Micro-foundations: Investment

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Why Study Investment?

1. Investment is the part of GDP that links the present and the future.

2. During recessions, much of the decline in GDP is due to investment. E.g., during the 1982 recession in the US, GDP fell by \$105 billion and investment fell by \$152 billion.

Types of Investment

- Business fixed investment—the equipment and building structures the firms buy to run their businesses.
- Residential investment—the *new* housing households and landlords purchase.
- Inventory investment—goods (materials, work in process, and finished goods) put in storage (can be positive or negative).

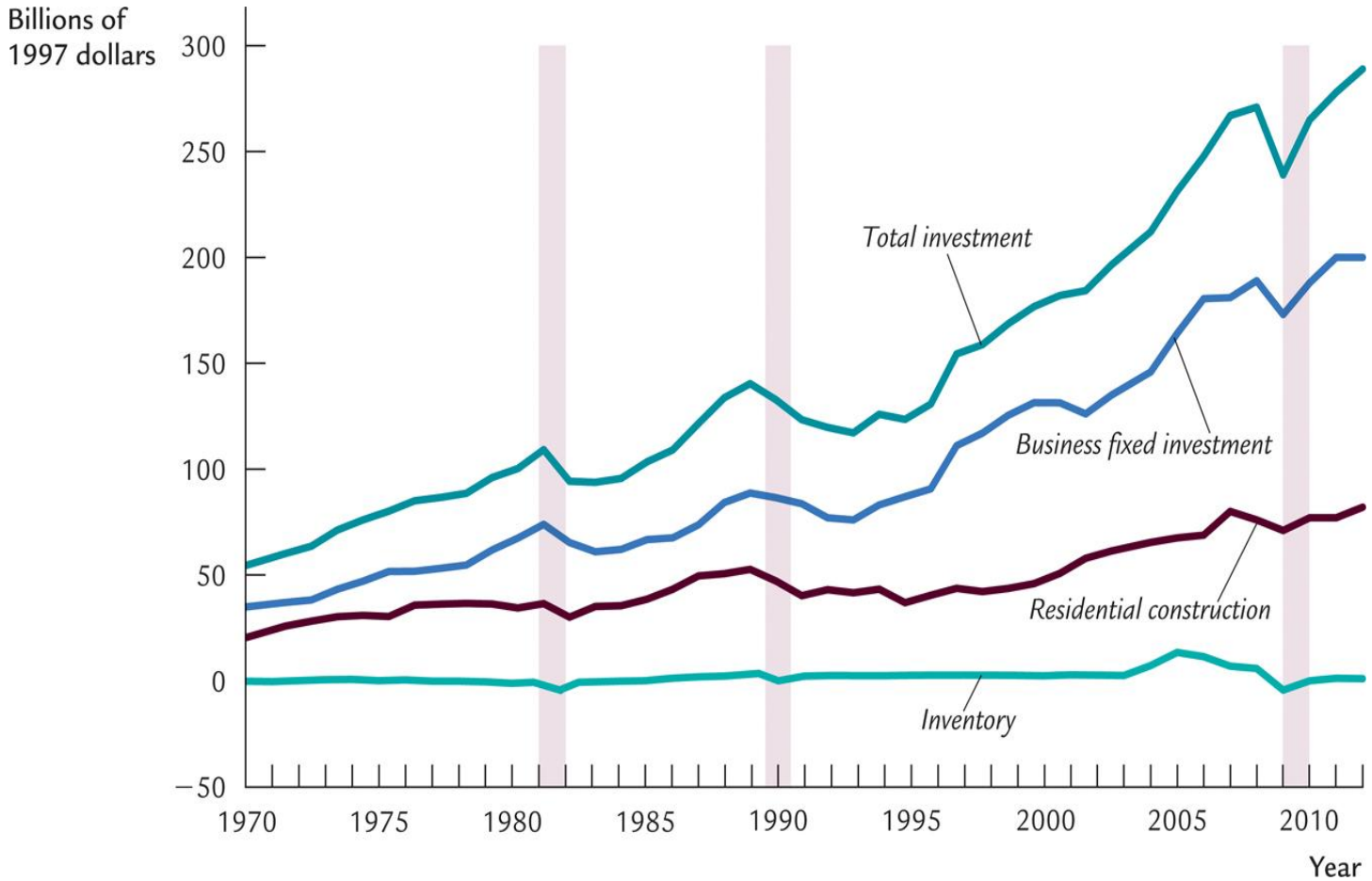

Figure 18-1 The Three Components of Investment
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Explaining the Business Fixed Investment

Assume there are two types of firms:

- production firms that rent equipment/structures, and
- rental firms that purchase new capital and, thus, undertake all of the investment in the economy.

