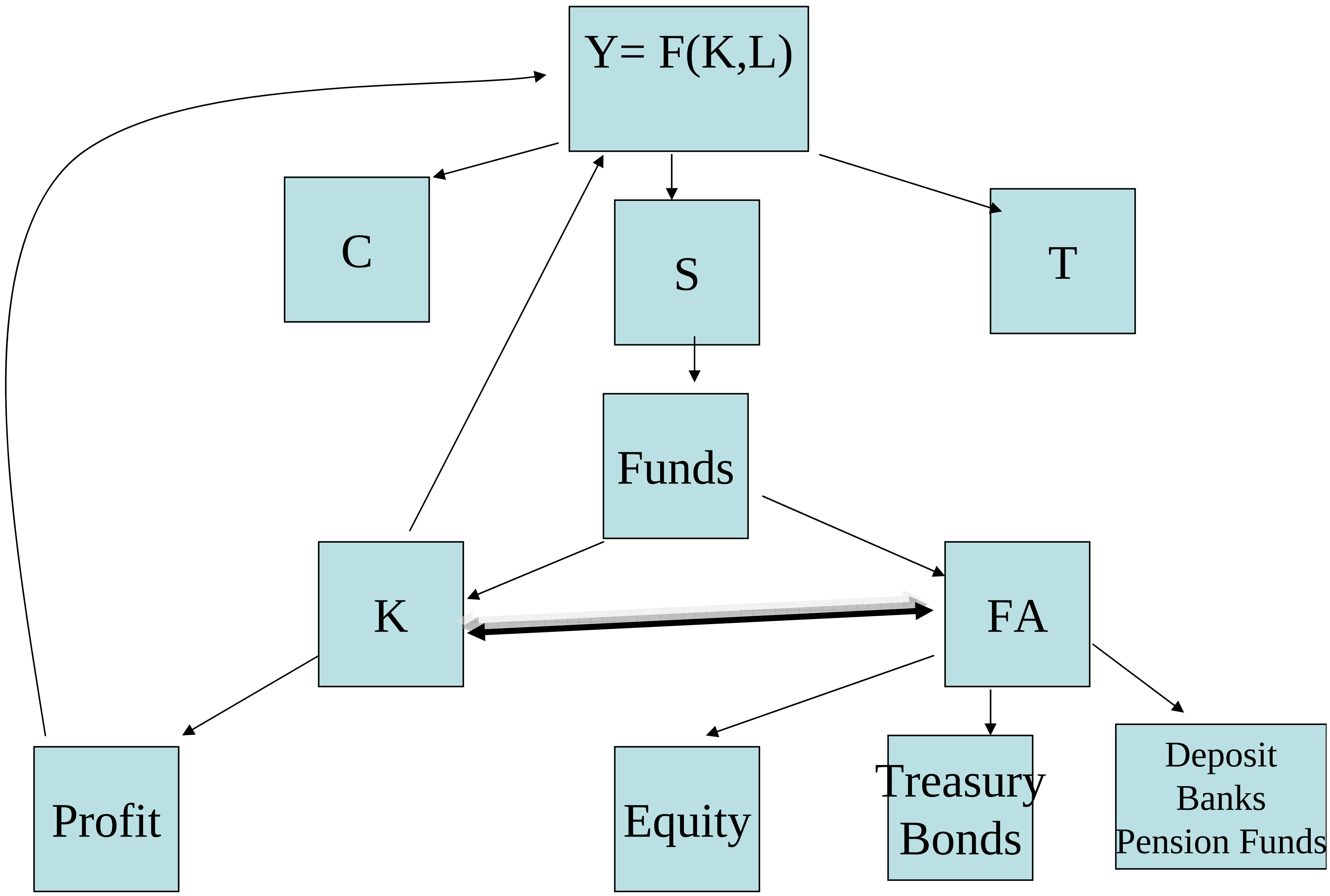
# Macroeconomic Theory and Policy

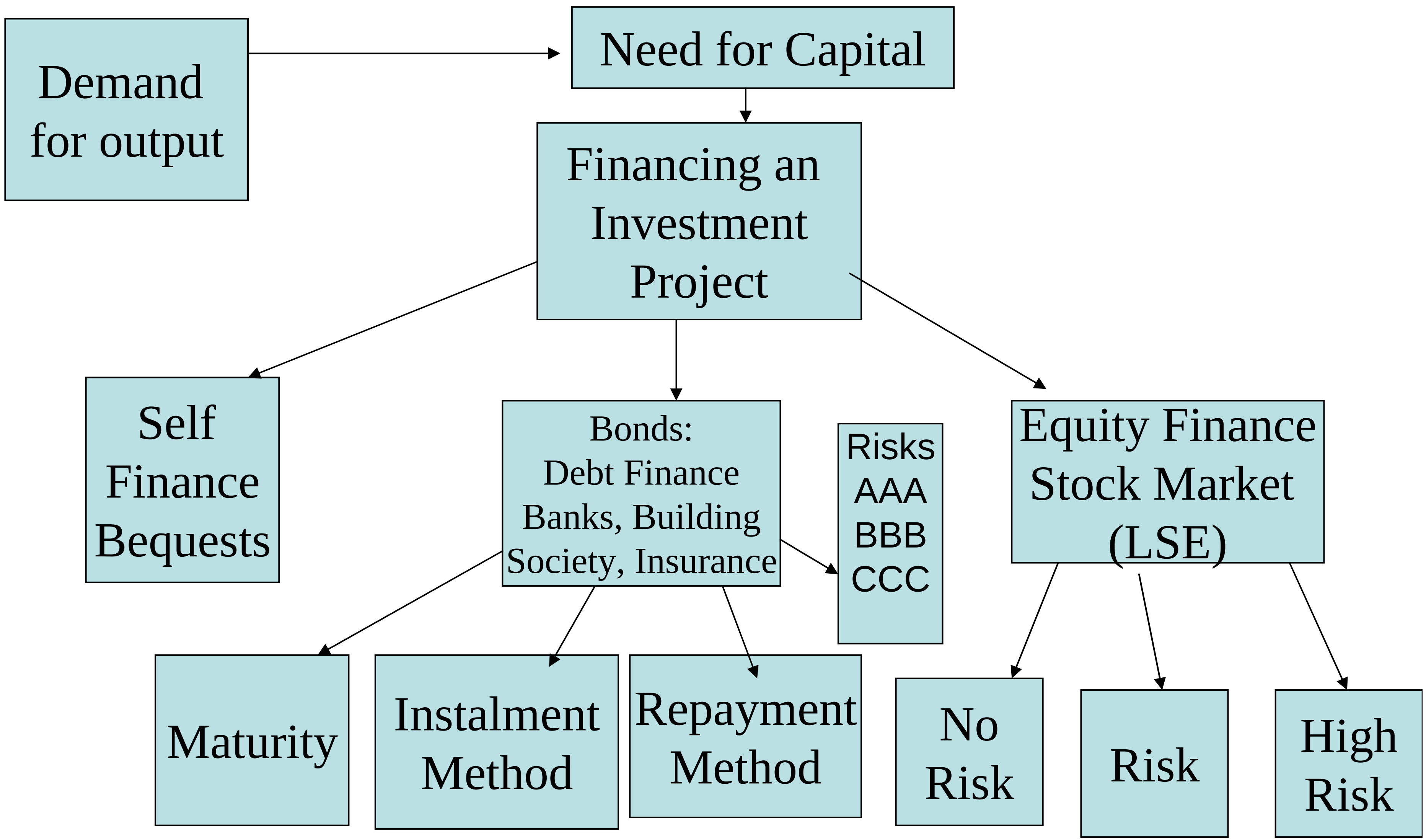
Lecture 21

Financial Market: Value of Bonds and Stocks

# Link Between Financial System and the Economy



# Financing of an Investment Project



# Three Sources of Financing an Investment Project

- Self-financing
  - Depends on retained earning
  - Personal savings
- Bonds
  - Various maturities and risks
- Stocks
  - Market signals and equity prices

