CHAPTER SEVENTEEN

Investment

macroeconomics

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Learning objectives

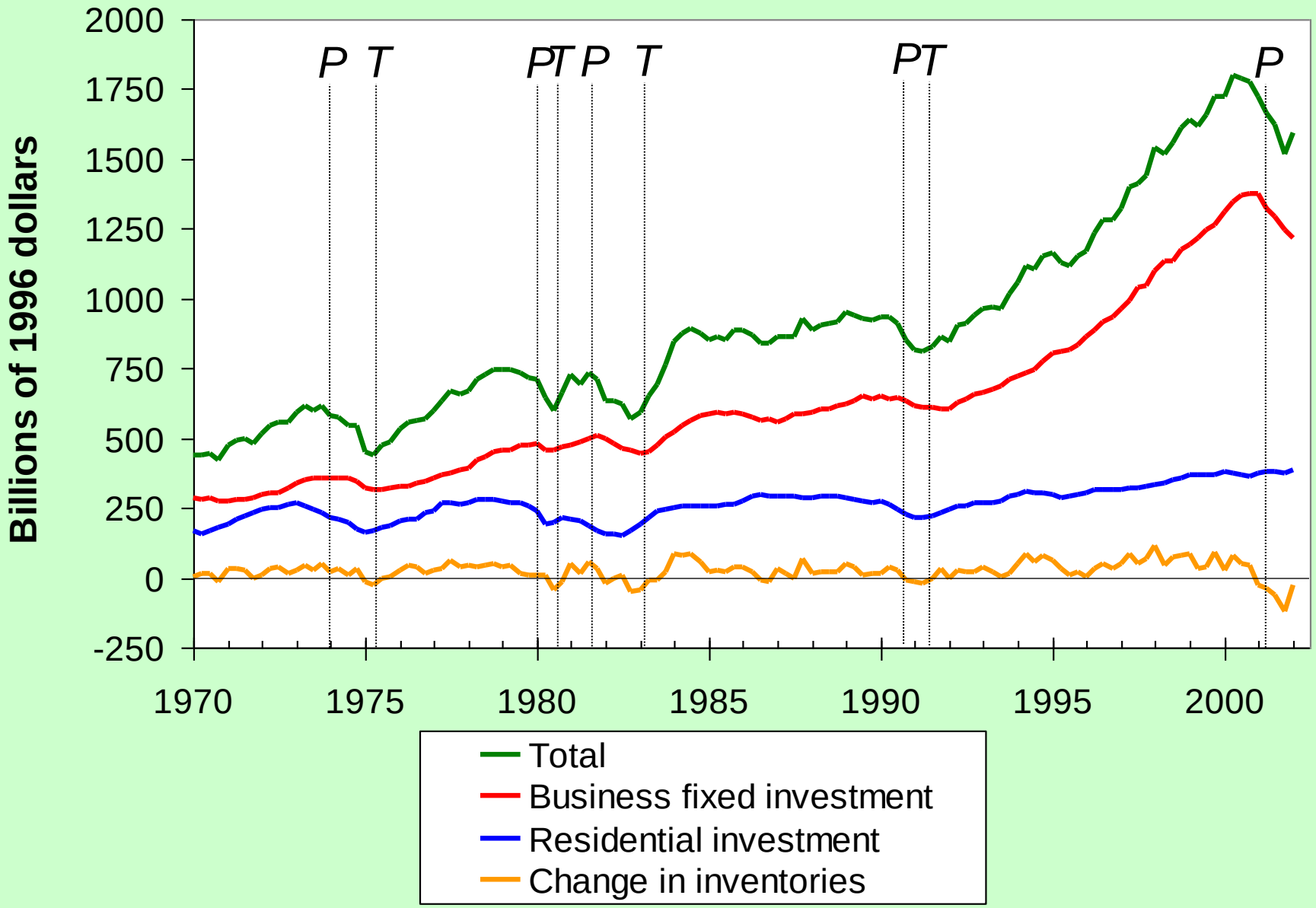
In this chapter, you will learn:

- leading theories to explain each type of investment
- why investment is negatively related to the interest rate
- things that shift the investment function
- why investment rises during booms and falls during recessions

Types of Investment

- **Business fixed investment**:
  businesses' spending on equipment and structures for use in production
- **Residential investment**:
  purchases of new housing units (either by occupants or landlords)
- **Inventory investment**:
  the value of the change in inventories of finished goods, materials and supplies, and work in progress.