The Rental Price of Capital

- Assume that the economy is populated by competitive production firms, and all of them face the price for their good, P.
- Thus, the aggregate price level is P.
- The *real* cost of renting a unit of capital for the *production* firm is R/P, where R is the rental price of a unit of capital.
- If $Y = AK^{\alpha}L^{1-\alpha}$, the *real* return from renting a marginal unit of capital is $MPK = \alpha \times A\left(\frac{K}{L}\right)^{\alpha-1}$.
- To maximize the profit, the **production firm** chooses K such that

$$\underbrace{\frac{R}{P}}_{\substack{\text{real marginal cost from} \\ \text{renting 1 more unit}}} = \underbrace{\alpha \times A\left(\frac{K}{L}\right)^{\alpha-1}}_{\substack{\text{real marginal benefit from} \\ \text{renting 1 more unit}}}.$$

Optimal choice of capital

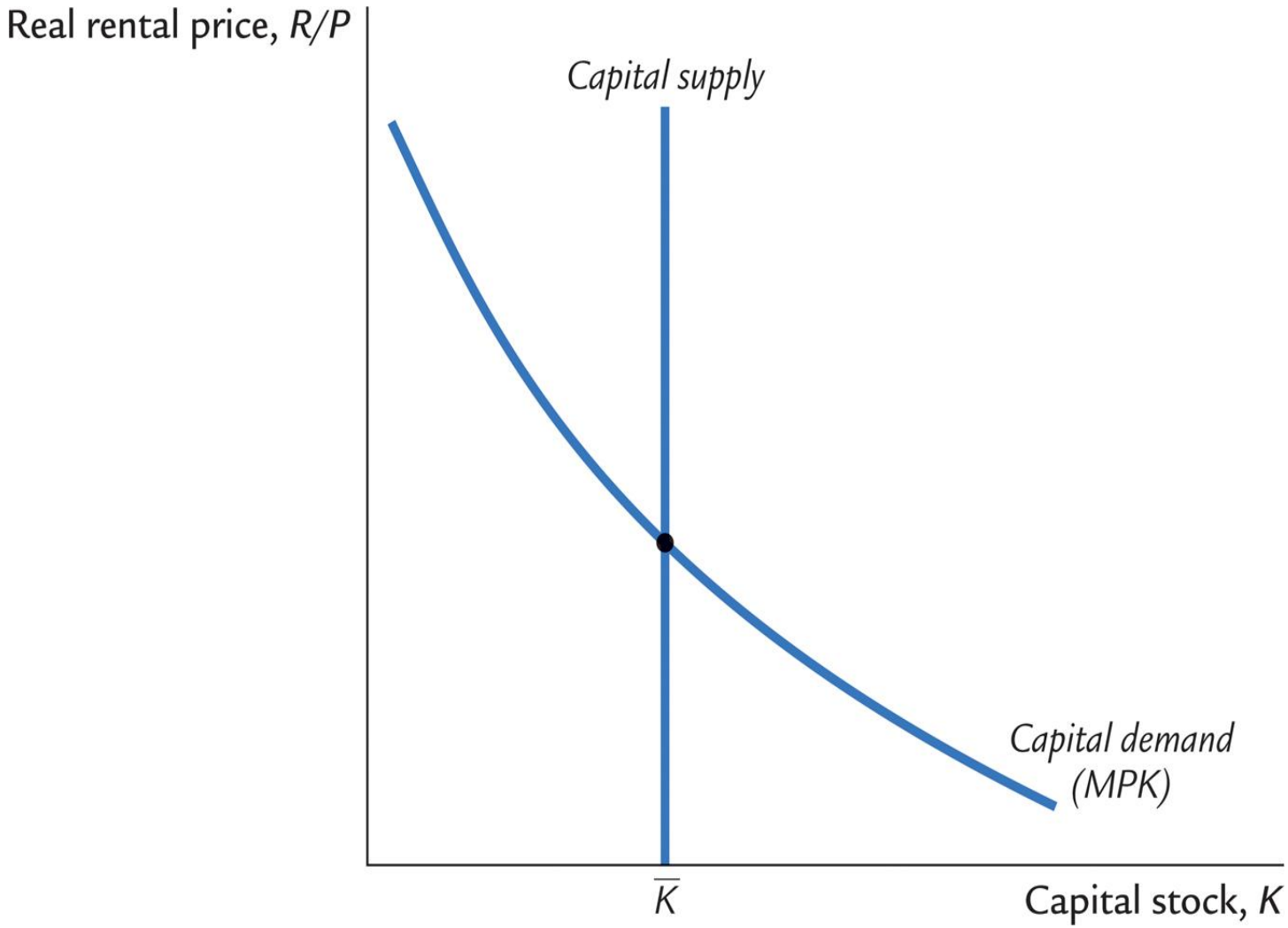

Figure 18-2 The Rental Price of Capital
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Notes

