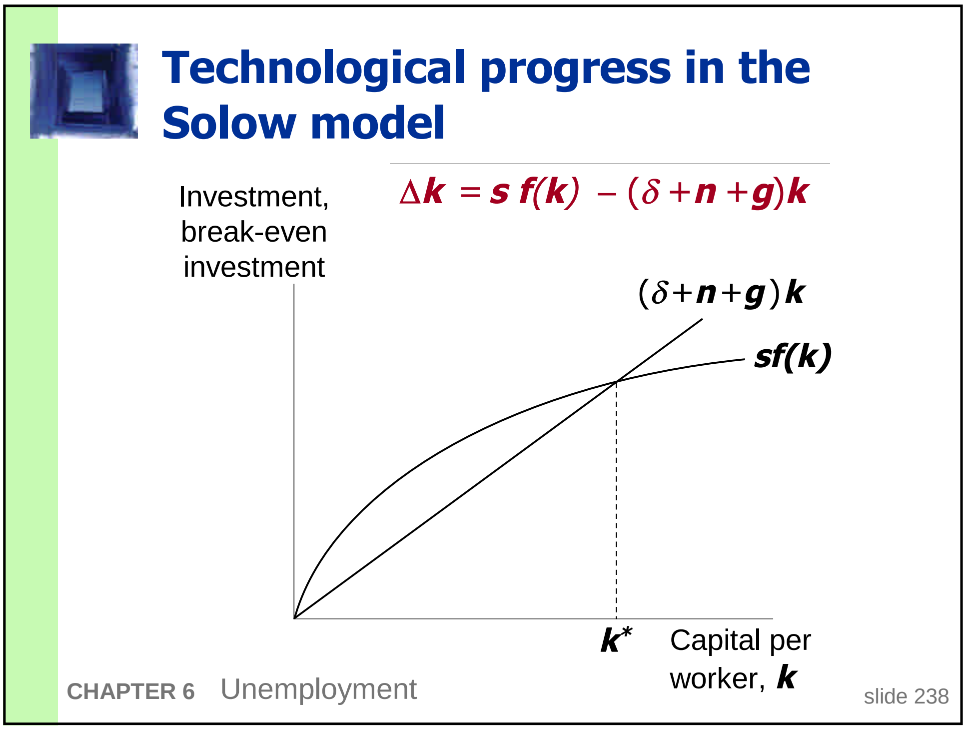
  $sy = sf(k)$

Technological progress in the Solow model

$(\delta + n + g)k$ = break-even investment:
the amount of investment necessary
to keep k constant.

Consists of:

- δk to replace depreciating capital
- nk to provide capital for new workers
- gk to provide capital for the new “effective” workers created by technological progress



Technological progress in the Solow model

$\Delta k = s\,f(k) - (\delta + n + g)k$

Steady-state growth rates in the Solow model with tech. progress

Variable	Symbol	Steady-state growth rate
Capital per effective worker	$k = K/(L \times E)$	0
Output per effective worker	$y = Y/(L \times E)$	0
Output per worker	$(Y/L) = y \times E$	g
Total output	$Y = y \times E \times L$	$n + g$

The Golden Rule

To find the Golden Rule capital stock, express c^* in terms of k^*:

$$\begin{aligned} c^* &= y^* - i^* \\ &= f(k^*) - (\delta + n + g)k^* \end{aligned}$$

c^* is maximized when

$$MPK = \delta + n + g$$

or equivalently,

$$\boxed{MPK - \delta = n + g}$$

In the Golden Rule steady state, the marginal product of capital net of depreciation equals the pop. growth rate plus the rate of tech progress.