U.S. Investment and its components, 1970-2002



Understanding business fixed investment

- The standard model of business fixed investment:
  the neoclassical model of investment
- Shows how investment depends on
  - MPK
  - interest rate
  - tax rules affecting firms

Two types of firms

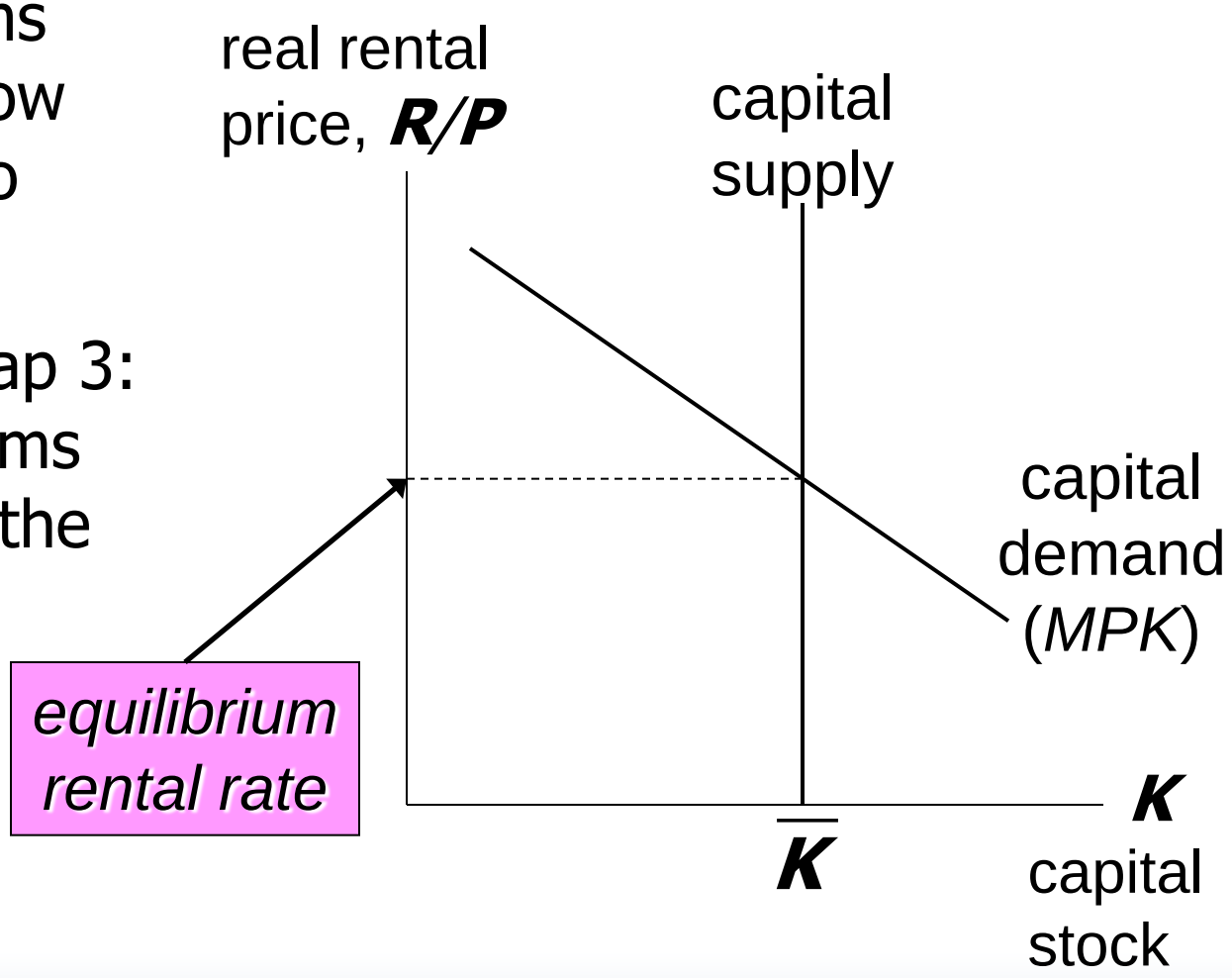
For simplicity, assume two types of firms:

1. *Production firms* rent the capital they use to produce goods and services.
2. *Rental firms* own capital, rent it out to production firms.

In this context,
"investment" is the rental firms' spending on new capital goods.

The capital rental market

- Production firms must decide how much capital to rent.
- Recall from chap 3: Competitive firms rent capital to the point where MPK = ***R/P***.



Factors that affect the rental price

For the Cobb-Douglas production function,

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

the MPK (and hence equilibrium ***R/P***) is

$$\frac{R}{P} = MPK = \alpha A\left(L/K\right)^{1-\alpha}$$

The equilibrium ***R/P*** would increase if:

- ↓***K*** *(due, e.g., to earthquake or war)*
- ↑***L*** *(due, e.g., to pop. growth or immigration)*
- ↑***A*** *(technological improvement, or deregulation)*

Rental firms' investment decisions

Rental firms invest in new capital when the benefit of doing so exceeds the cost.

The benefit (per unit capital):
R/P, the income that rental firms earn from renting the unit of capital out to production firms.

The cost of capital

Components of the cost of capital:

- *interest cost:* $i \times P_K$,
  where P_K = nominal price of capital
- *depreciation cost:* $\delta \times P_K$,
  where δ = rate of depreciation
- *capital loss:* $-\Delta P_K$
  (A capital gain, $\Delta P_K > 0$, reduces cost of K)

The total cost of capital is the sum of these three parts:

The cost of capital

Nominal cost of capital $= i P_K + \delta P_K - \Delta P_K = P_K \left(i + \delta - \frac{\Delta P_K}{P_K} \right)$

Example car rental company (capital: cars)

Suppose P_K = \$10,000, i = 0.10, δ = 0.20, and $\Delta P_K / P_K$ = 0.06

Then,

interest cost =	\$1000
depreciation cost =	\$2000
capital loss =	– \$600
total cost =	**\$2400**

The cost of capital

For simplicity, assume $\Delta P_K / P_K = \pi$.