# Investor Care about the Real Return: Fisher equation

## Gross nominal return

| Time | today | Tomorrow |
|---|---|---|
| Amount | $P_t$ | $(1+i)P_t$. |

**Gross real return (take account of inflation)**

| Time | Today | Tomorrow |
|---|---|---|
| Amount | $P_t$ | $(1+r)=(1+i)\frac{P_t}{P_{t+1}^e}$ |
| Approximation | $P_t$ | $(1+r)=\frac{1+i}{1+\pi^e}\approx\left(1+i-\pi^e\right)$ |

$$\frac{P_t}{P_{t+1}^e}=\frac{1}{1+\pi_t^e} \quad \text{and} \quad \pi_t^e=\frac{P_{t+1}^e-P_t}{P_t}.$$

# Fisher Approximation Rule is Good only for Small Interest Rates

If i=4% and $\pi^e = 2\ \%$ $r \approx i - \pi$

$$r = 4\% - 2\% \cong 2\%$$

$$\left(1+r\right) = \frac{1+i}{1+\pi^e} = \frac{1+0.04}{1+0.02} = 1.01961$$

$$==> r = 1.961\% \cong 2\%$$

But the $r \approx i - \pi$ not good for large $r$, $i$ and $\pi$

$$r = 84\% - 54\% \cong 30\%$$

$$\left(1+r\right) = \frac{1+i}{1+\pi} = \frac{1+0.84}{1+0.54} = 1.195 => r = 19.5\%$$

# Key Points about Prices Financial Assets

Prices depend on

- Expected earnings from these assets
  - Expected returns from bonds
  - Expected stream of dividends from stocks
- Expected interest rates
  - Interest rates discount future earnings to present values
- Expected resale values of those assets
  - short run vs. long run
- Arbitrage implies investors reshuffle assets until the rate of return equalise s in every asset

# Market Price of a bond (console)

What is the market price (value) of a console that pays 100 each year forever at the interest rate, r?

$$PV = \frac{100}{(1+r)^1} + \frac{100}{(1+r)^2} + \frac{100}{(1+r)^3} + \ldots\ldots\ldots\ldots + \frac{100}{(1+r)^n}$$

$$PV = \frac{100}{(1+r)^1}\left[\frac{1-\frac{1}{(1+r)^{n+1}}}{1-\frac{1}{1+r}}\right] \quad \text{as } n \to \infty \quad \frac{1}{(1+r)^{n+1}} \to 0$$

$$PV = \frac{100}{(1+r)^1}\left[\frac{1+r}{r}\right] = \frac{100}{r} = \frac{100}{0.1} = 1000.$$

# Market Prices of Bonds By Maturity

One Period Bond: $$P^B_{1,t} = \frac{Face\ \ value}{\left(1+i_{1,t}\right)}$$

Two Period Bond: $$P^B_{2,t} = \frac{Face\ \ value}{\left(1+i_{1,t}\right)\left(1+i^e_{1,t+1}\right)}$$

Derivation

$$P_{2t} = \frac{P^e_{1,t+1}}{1+i_{1,t}} \qquad P^e_{1,t+1} = \frac{1}{1+i^e_{1,t+1}}$$

$$P^B_{2t} = \frac{P^e_{1,t+1}\left(Face\ \ value\right)}{1+i_{1,t}} = \frac{Face\ \ value}{\left(1+i_{1,t}\right)\left(1+i^e_{1,t+1}\right)}$$

# Yield to maturity on Bonds

Face Value 100

Maturity 2 years

Market Price $P_{2t}^{B} = 90$

$$\left(1 + i_{2t}\right) = \sqrt{100/90} = 1.054$$

Yield to maturity 5.4%

Note $P_{2t}^{B} = \frac{Face \quad value}{\left(1 + i_{2t}\right)^{2}} = \frac{100}{\left(1 + i_{2t}\right)^{2}}$

# Arbitrage Between Short and Long Run Yields

Long Term Short term

$$\left(1+i_{2t}\right)^2 = \left(1+i_{1t}\right)\left(1+i^e_{1,t+1}\right)$$

Approximations:

$$\left(1+2\,i_{2t}\right)=\left(1+i_{1t}+i^e_{2t}\right) \Rightarrow i_{2t}=\frac{1}{2}\left(i_{1t}+i^e_{2t}\right)$$

$$i_{nt}=\frac{1}{n}\left(i_{1t}+i^e_{2t}+i^e_{3t}+\ldots+i^e_{nt}\right)$$

Long-term interest rate (yield) is average of expected short run interest rates.

