

# Investment Demand

This lecture focuses on the demand for the major components of investment by reconciling the decisions of households and businesses with the interest rate and the price of those goods.

## Fluctuations in Investment Spending

### A. Movements in aggregate investment

1. Over the short-run business cycle, investment moves with output but its fluctuations are more pronounced than those of output.
2. That is, investment rises rapidly at the beginning of expansions but it also falls sharply at the beginning of recessions.
3. Economists, however, cannot determine if output movements are inducing investment to move or vice versa.

B. Investment is divided into three categories.

1. Capital investment by firms

a. This component is the largest and the most stable of the three components over the business cycle.

b. One reason why capital investment is the least sensitive to business cycle movements is that it takes a long time to build plants and structures.

2. Residential investment

a. Residential investment is very sensitive to the interest rate.

b. Since interest rates are procyclical, residential investment usually turns down just before a recession but it usually is one of the first areas to recover during an expansion.

### 3. Inventory investment

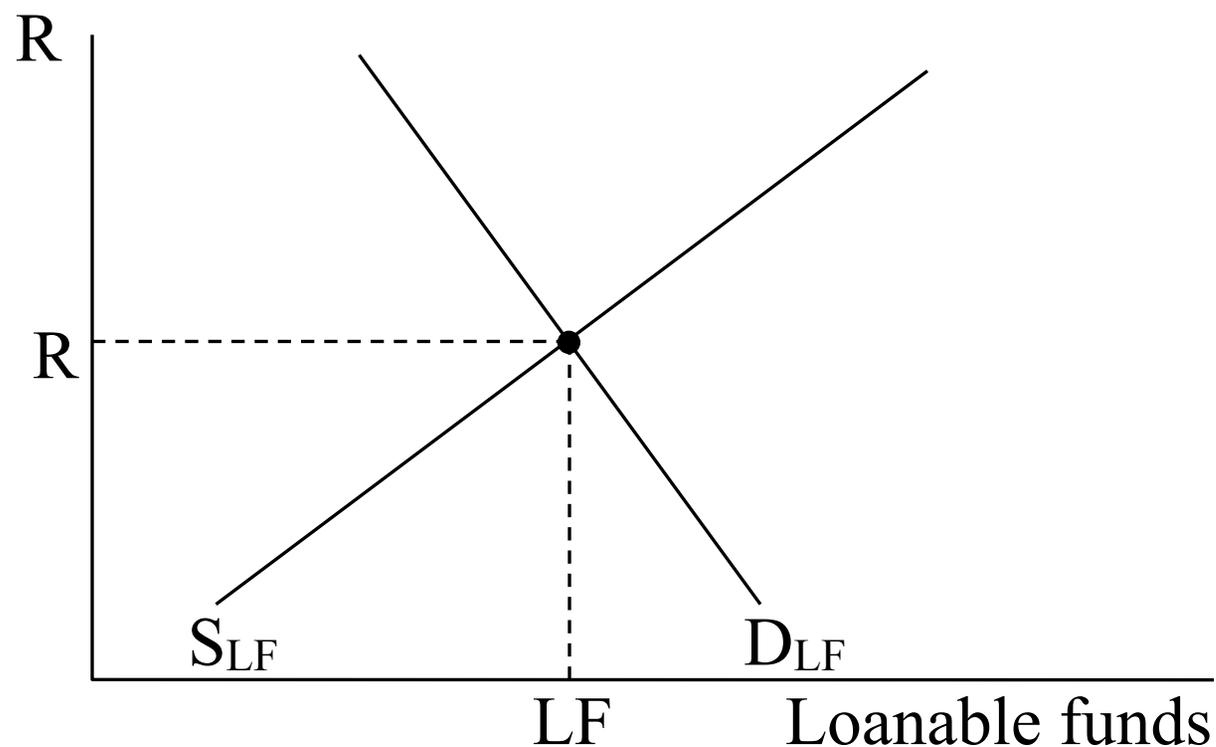
- a. This component is the most volatile of the investment components.
- b. Planned inventory investment is usually a sign an expansion is in progress but unplanned inventory investment is usually a sign a recession is looming.