Then, the nominal cost of capital equals

$$P_K(i + \delta - \pi) = P_K(r + \delta)$$

and the real cost of capital equals $\frac{P_K}{P}(r + \delta)$

The real cost of capital depends positively on:

- the relative price of capital
- the real interest rate
- the depreciation rate

The rental firm's profit rate

Firm's net investment depends on the profit rate:

$$\text{Profit rate} = \frac{R}{P} - \frac{P_K}{P}(r + \delta) = MPK - \frac{P_K}{P}(r + \delta)$$

- If profit rate > 0,
  then it's profitable for firm to increase ***K***
- If profit rate < 0, then firm increases profits by reducing its capital stock.
  (Firm reduces ***K*** by not replacing it as it depreciates)

Net investment & gross investment

Hence,

$$\text{net investment} = \Delta K = I_n\left[MPK - \left(P_K/P\right)\left(r + \delta\right)\right]$$

where $I_n(\ )$ is a function showing how net investment responds to the incentive to invest.

Total spending on business fixed investment equals net investment plus the replacement of depreciated capital:

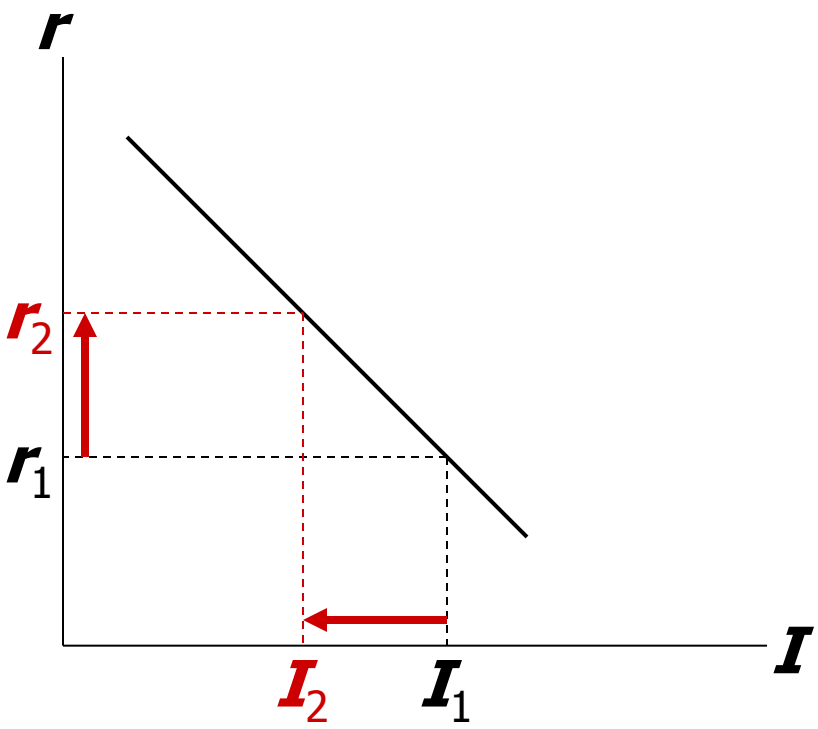
$$\begin{aligned}\text{gross investment} &= \Delta K + \delta K \\ &= I_n\left[MPK - \left(P_K/P\right)\left(r + \delta\right)\right] + \delta K\end{aligned}$$

The investment function

$$I = I_n\left[MPK - \left(P_K/P\right)\left(r + \delta\right)\right] + \delta K$$

An increase in r

- raises the cost of capital
- reduces the profit rate
- and reduces investment:

