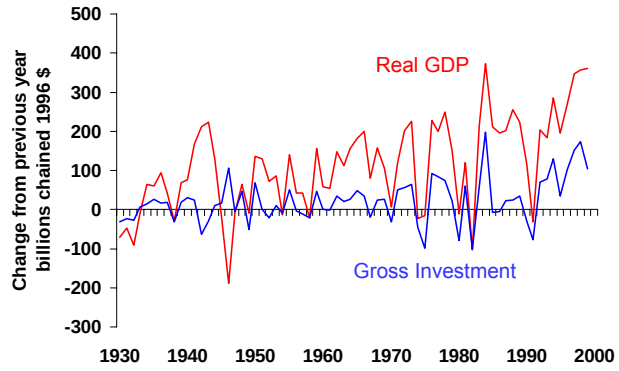
Intermediate Macroeconomics

Chapter 11
Investment

Investment

1. Introduction
2. Definitions
3. Model 1 – Net present value (NPV)
4. Model 2 – Simple accelerator
5. Model 3 – Neoclassical
6. Model 4 – Tobin's *q*
7. Complications
8. Policy Implications

1. Introduction
Change in investment vs change in GDP



2. Definitions
Net investment

Net investment = increase in productive capital stock

$I^n_t = K_t - K_{t-1}$

I^n_t = Net investment during period t
K_t = Capital stock at end of period t

2. Definitions
Replacement investment and depreciation

Replacement investment = spending necessary to maintain a constant productive capital stock

$I^r_t = d\ K_{t-1}$

I^r_t = investment in replacement capital in period t

d = rate of depreciation, percent/year

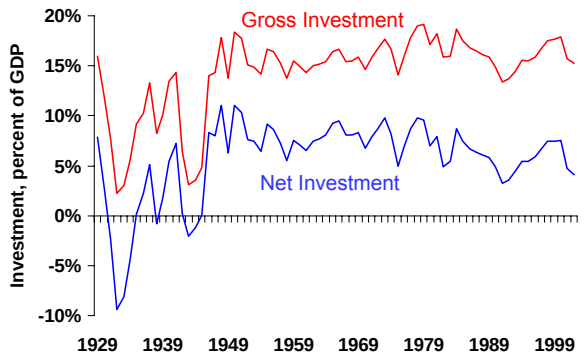
2. Definitions
Gross investment

Gross investment = total spending on goods used to produce other goods and services

$I^g_t = I^n_t + I^r_t$

I^g_t = gross investment in period t

2. Definitions
Gross and net investment



3. Model 1 - Net Present Value (NPV)

- Present Value – present day value of a future revenue or expense

$$\text{Present Value} = \frac{\text{cash flow year } n}{(1+i)^{n-1}}$$

i = nominal interest rate

- Net Present Value – total present day value of all current and expected future revenues and expenses

3. Model 1 - Net Present Value (NPV) Case 1

Assume nominal interest rate = 10% = 0.10
All revenues and expenses occur at the beginning of the year.

	Revenue	Expense	Net Cash Flow	NPV
Year 1	$ 0	$100	- $100	- $100
Year 2	50	0	50	45.45
Year 3	80	0	80	66.12
Totals	$130	$100	$30	$11.57

$$NPV = \frac{\text{Year 1 Net}}{1} + \frac{\text{Year 2 Net}}{1+i} + \frac{\text{Year 3 Net}}{(1+i)*(1+i)}$$

3. Model 1 - Net Present Value (NPV) Case 2

Year 3 revenue lowered from $80 to $60.
Total revenue still exceeds total expense but NPV < $0.
Assume nominal interest rate = 10% = 0.10
All revenues and expenses occur at the beginning of the year.

	Revenue	Expense	Net Cash Flow	NPV
Year 1	$ 0	$100	- $100	- $100
Year 2	50	0	50	45.45
Year 3	60	0	60	49.59
Totals	$110	$100	$10	- $ 4.96

$$NPV = \frac{\text{Year 1 Net}}{1} + \frac{\text{Year 2 Net}}{1+i} + \frac{\text{Year 3 Net}}{(1+i)*(1+i)}$$

3. Model 1 - Net Present Value (NPV) Variables that affect investment

Variables that affect investment:

- Demand (and income): increase in demand increases revenues and NPV of investment.
- Nominal interest rate: increase in interest rate reduces the NPV of future cash flows. If future net cash flows are positive, result is a lower NPV of investment.