C. The amount of investment in the economy depends on actions in two markets.

#### 1. The loanable funds market

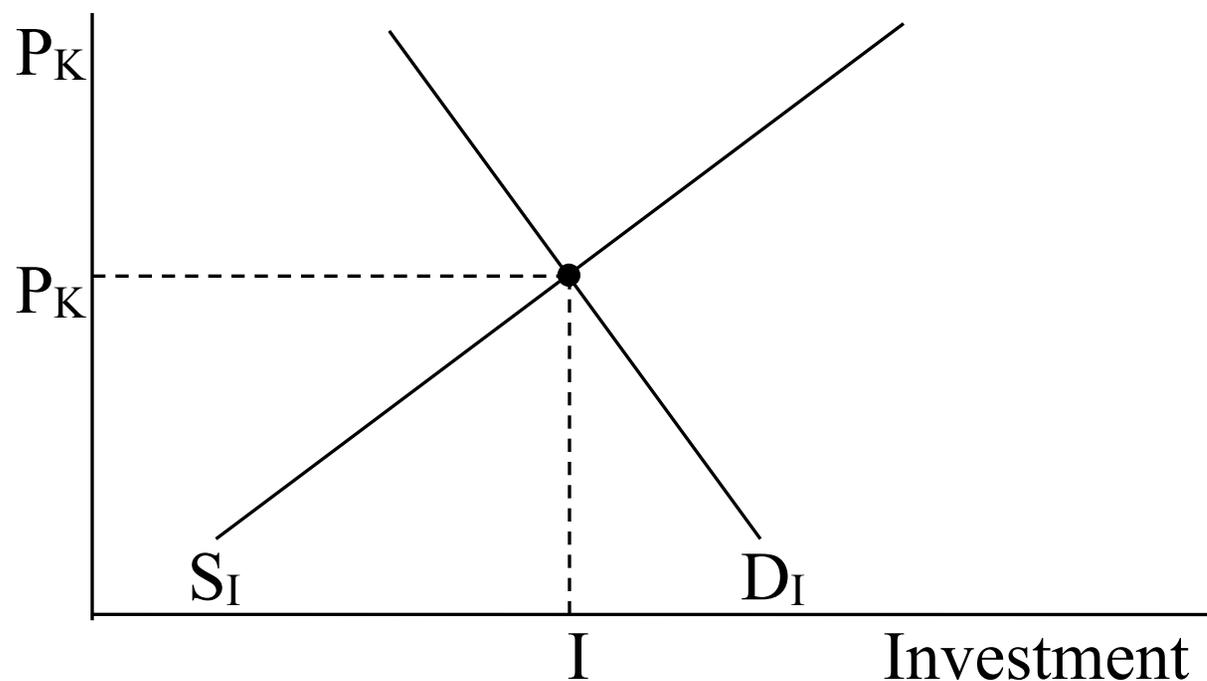
- a. Firms finance their investment purchases by borrowing funds from the loanable funds market. If firms internally finance their investment, they must forgo the interest they would have otherwise earned on the resources used to fund these purchases.

- b. Investment demand determines the demand for loanable funds.
- c. Savings decisions by private agents, governmental budget decisions, and the amount of direct foreign investment determine the supply of loanable funds.
- d. The interest rate clears this market.



## 2. The market for investment goods

- a. Investment demand is determined by how much investment businesses decide to undertake.
- b. Investment supply is determined by how much the producers of investment goods decide to supply.
- c. The relative price of investment goods to other goods in the economy ( $P_K$ ) clears this market.