Growth empirics: Convergence

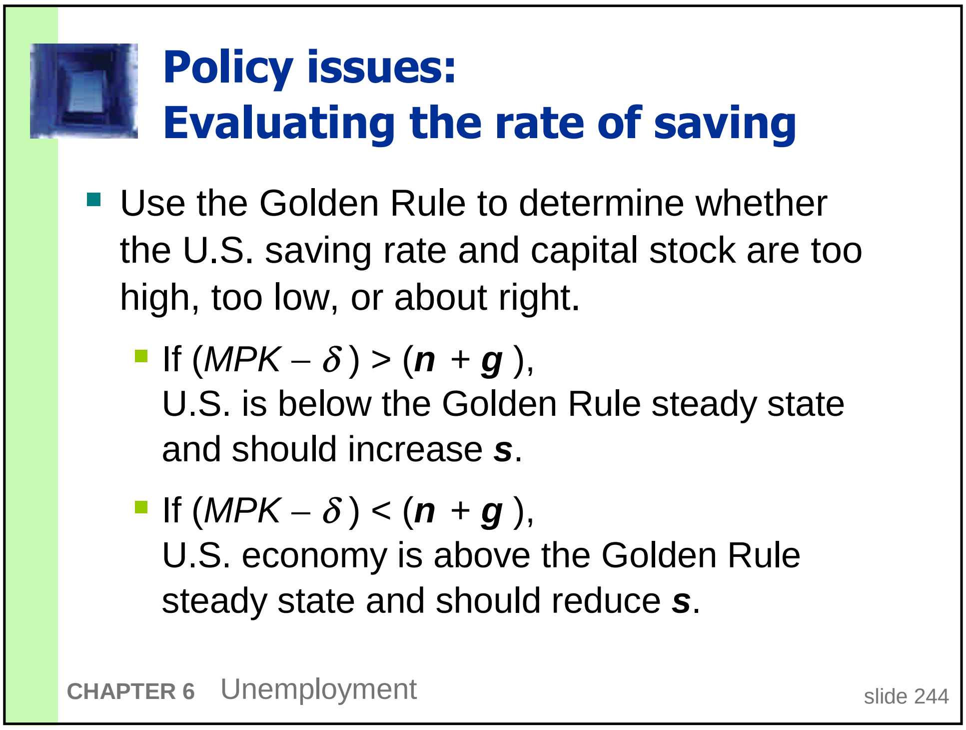
- Solow model predicts that, other things equal, “poor” countries (with lower Y/L and K/L) should grow faster than “rich” ones.
- If true, then the income gap between rich & poor countries would shrink over time, causing living standards to “converge.”
- In real world, many poor countries do NOT grow faster than rich ones. Does this mean the Solow model fails?

Growth empirics: Convergence

- Solow model predicts that, other things equal, "poor" countries (with lower ***Y***/***L*** and ***K***/***L***) should grow faster than "rich" ones.
- No, because "other things" aren't equal.
  - In samples of countries with similar savings & pop. growth rates, income gaps shrink about 2% per year.
  - In larger samples, after controlling for differences in saving, pop. growth, and human capital, incomes converge by about 2% per year.

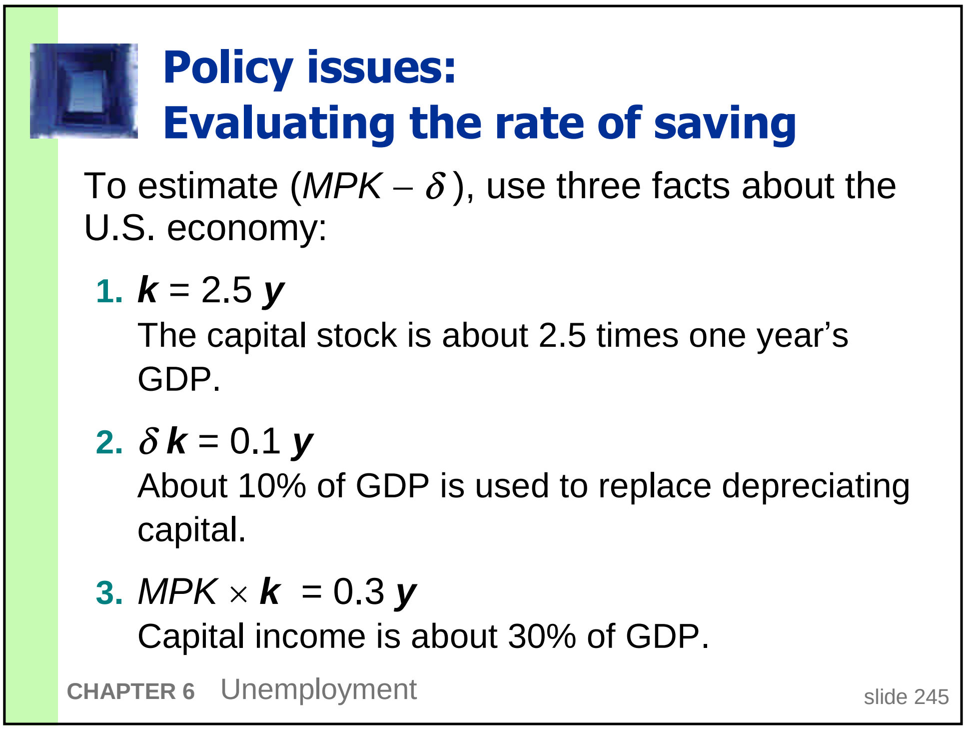
Growth empirics: Convergence

- What the Solow model really predicts is **conditional convergence** - countries converge to their own steady states, which are determined by saving, population growth, and education.
- This prediction comes true in the real world.



Policy issues: Evaluating the rate of saving

- Use the Golden Rule to determine whether the U.S. saving rate and capital stock are too high, too low, or about right.
  - If $(MPK - \delta) > (\boldsymbol{n} + \boldsymbol{g})$, U.S. is below the Golden Rule steady state and should increase $\boldsymbol{s}$.
  - If $(MPK - \delta) < (\boldsymbol{n} + \boldsymbol{g})$, U.S. economy is above the Golden Rule steady state and should reduce $\boldsymbol{s}$.