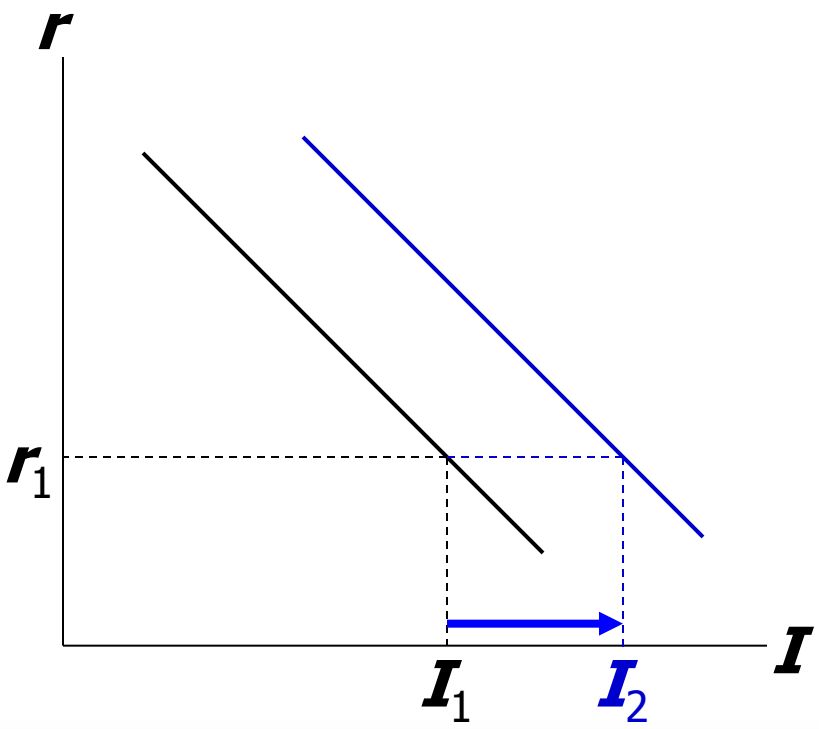


The investment function

$$I = I_n\left[MPK - \left(P_K/P\right)\left(r + \delta\right)\right] + \delta K$$

An increase in MPK or decrease in P_K/P

- increases the profit rate
- increases investment at any given interest rate
- shifts I curve to the right.



Taxes and Investment

Two of the most important taxes affecting investment:

1. Corporate income tax
2. Investment tax credit

Corporate Income Tax: A tax on profits

Impact on investment depends on definition of "profits"

- If the law used our definition (rental price minus cost of capital), then the tax doesn't affect investment.
- In our definition, depreciation cost is measured using the current price of capital.
- But, legal definition uses the historical price of capital.
- If P_K rises over time, then the legal definition understates the true cost and overstates profit, so firms could be taxed even if their true economic profit is zero.
- Thus, corporate income tax discourages investment.

The investment tax credit (ITC)

- The ITC reduces a firm's taxes by a certain amount for each dollar it spends on capital
- Hence, the ITC effectively reduces $\boldsymbol{P_K}$
- which increases the profit rate and the incentive to invest.

Tobin's *q*

$$q = \frac{\text{Market value of installed capital}}{\text{Replacement cost of installed capital}}$$

- *numerator:* the stock market value of the economy's capital stock
- *denominator:* the actual cost to replace the capital goods that were purchased when the stock was issued
- If $q > 1$, firms buy more capital to raise the market value of their firms
- If $q < 1$, firms do not replace capital as it wears out.

Relation between *q* theory and neoclassical theory described above

$$q = \frac{\text{Market value of installed capital}}{\text{Replacement cost of installed capital}}$$

- The stock market value of capital depends on the current & expected future profits of capital.
- If MPK > cost of capital,
  then profit rate is high, which drives up the stock market value of the firms, which implies a high value of ***q***.
- If MPK < cost of capital, then firms are incurring loses, so their stock market value falls, and ***q*** is low.

The stock market and GDP

Why one might expect a relationship between the stock market and GDP:

1. A wave of pessimism about future profitability of capital would
   - cause stock prices to fall
   - cause Tobin's ***q*** to fall
   - shift the investment function down
   - cause a negative aggregate demand shock

The stock market and GDP

Why one might expect a relationship between the stock market and GDP:

2. A fall in stock prices would
   - reduce household wealth
   - shift the consumption function down
   - cause a negative aggregate demand shock