## Firms Make Two Separate Decisions Regarding Their Level of Capital Investment

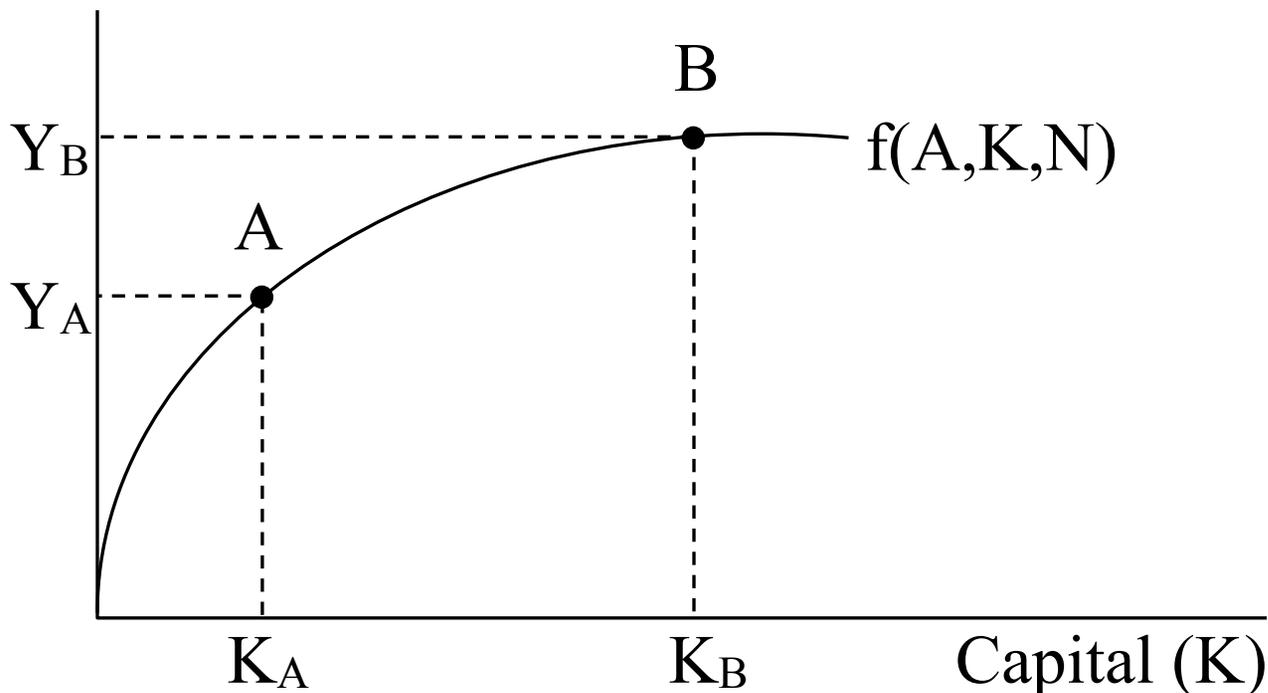
- A. What is their optimal level of capital stock ( $K^*$ )? (i.e., How many factories and machines does the company want?)
- B. What is their flow of investment? (i.e., How fast do they build factories and buy machines?)

Firms Choose  $K^*$  at the Point Where the Marginal Product of Capital Equals the Marginal Cost of Capital.

A. The marginal product of capital ( $MP_K$ ) is the additional output produced by using one additional unit of capital

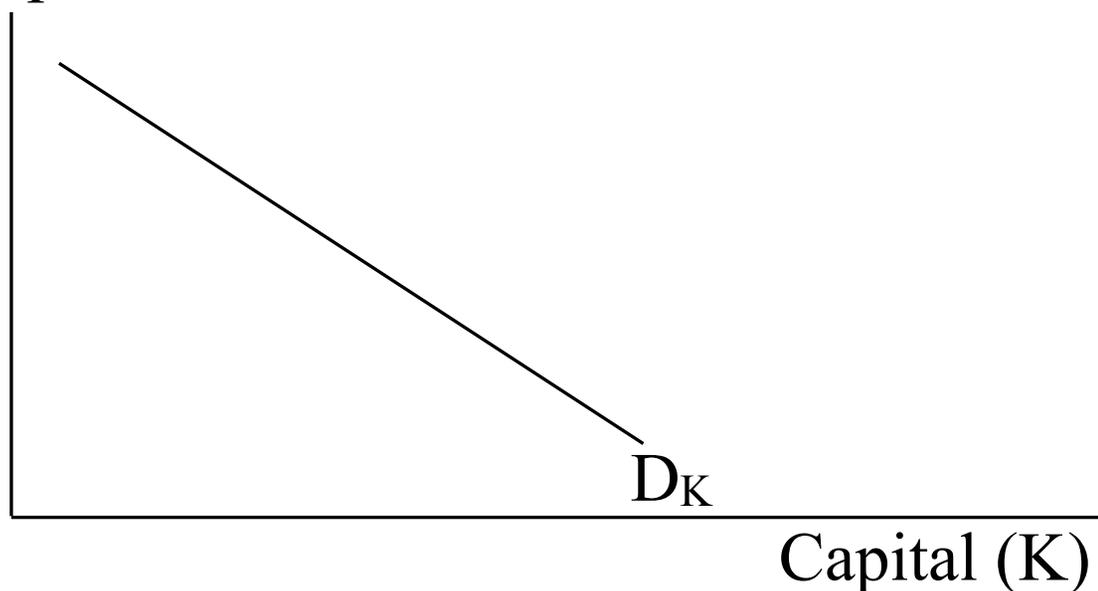
1. When graphing the production function,  $Y = f(A, K, N)$ , against  $K$ , we see that the  $MP_K = (Y_B - Y_A)/(K_B - K_A)$