Policy issues: Evaluating the rate of saving

To estimate $(MPK - \delta)$, use three facts about the U.S. economy:

1. $\boldsymbol{k} = 2.5\,\boldsymbol{y}$
   The capital stock is about 2.5 times one year's GDP.
2. $\delta\,\boldsymbol{k} = 0.1\,\boldsymbol{y}$
   About 10% of GDP is used to replace depreciating capital.
3. $MPK \times \boldsymbol{k} = 0.3\,\boldsymbol{y}$
   Capital income is about 30% of GDP.

Policy issues: Evaluating the rate of saving

1. $\boldsymbol{k} = 2.5\,\boldsymbol{y}$
2. $\delta\,\boldsymbol{k} = 0.1\,\boldsymbol{y}$
3. $MPK \times \boldsymbol{k} = 0.3\,\boldsymbol{y}$

To determine δ, divide **2** by **1**:

$$\frac{\delta \boldsymbol{k}}{\boldsymbol{k}} = \frac{0.1\boldsymbol{y}}{2.5\boldsymbol{y}} \quad\Rightarrow\quad \delta = \frac{0.1}{2.5} = 0.04$$

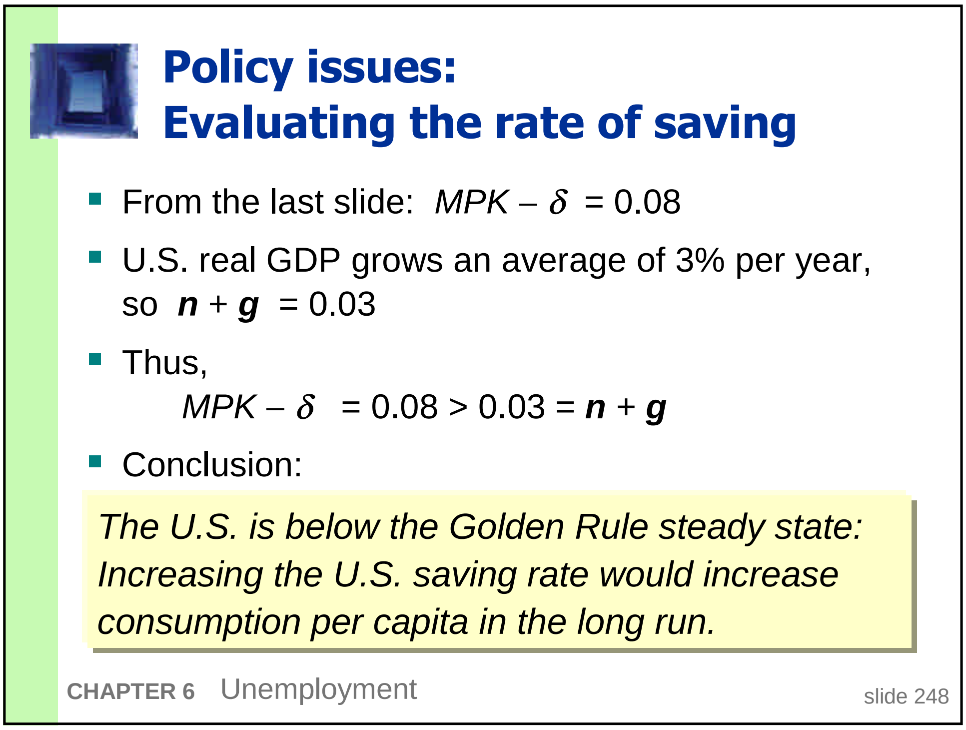
Policy issues: Evaluating the rate of saving

1. $\boldsymbol{k} = 2.5\,\boldsymbol{y}$
2. $\delta\,\boldsymbol{k} = 0.1\,\boldsymbol{y}$
3. $MPK \times \boldsymbol{k} = 0.3\,\boldsymbol{y}$

To determine *MPK*, divide **3** by **1**:

$$\frac{\text{MPK} \times \boldsymbol{k}}{\boldsymbol{k}} = \frac{0.3\,\boldsymbol{y}}{2.5\,\boldsymbol{y}} \quad\Rightarrow\quad \text{MPK} = \frac{0.3}{2.5} = 0.12$$

Hence, $MPK - \delta = 0.12 - 0.04 = \underline{0.08}$



Policy issues: Evaluating the rate of saving

- From the last slide: $MPK - \delta = 0.08$
- U.S. real GDP grows an average of 3% per year, so $\boldsymbol{n} + \boldsymbol{g} = 0.03$
- Thus,

$$MPK - \delta = 0.08 > 0.03 = \boldsymbol{n} + \boldsymbol{g}$$

- Conclusion:

The U.S. is below the Golden Rule steady state: Increasing the U.S. saving rate would increase consumption per capita in the long run.