# Market Price of Stocks

Arbitrage between bonds and stock: $\left(1+i_{1,t}\right)=\dfrac{D^e_{t+1}+P^e_{S,t+1}}{P_{S,t}}$

By Rearranging: $P_{S,t}=\dfrac{D^e_{t+1}}{\left(1+i_{1,t}\right)}+\dfrac{P^e_{S,t+1}}{\left(1+i_{1,t}\right)}$

Stock Price depends on expected stream of dividends and resale:
(by iterating forward the above equation)

$$P_{S,t}=\frac{D^e_{t+1}}{\left(1+i_{1,t}\right)}+\frac{D^e_{t+2}}{\left(1+i_{1,t}\right)\left(1+i^e_{1,t}\right)}+\ldots+\frac{D^e_{t+n}}{\left(1+i_{1,t}\right)\left(1+i^e_{1,t}\right)..\left(1+i^e_{n,t}\right)}$$

$$+\frac{P^e_{S,t+n}}{\left(1+i_{1,t}\right)\left(1+i^e_{1,t}\right)..\left(1+i^e_{n,t}\right)}$$

# Price of a Stock: An example

$$P_{Share} = \left( \frac{D}{r - g + x} \right)$$

$P_{Share}$ = Price of a Stock
D = expected Dividend
r = interest rate
g = growth rate of dividend
x = risk premium

D = 1000 and r =5% and g=3% has a risk x =0;

$$P_{Share} = \left( \frac{1000}{0.05 - 0.03 + 0} \right) = \frac{1000}{0.02} = 50{,}000$$

If r =8% $$P_{Share} = \left( \frac{1000}{0.08 - 0.03 + 0} \right) = \frac{1000}{0.05} = 20{,}000$$

# Price of Stock with Risks: An example

D =1000 and r =5% and g=3% has a risk x =8%

$$P_{Share} = \left( \frac{D}{r-g+x} \right) = 1000 \left( \frac{1}{0.05-0.03+0.08} \right) = \frac{1000}{0.1} = 10000$$

when r=8%

$$P_{Share} = \left( \frac{D}{r-g+x} \right) = 1000 \left( \frac{1}{0.08-0.03+0.08} \right) = \frac{1000}{0.13} = 7692.31$$

## Observations From the above Analysis of Stock Markets

- Lower the market interest rate, higher is the value of stock. Because future earnings  are discounted at lower rate.
- Higher the growth rate of dividend higher the value of stock. As dividend grows earning from the share rises and hence price rise.
- Higher the risk premium lower is the value of the share. A decrease in the risk premium will increase the market value of a stock.
- Arbitrage implies same rate of risk adjusted returns in both stocks and bonds.
- (in the short run) Higher the resale value of the stock higher is its price.

# A Question on Investment Decision

- Suppose a manufacturer is considering buying a machine that costs (K) £100,000.
- The machine will depreciate ( $\delta$) by 8% per year.
- It will generate real profits (R) equal to £18000 next year, £18,000(1-8%) two years from now and £18,000(1-8%)2 three years from now and so on.
- Manufacturer wants to continue project by allocating sufficient amount for wear and tear.
- How can you determine whether the manufacturer should buy the machine if the real interest rate is
- (a) 5%
- (b) 10%
- (c) 15%?