Output



2. Formally, the  $MP_K$  is the slope of the production function.
3. The production function's bowed shape is due to the law of diminishing returns. This means that the  $MP_K$  declines as  $K$  increases, holding technology ( $A$ ) and labor ( $N$ ) constant.
4. Increases in  $A$  or  $N$  rotate the production function upward.
5. The demand curve for capital ( $D_K$ ) is the  $MP_K$  schedule (recall, the demand curve for labor is just the  $MP_L$  schedule).

Rental price  
of capital



B. The marginal cost of capital is the rental price per unit charged by renting firm ( $R_K$ ).

1. In the case where a firm owns its own capital, that firm's opportunity cost of utilizing its own capital is the rental revenue it forgoes.
2. The rental price of capital ( $R_K$ ) is a function of the price of capital goods ( $P_K$ ), the interest rate ( $R$ ) and the depreciation rate of capital ( $\delta_K$ ) such that

$$R_K = (R + \delta_K) \times P_K.$$

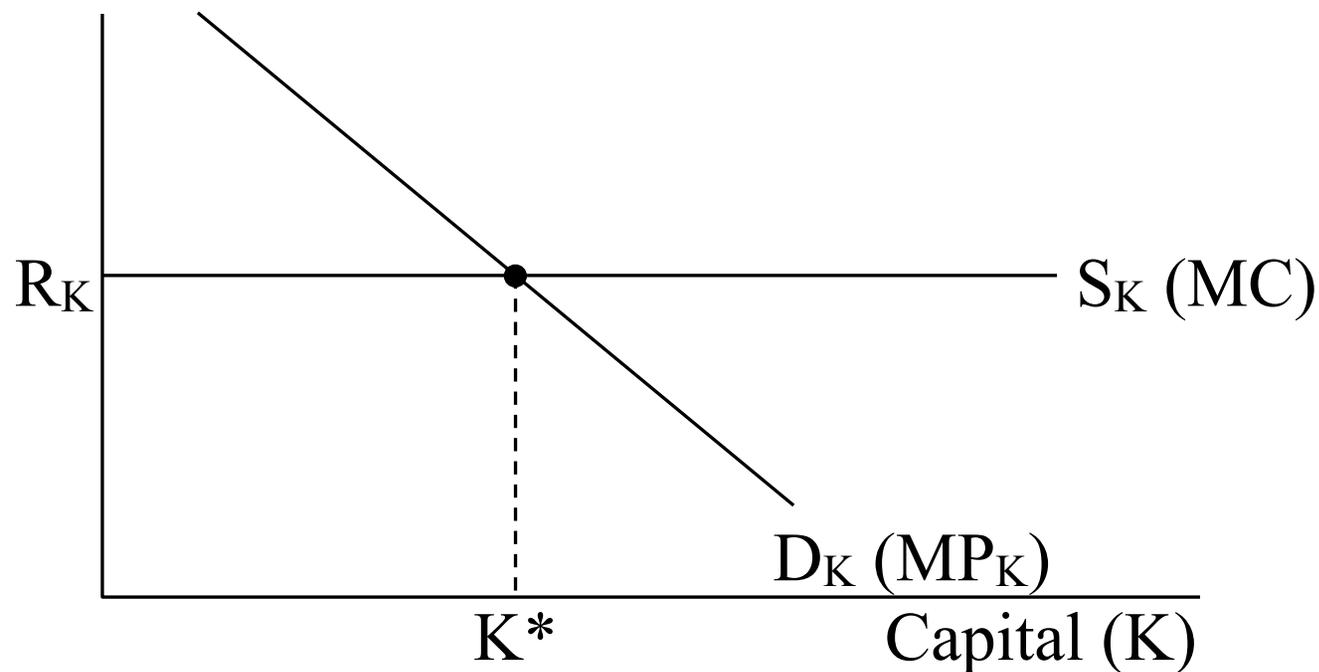
- a.  $R \times P_K$  is the opportunity cost that rental firms incur from owning a unit of capital.
- b.  $\delta_K \times P_K$  is the cost that rental firms incur to replace the depreciated capital.
- c. Estimates place the capital depreciation rate, ( $\delta_K$ ), around 10% annually.

d. Example, suppose  $P_K = 1$ ,  $R = 0.05$ , and  $\delta_K = 0.10$ .