4. Model 2 – Simple Accelerator

The desired level of capital stock is a fixed function of aggregate demand.

$$K_t = ß\ Y_t$$
$$K_{t-1} = ß\ Y_{t-1}$$

K_{t-1} = stock of capital at end of period t-1
Y_t = aggregate demand in period t

4. Model 2 – Simple Accelerator
Net investment

Net investment equals the change in the level of capital stock.

$I^n_t = K_t - K_{t-1}$

I^n_t = net investment in period t

Firms instantaneously adjust the level of capital to the observed level of demand.

$I^n_t = ß\ Y_t - ß\ Y_{t-1}$

$= ß\ (Y_t - Y_{t-1})$

4. Model 2 - Simple Accelerator
Variables that affect investment

Variables that affect investment:

- Demand: increase in demand increases desired level of capital stock and investment.

Desired net investment equals some fraction (ß) of the growth in demand.

Desired gross investment equals some fraction of the growth in demand plus some fraction (d) of the beginning stock of capital.

5. Model 3 - Neoclassical

- Derive desired level of capital stock, K*
- Calculate investment as a function of:

$K^* - K_{t-1}$

where,

K^* = desired level of capital

K_{t-1} = stock of capital at start of the period t
(end of preceding period, t-1)

5. Model 3 – Neoclassical
Desired stock of capital, K*

- Profit maximization problem
- Marginal product of capital
- Value of the marginal product of capital
- Rental (user) cost of capital
- Real interest rate and depreciation rate
- Nominal interest rate
- Expected inflation rate

5. Model 3 – Neoclassical
Profit maximization

$$\text{Profit} = p \bullet Y - c \bullet K - w \bullet L$$

p = average product price
Y = physical measure of output
= production function, Y = f(K,L)
c = rental (user) cost of capital
K = available capital stock
w = wage rate
L = quantity of labor input

5. Model 3 – Neoclassical
Profit maximization

$$\text{Profit} = p \cdot Y - c \cdot K - w \cdot L$$

$$\frac{\partial \text{ profit}}{\partial K} = p * \frac{\partial Y}{\partial K} - c = 0$$

$$c = p * \frac{\partial Y}{\partial K}$$

$$K^* = f(p, \mathbf{c}, w)$$

p and w are observable,
c is not observable

Where

$\frac{\partial Y}{\partial K}$ = marginal product of capital

$p \frac{\partial Y}{\partial K}$ = value of marginal product of capital

c = rental cost of capital

K* = desired level of capital

5. Model 3 – Neoclassical
Rental cost of capital

Rental cost – equivalent to what it costs to buy capital today and then sell it one year from now.

$$c^* = \mathbf{r} + d$$

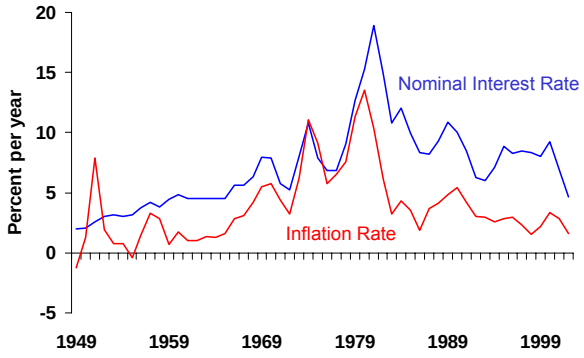
c* = rental cost of capital
r = real interest rate
d = depreciation rate

5. Model 3 – Neoclassical
Real interest rate

$$r = i - E(\pi)$$

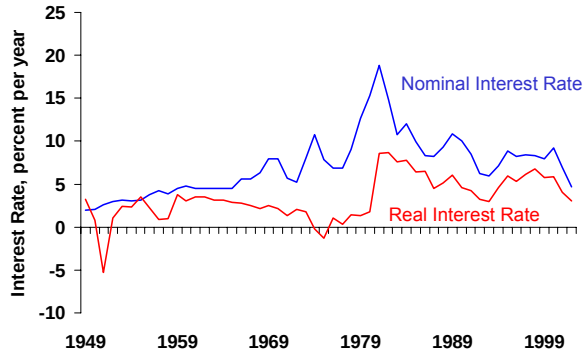
r = real interest rate
i = nominal interest rate
E(π) = expected inflation rate