# Investment Decision Analysis

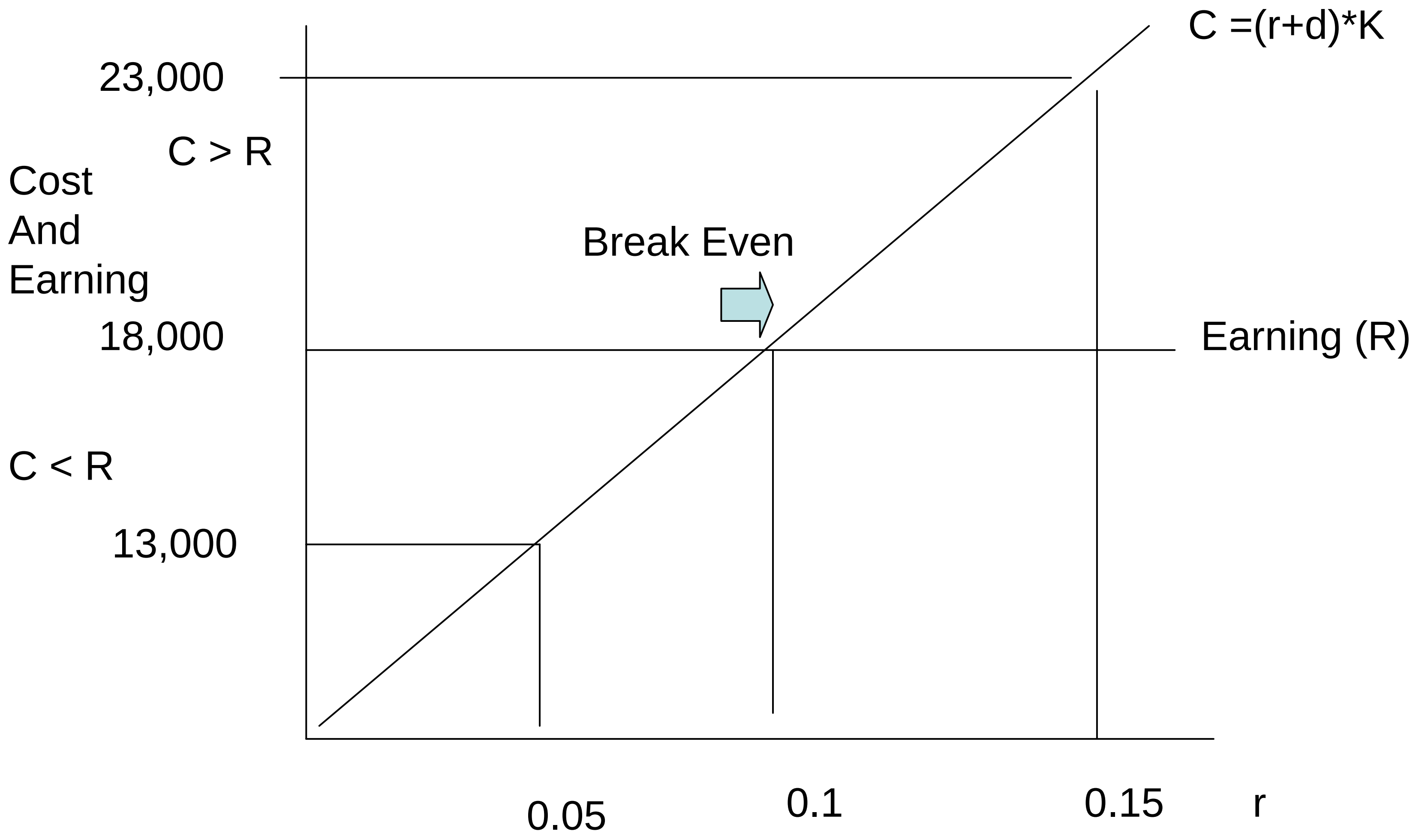
Breaks even point: $(r+\delta)K = R$

The value of this investment project: $V = \dfrac{18000}{r+\delta}$

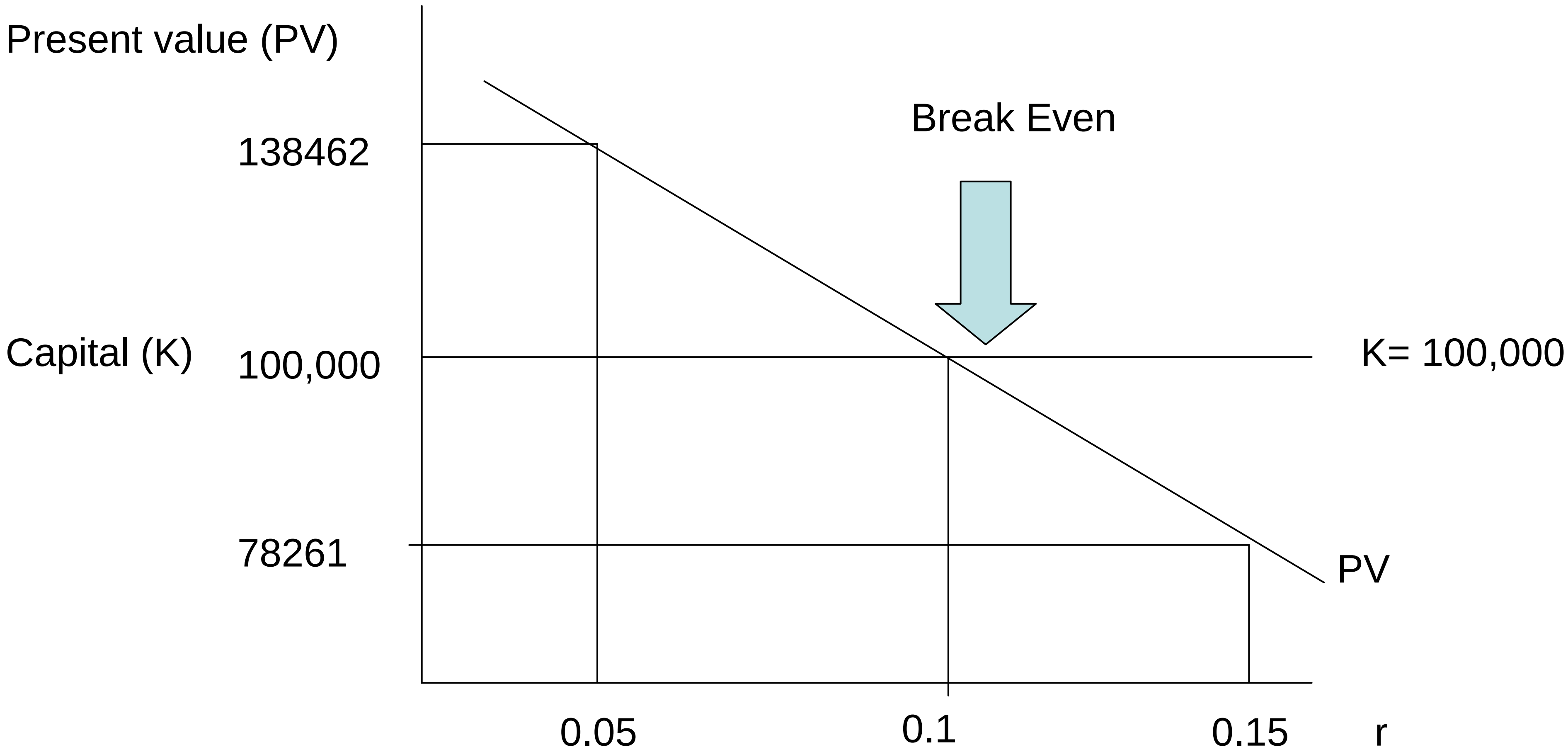
Cost of the Project (K): 100,000

| | | | |
|---|---|---|---|
| Capital | 100000 | 100000 | 100000 |
| r | 0.05 | 0.1 | 0.15 |
| d | 0.08 | 0.08 | 0.08 |
| C=(r+d)*K | 13000 | 18000 | 23000 |
| Earnings | 18000 | 18000 | 18000 |
| PV | 138461.5 | 100000 | 78260.87 |