Thus,  $R_K = 0.15$

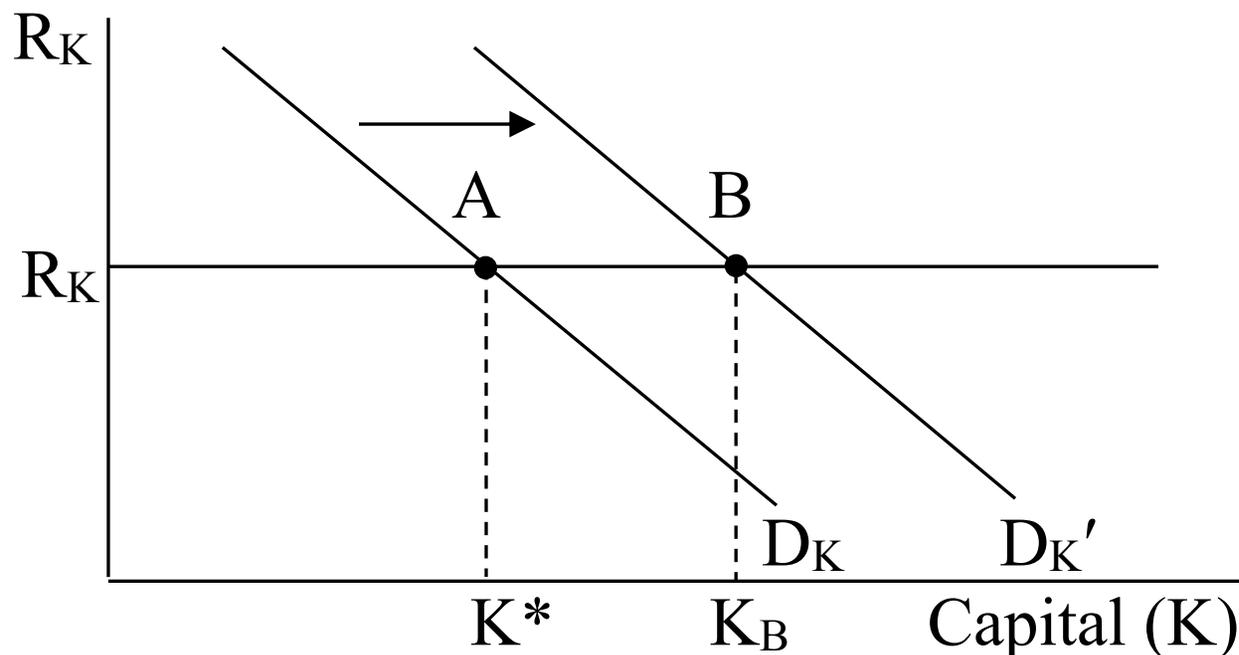
C. Firms choose  $K^*$  where  $MP_K = R_K$ .