$$\frac{R}{P} = \alpha \times A(\frac{K}{L})^{\alpha-1} = \alpha \times AK^{\alpha-1}L^{1-\alpha} = A\left(\frac{K^{\alpha}}{K}\right)\left(\frac{L}{L^{\alpha}}\right).$$

The real rental price, ceteris paribus, is higher if:

- A is higher, i.e., if technology improves;
- L is higher;
- K is lower.

The Cost of Capital to the Rental Firm

Since I is done by *rental* firms, we want to understand the (marginal) costs and benefits of carrying one unit of capital from current to the next period for the rental firm. Let

- the nominal interest rate from period t to period $t+1$ be i (paid to finance the loan needed to purchase an extra unit of K, or an opportunity cost of own funds);
- the price of a unit of capital in period t be $P_{K,t}$, and in period $t+1$ $P_{K,t+1}$;
- the depreciation rate be δ: $(1-\delta)$ units of capital are left in $t+1$ from one unit of capital acquired at t.

The Cost of Capital to the Rental Firm

Consider the cost of the following transaction.

The rental firm acquires one unit of capital at time t and sells it at time $t+1$. The (expected) cost is:

$$
\begin{aligned}
& P_{K,t} \times (1+i) - (1-\delta) \times P^e_{K,t+1} \\
&= P_{K,t} \times \left(1 + i - (1-\delta) \times \underbrace{\frac{P^e_{K,t+1}}{P_{K,t}}}_{=1+\pi^e} \right) \\
&= P_{K,t} \times (1 + i - (1-\delta) \times (1+\pi^e)) \\
&= P_{K,t} \times (1 + i - 1 - \pi^e + \delta + \underbrace{\delta \times \pi^e}_{\approx 0}) \\
&\approx P_{K,t} \times (\underbrace{i - \pi^e}_{=r} + \delta) = P_{K,t} \times (r + \delta).
\end{aligned}
$$

The Cost of Capital—Summary

We've done two assumptions to arrive at the formula:

1. The proportional change in the price of capital is equal to the proportional change in the overall price level. I.e., $P^e_{K,t+1}/P^e_{K,t} = P^e_{t+1}/P_t$.

2. The term $\delta \times \pi^e$ is small and so can be safely ignored.

3. Note that an *investment tax credit*—a tax provision that reduces a firm's taxes for each dollar spent on capital goods—stimulates investment since the effective price of a unit of capital is below $P_{K,t}$ and the per unit cost of investment will be below $P_{K,t} \times (r + \delta)$.

The Real Cost of a Unit of Capital

The real cost of a unit of capital is:

$$\frac{P_{K,t}}{P_t} \times (r + \delta).$$

(Notice the division by P_t, the price of a unit of final good.)

A per unit real profit of the rental firm is:

$$\begin{aligned} &\frac{R}{P} - \frac{P_{K,t}}{P_t} \times (r + \delta) \\ &= MPK - \frac{P_{K,t}}{P_t} \times (r + \delta), \end{aligned}$$

where the second line comes from the maximization problem of the production firm.
The desired stock of capital, K_t^*, will negatively depend on r, δ, and $\frac{P_{K,t}}{P_t}$: $K_t^* = K_t^* \left(r, \delta, \frac{P_{K,t}}{P_t} \right)$.

Net and Gross investment

Recall the law of motion of capital:

Net investment demand: $\Delta K_t = K_t^*(r, \delta) - K_{t-1} = I_t^d - \delta K_{t-1}$.

Net investment demand negatively depends on δ, r since K_t^* negatively depends on those parameters.

Gross investment demand: $I_t^d = \Delta K_t + \delta K_{t-1} = K_t^*(r, \delta) - (1-\delta)K_{t-1}$

=Net investment+replacement of depreciated capital.

The effect of δ on gross investment demand is ambiguous:

- higher δ pushes down K_t^* for sure
- a high δ also implies high I^d to reach the desired level of capital K_t^*.