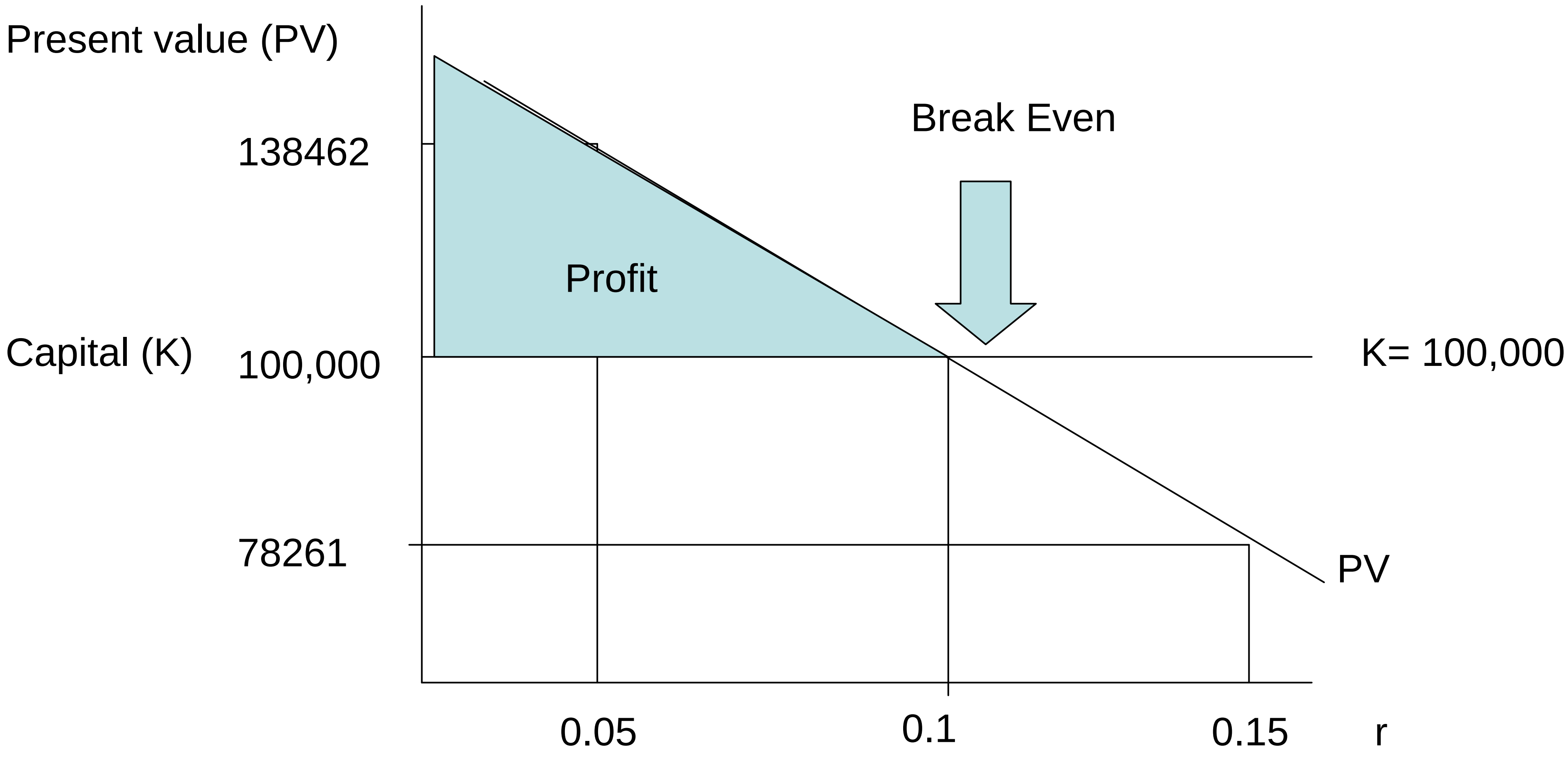
# Analysis of Earnings and Cost from the Project