Rental price  
of capital



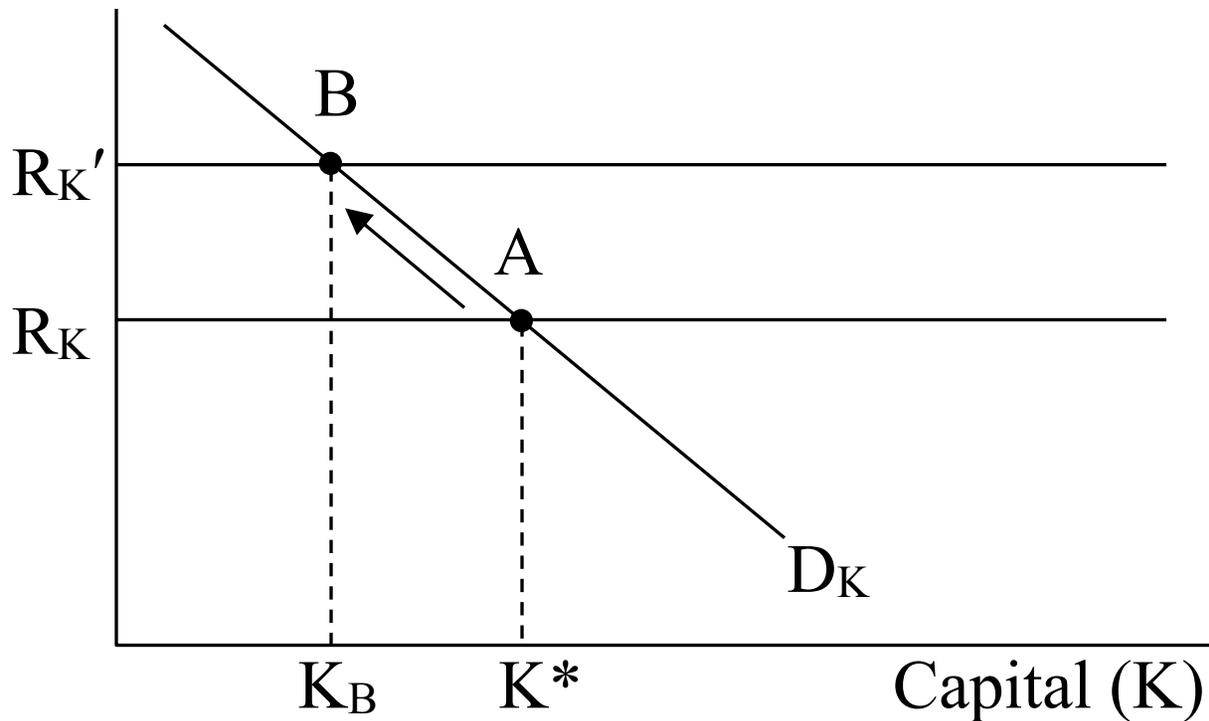
## D. Factors that shift the demand for capital

1. A rise (fall) in  $Y$  increases (decreases) the demand for capital which causes  $D_K$  to shift rightward (leftward).
2. A rise (fall) in the real wage ( $W/P$ ) means that the price of a substitute factor of production is higher (lower). This leads to an increase (decrease) in the demand for capital, which causes  $D_K$  to shift rightward (leftward).
3. A rise in  $D_K$  to  $D_K'$  causes  $K$  to climb to  $K_B$



4. An increase (decrease) in  $R_K$  to  $R_K'$  raises (lowers) the cost of  $K$  so firms reduce (expand) their level of  $K$  to  $K_B$ . This is represented by a leftward (rightward) movement along the  $D_K$  curve.

Rental price  
of capital



E. Expected changes in the future price of capital.

1. The current specification of the rental price of capital ( $R_K$ ) assumes the price of capital goods ( $P_K$ ) is NOT expected to change.

$$R_K = (R + \delta_K) \times P_K \quad (1)$$

2. If  $P_K$  is EXPECTED to decrease (increase) next period, the rental company expects to incur a loss (gain) by holding on to the capital. Thus, rental firm will raise (lower)  $R_K$  to compensate for the expected decline (rise) in  $P_K$ .

$$R_K = (R + \delta_K) \times P_K - (P_{K(+1)} - P_K) \quad (2)$$

where  $P_{K(+1)}$  is the expected relative price of capital next period.

3. It is IMPORTANT to note that equation (2) ONLY holds if the change in  $P_K$  is EXPECTED. If the change in  $P_K$  is UNEXPECTED, then equation (1) holds.

## How Much Investment Do Firms Undertake?

A. The investment demand function tells how much capital firms will purchase given planned  $Y$  and  $R_K$ .

1. Recall,  $K^*$  depends positively on  $Y$  and  $W/P$  and depends negatively on  $R_K$ . That is,  $K^*$  is a function of  $Y$ ,  $W/P$  and  $R_K$  such that

$$K^* = f(Y, W/P, R_K)$$

2. The actual level of capital investment ( $I_K$ ) in the economy is the difference between  $K^*$  and the level of capital last period ( $K_{-1}$ ) plus the replacement of last period's depreciated capital stock ( $\delta_K \times K_{-1}$ ).

$$I_K = K^* - K_{-1} + \delta_K \times K_{-1}$$

- a. Gross capital investment is  $I_K$ .
- b. Net capital investment is  $I_K - \delta_K \times K_{-1}$ .

c. The amount of replacement investment due to depreciation ( $\delta_K \times K_{-1}$ ) is typically a large fraction of capital investment each year.

3. The capital investment function is

$$I_K = f(Y, W/P, R_K) - K_{-1} + \delta_K \times K_{-1}$$

where  $I_K$  depends positively on  $Y$  and  $W/P$  and depends negatively on  $R_K$ .