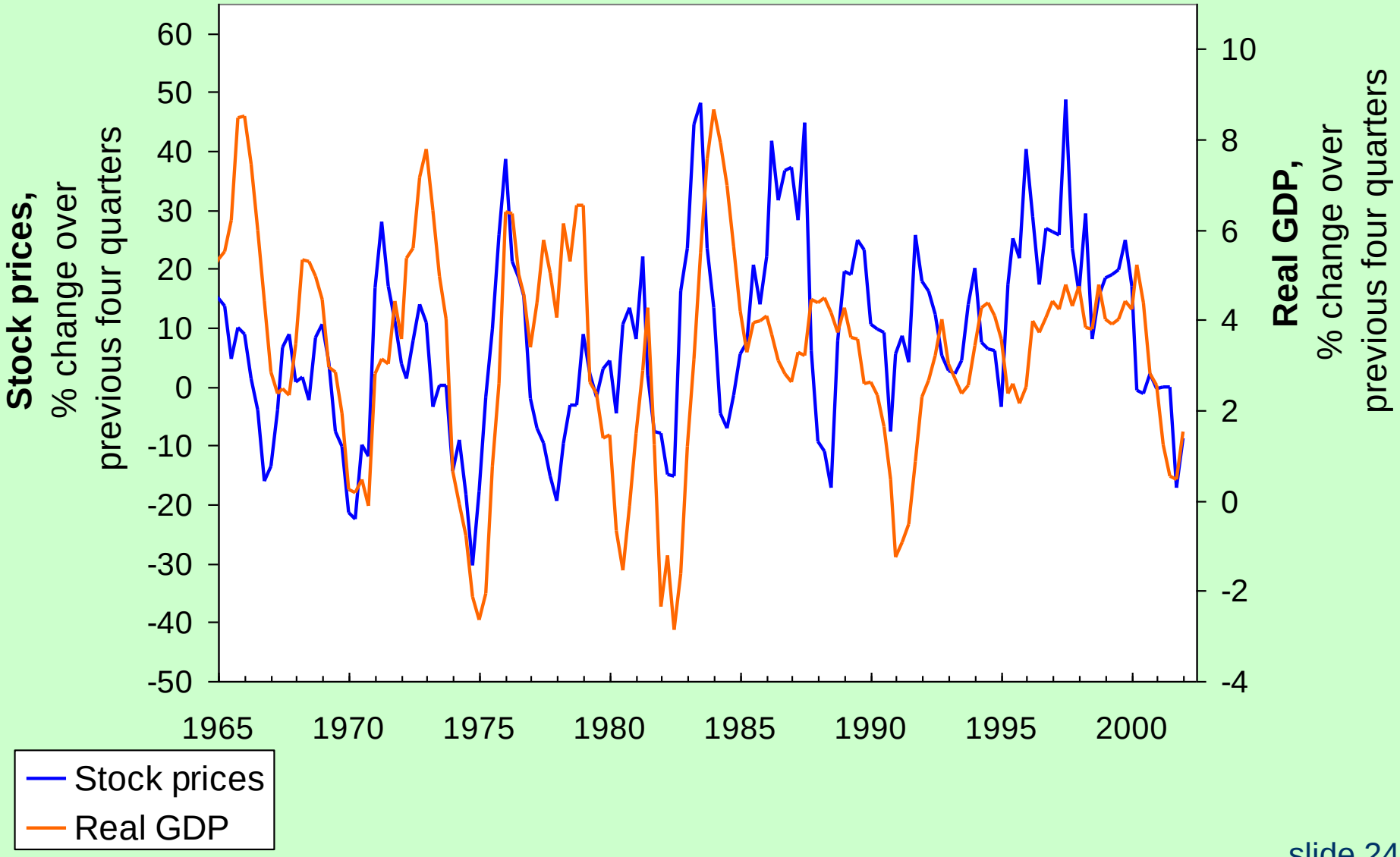
The stock market and GDP

Why one might expect a relationship between the stock market and GDP:

3. A fall in stock prices might reflect bad news about technological progress and long-run economic growth.

   This implies that aggregate supply and full-employment output will be expanding more slowly than people had expected.

The stock market and GDP



Financing constraints

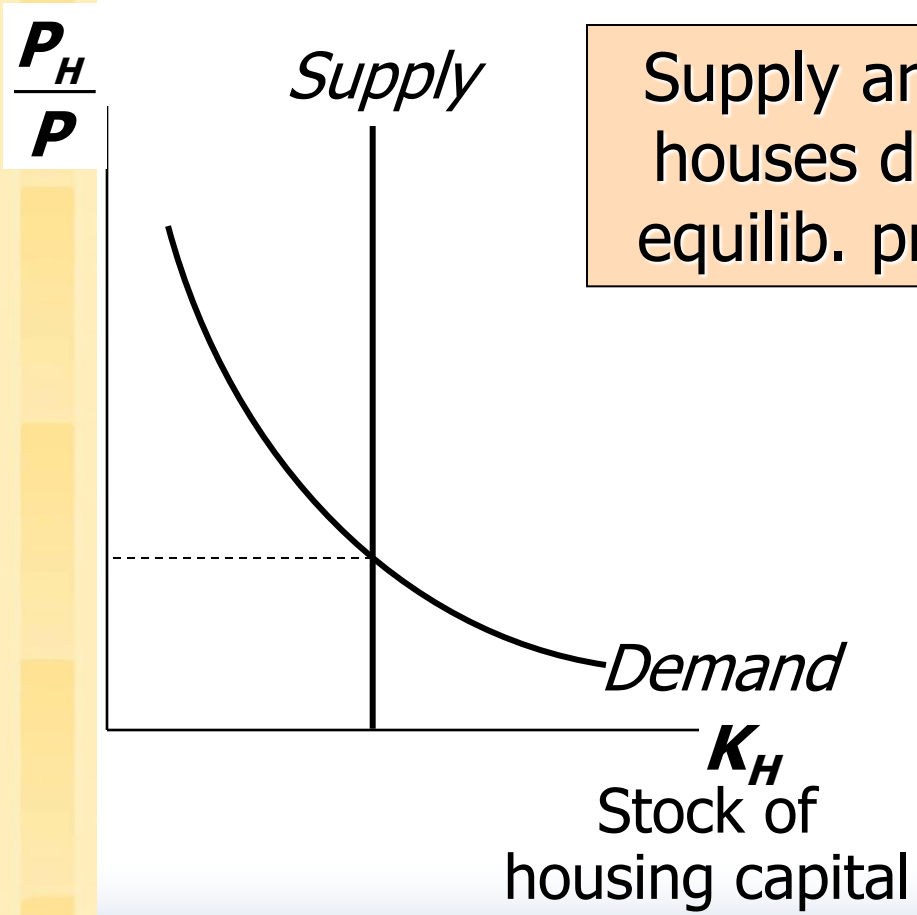
- Neoclassical theory assumes firms can borrow to buy capital whenever doing so is profitable
- But some firms face **financing constraints**: limits on the amounts they can borrow (or otherwise raise in financial markets)
- A recession reduces current profits.
  If future profits expected to be high,
  it might be worthwhile to continue to invest.
  But if firm faces financing constraints,
  then firm might be unable to obtain funds
  due to current profits being low.