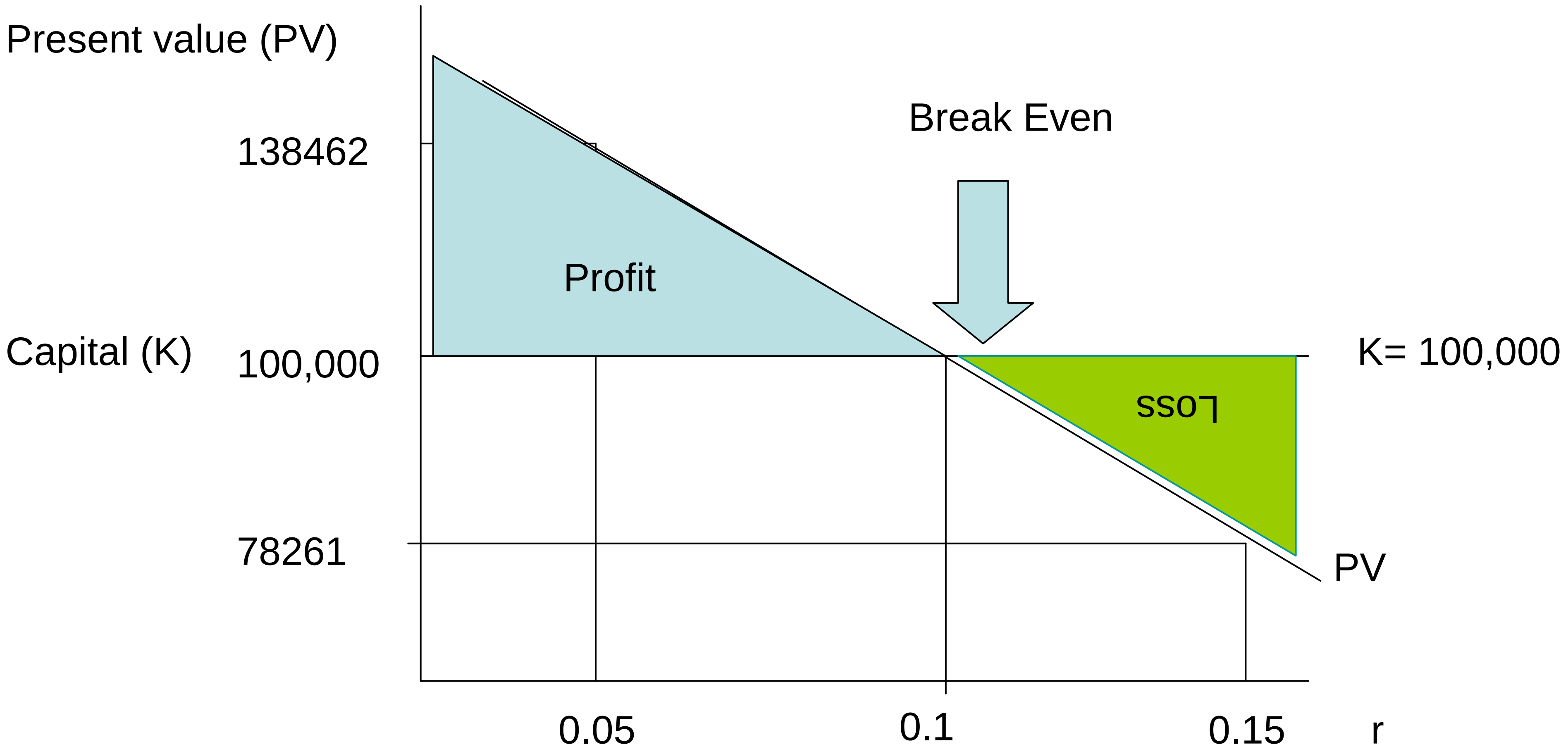
# Analysis of Present Value of the Project and Capital Cost



# Analysis of Present Value of the Project and Capital Cost



# Analysis of Present Value of the Project and Capital Cost



# References


- B&W 19, , M&S 21-23, Bl 16,17, MK 18
- http://www.bankofengland.co.uk/Links/setframe.html
http://www.londonstockexchange.com/default.asp
- **Bhattarai (2000) Welfare and distributional Impacts of financial liberalisation in a developing economy: Lessons from a forward looking CGE model of Nepal, Working Paper no. 7, Hull Advances in Policy Economics Research Papers.**
- IMF Institute, (1992) Macroeconomic Adjustment: Policy Instruments and Issues, IMF, Washington D.C.
- King, Robert G. and Levine, Ross (1993) Finance and Growth: Shumpeter Might Be Right, Quarterly Journal of Economics, Aug. pp.717-737.
- Monetary Policy Committee, Bank of England Transmission Mechanism of Monetary Policy.
- Modiogliani Franco, and Miller, Nerton H. (1958) The Cost of Capital, Corporation Finance and the Theory of Investment, AER, vol. XLVII, June .
- Montiel, Peter J and Agenor Pierre-Richard and Haque Nadeem Ul, (1993): Informal financian Markets in Developing Countries: A Macroeconomic Analysis, Oxford: Basil Backwell.
- Robinson, Sherman (1991) Macroeconomics, Financial Variables, and Computable General Equilibrium Models, World Development, vol. 19, no.11, pp.1509-1523, Pergamon Press plc.