4. The positive effect of output on investment is called the accelerator effect. To simplify notation, we can specify  $K^*$  as

$$K^* = v \times Y$$

where  $v$  depends on  $W/P$  and  $R_K$ .

5. Assuming  $K_{-1} = K^*_{-1}$ ,  $K_{-1}$  is described as follows:

$$K^*_{-1} = v \times Y_{-1}$$

6. Thus, the capital investment function

$$I_K = K^* - K^*_{-1} + \delta_K \times K^*_{-1}$$

can be restated as

$$I_K = v \times (Y - Y_{-1}) + \delta_K \times v \times Y_{-1}$$

7. In words, the level of  $I_K$  depends on the change in  $Y$ .

- B. For many projects, there is a lag of several years between when a firm decides to invest in capital and when that capital is installed.
1. Example, major investment projects such as new plants and custom equipment take one or more years to put in place.
  2. An algebraic expression of lags in the capital investment function is

$$I_K = s \times (K^* - K_{-1}) + \delta_K \times K_{-1}$$

where  $s$  is the fraction of the difference between  $K^*$  and  $K_{-1}$  that firms change their capital stock by. (i.e.,  $0 \leq s \leq 1$ ).

- C. While the capital investment demand function is firm specific, it has the same characteristics as the aggregate capital investment function so it is a good approximation for the aggregate capital investment demand function.

# Taxes and Investment

## A. Permanent tax changes

1. Permanent changes in taxes and subsidies on investment impact the marginal cost of investment, i.e. the rental price of capital, ( $R_K$ ).
2. Suppose rental income is taxed at a rate of  $u$  percent. Thus, the after tax rental income is  $(1 - u) \times R_K$ .
2. Suppose the cost of investment is subsidized at a rate of  $z$  percent. Thus, the actual cost of investment to a firm is  $(1 - z) \times (R + \delta_K) \times P_K$ .
4. Equating after-tax income with after-tax costs gives us

$$(1 - u) \times R_K = (1 - z) \times (R + \delta_K) \times P_K.$$

5.  $R_K$  is calculated by dividing both sides by  $(1 - u)$ :

$$R_K = [(1 - z) \times (R + \delta_K) \times P_K] / [1 - u].$$

6. An increase (decrease) in taxes on rental income, ( $u$ ), leads to a rise (fall) in  $R_K$ , which causes  $I_K$  to fall (rise).
7. A decrease (increases) in subsidies for investment, ( $z$ ), leads to a rise (fall) in  $R_K$ , which causes  $I_K$  to fall (rise).
8. Example: Suppose the marginal tax rate of capital is 20% and incentives to invest (such as subsidies and tax deductions for depreciation) total 40%. If  $R = 0.06$ ,  $\delta_K = 0.10$ , and  $P_K = 1$  then  $R_K$  equals