Residential investment

- The flow of new residential investment, I_H, depends on the relative price of housing, P_H/P.
- P_H/P is determined by supply and demand in the market for existing houses.

How residential investment is determined

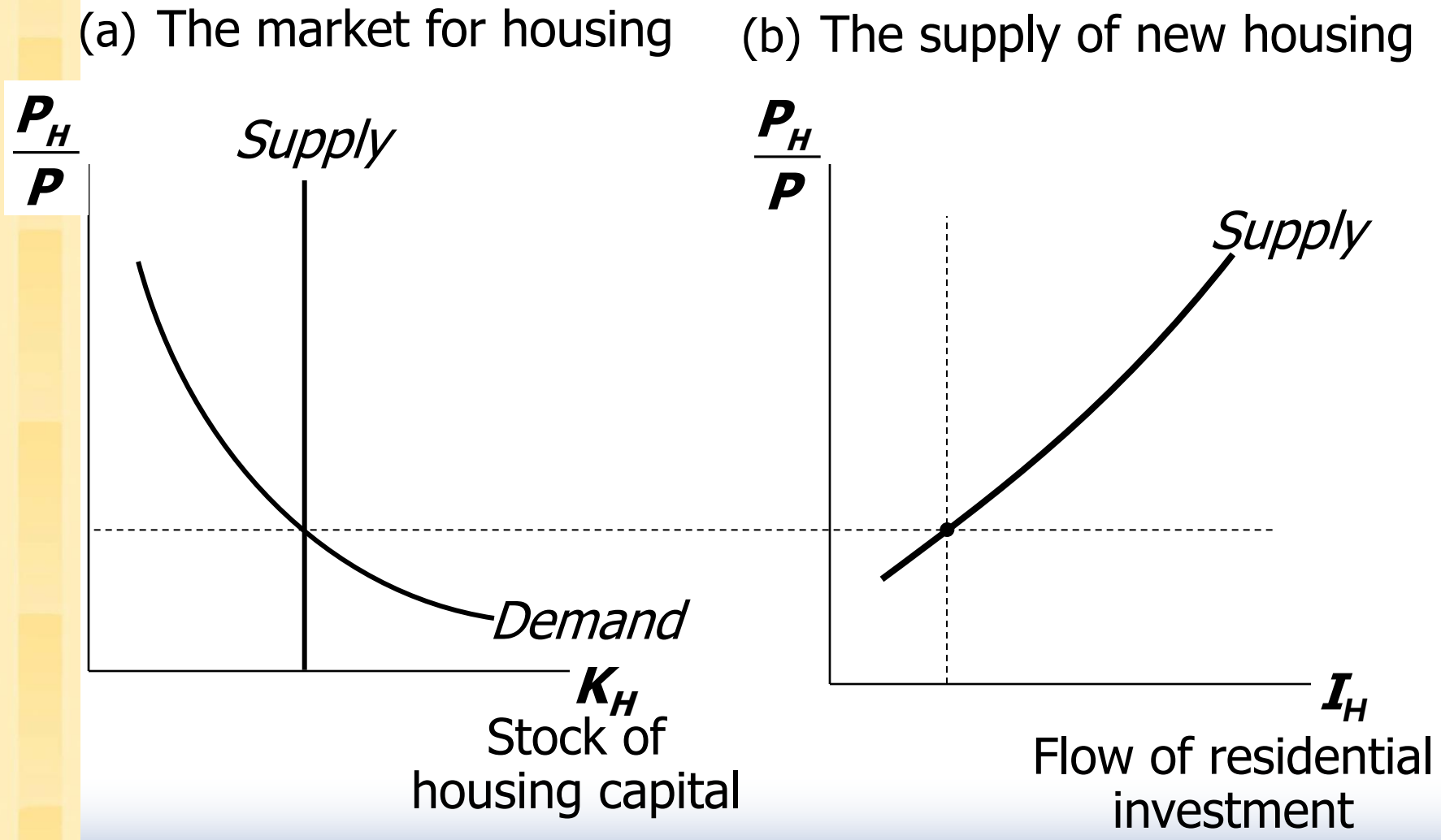
(a) The market for housing



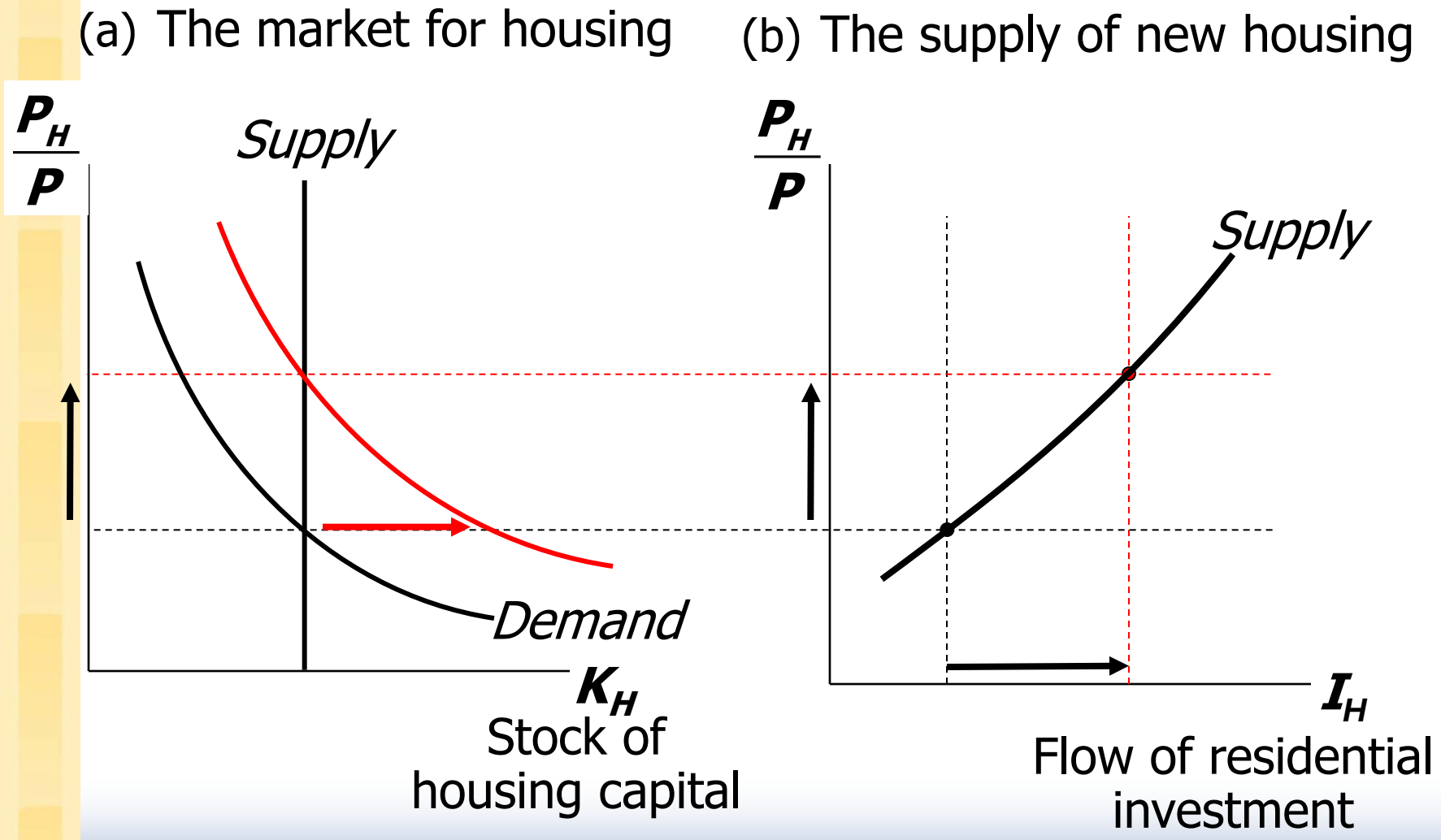
Supply and demand for houses determines the equilib. price of houses.

The equilibrium price of houses then determines residential investment:

How residential investment is determined



How residential investment responds to a fall in interest rates



The tax treatment of housing

- The tax code, in effect, subsidizes home ownership by allowing people to deduct mortgage interest.
- The deduction applies to the nominal mortgage rate,
  so this subsidy is higher when inflation and nominal mortgage rates are high than when they are low.
- Some economists think this subsidy causes over-investment in housing relative to other forms of capital
- But eliminating the mortgage interest deduction would be politically difficult.

Inventory Investment

Inventory investment is only about 1% of GDP

Yet, in the typical recession, more than half of the fall in spending is due to a fall in inventory investment.

Motives for holding inventories

1. **production smoothing**

   Sales fluctuate, but many firms find it cheaper to produce at a steady rate.

   When sales < production, inventories rise.

   When sales > production, inventories fall.

Motives for holding inventories

1. production smoothing
2. **inventories as a factor of production**

   Inventories allow some firms to operate more efficiently.

   - samples for retail sales purposes
   - spare parts for when machines break down

Motives for holding inventories

1. production smoothing
2. inventories as a factor of production
3. **stock-out avoidance**

   To prevent lost sales in the event of higher than expected demand.

Motives for holding inventories

1. production smoothing
2. inventories as a factor of production
3. stock-out avoidance
4. **work in process**

   Goods not yet completed are counted as part of inventory.

The Accelerator Model

A simple theory that explains the behavior of inventory investment, without endorsing any particular motive

The Accelerator Model

- Notation:
  N = stock of inventories
  ΔN = inventory investment

- Assume:
  Firms hold a stock of inventories proportional to their output

  $$N = \beta Y,$$

  where β is an exogenous parameter reflecting firms' desired stock of inventory as a proportion of output.