Summary

- Reduction in r raises K_t^* and investment demand
- An increase in MPK raises K_t^* and investment demand
- Investment demand declines if the previous stock of capital, K_{t-1}, rises
- An increase in δ lowers K_t^*, net investment demand declines, the effect on gross investment is ambiguous

Investment function

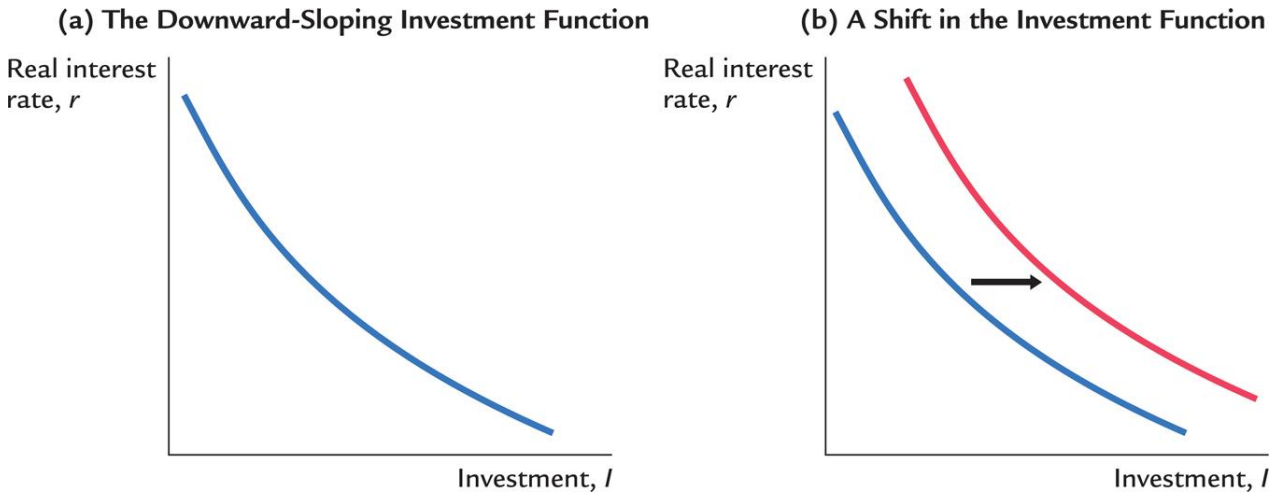

Figure 18-3 The Investment Function
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Panel (b): an increase in total factor productivity makes firms invest more at any interest rate (a rightward shift in the investment function).