$$R_K = [(1 - z) \times (R + \delta_K) \times P_K] / [1 - u]$$

$$R_K = [(1 - 0.4) \times (0.06 + 0.10)] / [1 - 0.2]$$

$$R_K = 0.75 \times 0.16$$

$$R_K = 0.12$$

## B. Anticipated tax changes

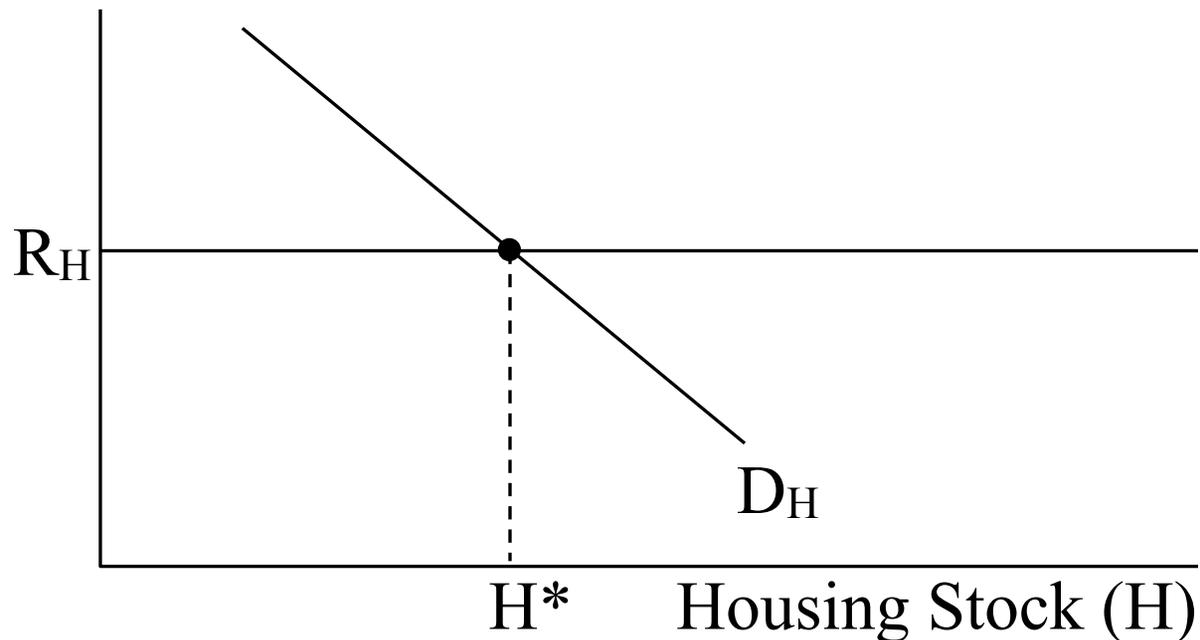
1. The previous calculations assume the tax rates are always in effect and that tax changes are UNANTICIPATED by firms.
2. Suppose firms ANTICIPATE that investment subsidies will decrease (increase) next period. This tax change will cause the price of capital goods ( $P_K$ ) to rise (fall) next period.
  - a. Since  $P_K$  will rise (fall) next period, firms will purchase more (less) capital this period before the price rises (falls) next period.
  - b. Since  $P_K$  will rise (fall) over the next period, rental firms will charge a lower (higher) price ( $R_K$ ).
  - c. The result is that  $I_K$  rises (falls) this period.

# Residential and Inventory Investment

## A. Residential investment

1. The demand for residential investment ( $D_H$ ) depends negatively on the rental price of houses ( $R_H$ ).
2. The desired stock of housing, ( $H^*$ ), is a function of  $R_H$ . This is true whether or not a person owns their house or rents it.

Rental price  
of houses



3. The rental price of houses ( $R_H$ ) is a function of the price of houses ( $P_H$ ), the interest rate ( $R$ ) and the depreciation rate of houses ( $\delta_H$ ) such that

$$R_H = (R + \delta_H) \times P_H$$

- a.  $R \times P_H$  is the opportunity cost that home owners incur from owning a house.
  - b.  $\delta_H \times P_H$  is the decline in housing value due to depreciation.
  - c. Since the estimates of household depreciation, ( $\delta_K$ ), are around 2% annually,  $R$  is a large component of  $R_H$ , which causes housing to be very sensitive to changes in  $R$ .
  - d. Example, suppose  $P_H = 1$ ,  $R = 0.05$ , and  $\delta_H = 0.02$ . Thus,  $R_H = 0.07$
4. Since housing can usually be built in less than one year, lags in housing investment ( $I_H$ ) are usually not a problem so that

$$I_H = H^* - H_{-1} + \delta_H \times H_{-1}$$

## B. Inventory investment

1. Inventories are the stock of goods in the production process and final goods waiting to be sold.
2. Inventories are an intrinsic part of the production process. This is called the pipeline function of inventories.
  - a. Inventory levels held due to the pipeline function tend to be procyclical. This helps accelerate investment as  $Y$  rises.
  - b. About  $2/3$  of all inventories are held because of the pipeline function.
3. Inventories are also held by firms to maintain a buffer stock against unplanned changes in demand.
  - a. Occasionally, unplanned increases (decreases) in demand deplete (boost) inventories below (above) planned levels.
  - b. About  $1/3$  of all inventories are held as buffer stock.

4. The rental price of inventories ( $R_{IN}$ ) is equal to the price of goods held as inventories ( $P_{IN}$ ) multiplied by the interest rate ( $R$ ). This is just the opportunity cost of the resources that are held as inventories:

$$R_{IN} = R \times P_{IN}$$

### An Overview of Aggregate Investment

- A. The total sum of investment depends on the interest rate ( $R$ ) and the change in income ( $Y$ ).
- B. A large increase in output causes capital investment and pipeline inventories to increase. This causes a bulge in investment as output is grows. Once output growth moderates, the level of investment will slow down.
- C. The level of investment is also affected by the interest rate. Lower interest rates encourage capital and residential investment, which pushes up the amount of aggregate investment.