5. Model 3 – Neoclassical
Nominal interest and inflation rates



Source: Nominal interest rate based on U.S. bank prime rate (www.federalreserve.gov/)
Inflation rate based on CPI measure of inflation (www.bls.gov)

5. Model 3 – Neoclassical
Nominal and real interest rates



Source: Nominal interest rate based on U.S. bank prime rate (www.federalreserve.gov/)
Real interest rate based on prime rate - CPI measure of inflation (www.bls.gov)

5. Model 3 – Neoclassical
Expected inflation rate

- Naive expectations:

  $E(\pi_t) = \pi_{t-1}$

- Adaptive expectations:

  $E(\pi_t) = E(\pi_{t-1}) + a * [\pi_{t-1} - E(\pi_{t-1})]$

- Rational expectations:

  $E(\pi_t) = \pi_t$ + random error

5. Model 3 – Neoclassical
Desired level of capital, K*

Positive function of:
- Product price, p
- Product demand, Y
- Labor wage rate, w

Negative function of
- Rental Cost of Capital, c $c = r + d$
  - real interest rate (+), r $= i - E(\pi_t) + d$
  - nominal interest rate (+), i
  - expected inflation rate (-), E
  - expected depreciation rate (+), d

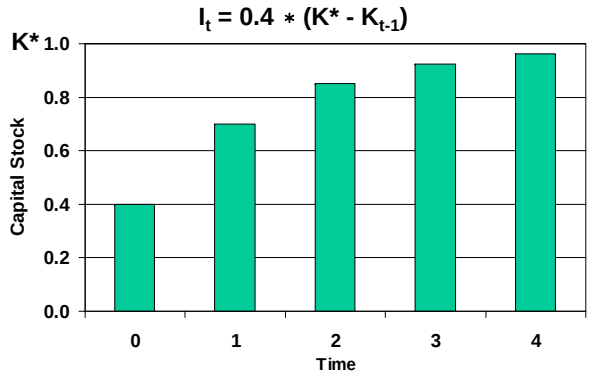
5. Model 3 – Neoclassical
Flexible accelerator

How do you go from desired level of capital to investment?

Flexible Accelerator Model - firms close a portion of the gap, *a*, between the desired and the current levels of capital

$$I_t = a * (K^* - K_{t-1})$$

5. Model 3 – Neoclassical
Adjustment of the capital stock



3. Model 3 – Neoclassical
Variables that affect investment

Variables that affect investment:

- Demand (and income) (+)
- Product price (+)
- Wage rate (+)
- Real interest rate (-)
- Nominal interest rate (-)
- Expected inflation rate (+)

6. Tobin's *q*

$$q = \frac{\text{company's market value}}{\text{replacement cost of capital}}$$

As the value of the stock market increases relative to the total stock of real capital then the rate of investment should increase.

7. Complications

- Credit Rationing – unable to borrow money even for a good investment
- Capacity Utilization – increase in demand does not motivate investment in existing capacity is underutilized.

8. Policy Implications Investment Tax Credits

- Temporary tax credit
  - small impact on desired capital stock
  - large impact on current period investment spending
  - anti-recession policy
- Permanent tax credit
  - larger impact on desired capital stock
  - smaller impact on current period investment spending
  - long-run growth policy

8. Policy Implications Corporate Income Tax

Is investment financed from borrowed funds or equity funds (e.g., stock sale)?

- Borrowed Funds - interest payments on borrowed funds deducted from firm's income before income tax calculated.
- Equity Funds - interest payments (e.g. dividends) on funds are not deducted from firm's income before tax is calculated.

8. Policy Implications Corporate Income Tax

Borrowed Funds	Equity Funds
+ Product sales	+ Product sales
- Raw materials & labor	- Raw materials & labor
-Depreciation	-Depreciation
- Interest payments on borrowed funds	
Gross Profit	Gross Profit
- Corporate income tax	- Corporate income tax
Net Profit	Net Profit
	- Dividends on equity funds