The Accelerator Model

Result:

$$\Delta N = \beta \Delta Y$$

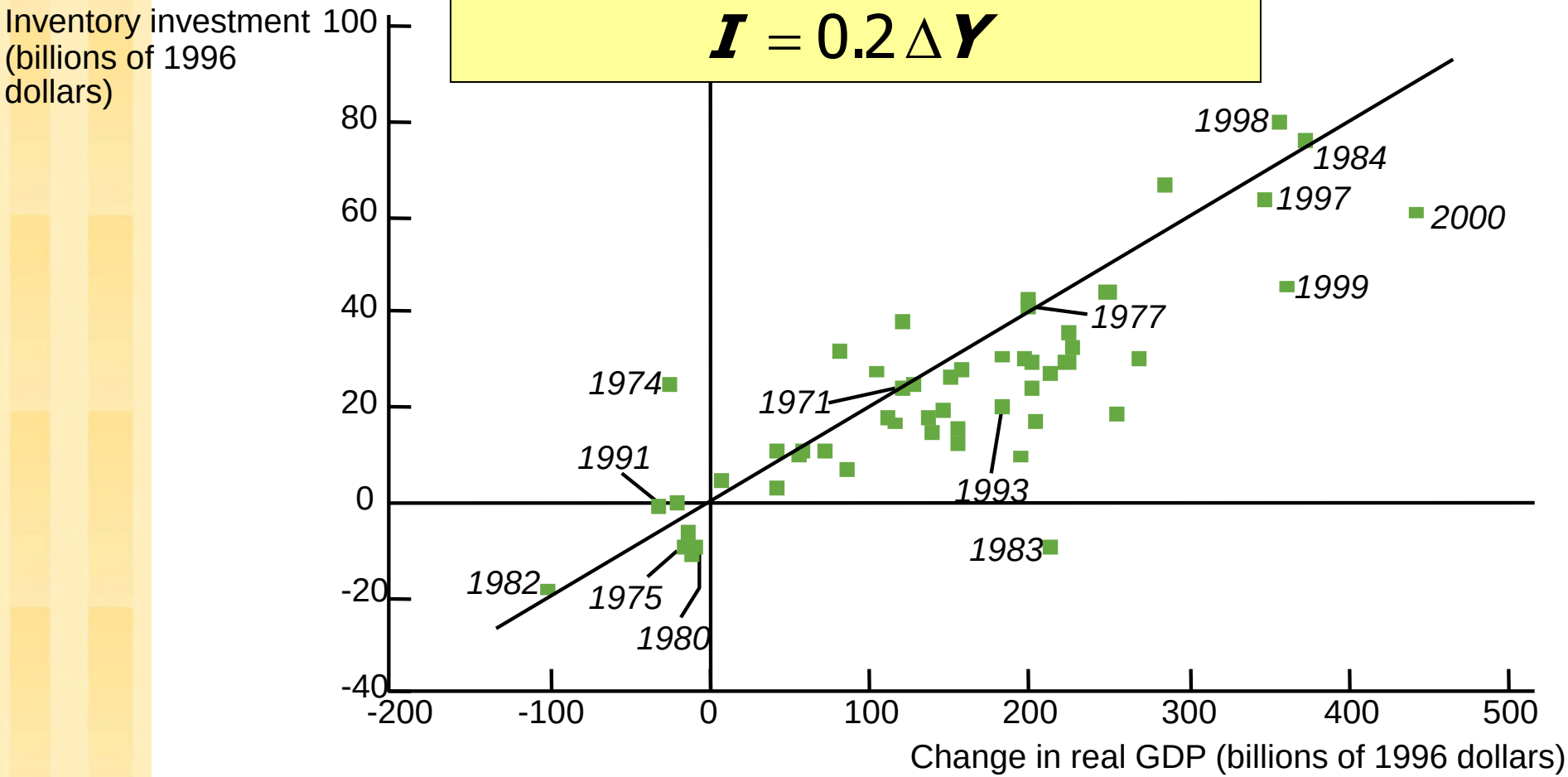
Inventory investment is proportion to the change in output.

- When output is rising, firms increase their inventories.
- When output is falling, firms allow their inventories to run down.

Evidence for the Accelerator Model

The estimated relationship is:

$$I = 0.2\,\Delta Y$$



Inventories and the real interest rate

- The opportunity cost of holding goods in inventory: the interest that could have been earned on the revenue from selling those goods.
- Hence, inventory investment depends on the real interest rate.
- *Example:*
  High interest rates in the 1980s motivated many firms to adopt *just-in-time* production, which is designed to reduce inventories.

Chapter summary

1. All types of investment depend negatively on the real interest rate.
2. Things that shift the investment function:
   - Technological improvements raise MPK and raise business fixed investment.
   - Increase in population raises demand for, price of housing and raises residential investment.
   - Economic policies (corporate income tax, investment tax credit) alter incentives to invest.

Chapter summary

3. Investment is the most volatile component of GDP over the business cycle.
   - Fluctuations in employment affect the MPK and the incentive for business fixed investment.
   - Fluctuations in income affect demand for, price of housing and the incentive for residential investment.
   - Fluctuations in output affect planned & unplanned inventory investment.