The demand for housing

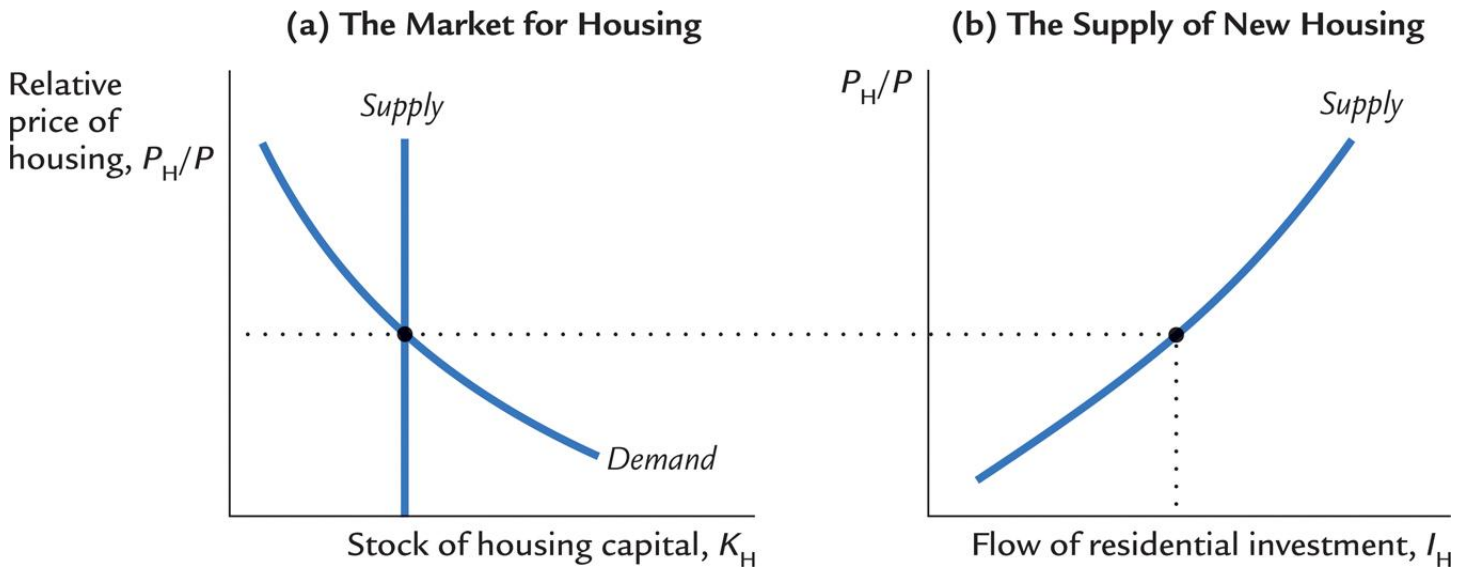

Figure 18-5 The Determination of Residential Investment
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Changes in housing demand

- business cycles (e.g., more demand for housing during booms)
- in- and out-migration
- real interest rate (servicing of a mortgage increases with the interest rate)
- credit availability (more demand with easy credit, e.g., during the period of subprime mortgage expansion)
- etc.

Shifts in the demand for housing (e.g., an inflow of immigrants, a boom, fall in the real interest rate, easy credit)

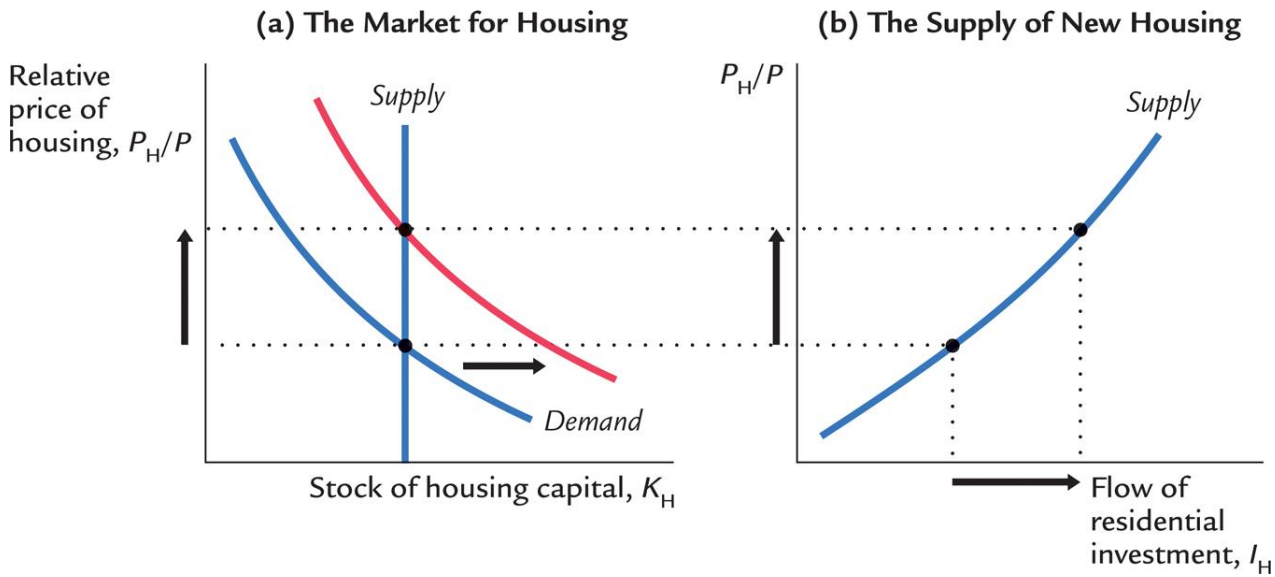

Figure 18-6 An Increase in Housing Demand
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Interest cost of a mortgage and the demand for housing

Interest Rate	Monthly Payment	Annual Income Required
5%	$582	$23,280
6	640	25,600
7	700	28,000
8	763	30,520
9	828	33,120
10	894	35,760
11	963	38,520
12	1,032	41,280

Table 18-1 How High Interest Rates Reduce Mortgage Eligibility and Housing Demand for a 25-year $100,000 Mortgage
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A 25 year $100,000 mortgage with the requirement that the monthly mortgage payment $< 30\%$ of a borrower's monthly income. If interest is 7%, households with income below 28,000 will be out of the market for owner-occupied housing.

Readings

Mankiw & Scarth. Chapter 18.