Lecture 5

Project investment criteria and budgeting capital decision

Chapter 8/234

Topics Covered

- Net Present Value (NPV)
- Other Investment Criteria
  - Payback
  - Profitability Index (PI)
  - Accounting rate of return (ARR)
  - Internal rate of return (IRR)
- Mutually Exclusive Projects
- Capital Rationing

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8.2.Net Present Value (NPV)

Net Present Value - Present value of cash flows minus initial investments.

Opportunity Cost of Capital - Expected rate of return given up by investing in a project.

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NPV (Contd)

$$NPV = C_0 + \frac{C_1}{(1+r)^1} + \frac{C_2}{(1+r)^2} + \ldots + \frac{C_t}{(1+r)^t}$$

Terminology
C_0: the initial cash outflow
C_t: the net cash flow generated
t = time period of the investment
r = "opportunity cost of capital"

The Cash Flow could be positive or negative at any time period.

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NPV (Contd)

Net Present Value Rule

Managers increase shareholders' wealth by accepting all projects that are worth more than they cost.

Therefore, they should accept all projects with a positive net present value.

A risky dollar is worth less than a safe one.

NPV > 0: Accept

NPV < 0: Reject

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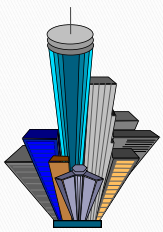
NPV (Contd)

Example

You have the opportunity to purchase an office building. You have a tenant lined up that will generate $16,000 per year in cash flows for three years. At the end of three years you anticipate selling the building for $450,000. How much would you be willing to pay for the building?



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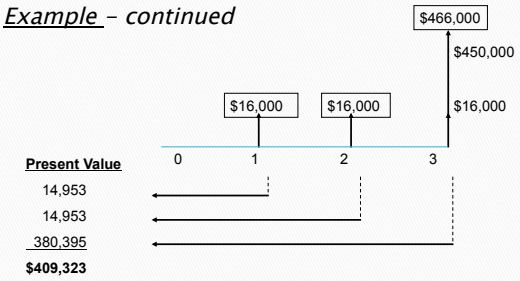
NPV (Contd)

Example – continued



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NPV (Contd)

Example – continued

If the building is being offered for sale at a price of $350,000, would you buy the building and what is the added value generated by your purchase and management of the building?

$$NPV = -350{,}000 + \frac{16{,}000}{(1.07)^1} + \frac{16{,}000}{(1.07)^2} + \frac{466{,}000}{(1.07)^3}$$

$$NPV = \$59{,}323$$

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Ex 1

- A project that cost $3,000 to install will provide annual cash flows of $800 for each of the next 6 years. Is this project worth pursuing if the discount rate is 10%?

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Ex 2

You have the opportunity to purchase an machine. You have a tenant lined up that will generate $12,000 per year in cash flows for fourth years. At the end of fourth years you anticipate selling the building for $400,000. How much would you be willing to pay for the building?

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8.2.Payback

- Payback Period(PBP) - Time until cash flows recover the initial investment of the project.
- Discounted payback period.

$$PBP = t + \frac{\left|\sum_{t=0}^{n} NCF_t\right|}{FCF_{t+1}}$$

NCF_t:net cash flow NCFt=CF+ ∑ FCFt

FCF_t:free cash flow

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8.2.Payback

- The *payback rule* specifies that a project be accepted if its payback period is less than the specified **cutoff period**. The following example will demonstrate the absurdity of this statement.

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Ex 1

- A project that costs $2,500 to install will provide annual cash flows of $600 for the next 6 years. The firm accepts projects with payback periods of less than 5 years. Will the project be accepted? Should this project be pursued if the discount rate is 2%

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Payback (Contd)

Example : 2

The three project below are available. The company accepts all projects with a 2-year or less payback period. Show how this decision will impact our decision.

	Cash Flows					
Project	C_0	C_1	C_2	C_3	Payback	NPV@10%
A	-2000	+1000	+1000	+10000		
B	-2000	+1000	+1000	0		
C	-2000	0	+2000	0		

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Payback (Contd)

Example

The three project below are available. The company accepts all projects with a 2-year or less payback period. Show how this decision will impact our decision.

	Cash Flows					
Project	C_0	C_1	C_2	C_3	Payback	NPV@10%
A	-2000	+1000	+1000	+10000	2	+ 7.249
B	-2000	+1000	+1000	0	2	- 264
C	-2000	0	+2000	0	2	- 347

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Use previous Ex NPV

- Ex1 ; Ex2

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Internal Rate of Return (IRR)

- **Internal Rate of Return (IRR)** – Discount rate at which NPV = 0.
- Rate of = profit / investment

$$NPV = C_0 + \frac{C_1}{(1+IRR)^1} + \frac{C_2}{(1+IRR)^2} + \ldots + \frac{C_t}{(1+IRR)^t} = 0$$

Where:

C_0: the initial cash outflow
C_t: the net cash flow generated
t = time period of the investment

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This suggests two rules for deciding whether to go ahead with an investment project:

- The NPV rule, Invest in any project that has a positive NPV when its cash flows are discounted at the opportunity cost of capital
- The rate of return rule. Invest in any project offering a rate of return that is higher than the opportunity cost of capital

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IRR (Contd)

- Accept: IRR > "opportunity cost of capital".
- Reject: IRR < "opportunity cost of capital".

Example: 1

You can purchase a building for $350,000. The investment will generate $16,000 in cash flows (i.e. rent) during the first three years. At the end of three years you will sell the building for $450,000. What is the IRR on this investment?

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Accounting Rate of Return (ARR)

- **Rate of Return Rule** – Invest in any project offering a rate of return that is higher than the opportunity cost of capital.

$$\text{Rate of Return} = \frac{C_1 - \text{investment}}{\text{investment}}$$

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IRR (Contd)

Example

You can purchase a building for $350,000. The investment will generate $16,000 in cash flows (i.e. rent) during the first three years. At the end of three years you will sell the building for $450,000. What is the IRR on this investment?

$$0 = -350{,}000 + \frac{16{,}000}{(1+IRR)^1} + \frac{16{,}000}{(1+IRR)^2} + \frac{466{,}000}{(1+IRR)^3}$$

IRR = 12.96%

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Ex 1

- MarielCompany forecasts the following cash flows on a project under consideration. It uses the internal rate of return rule to accept or reject projects. Should this project be accepted if the required return is 12%

Co	C1	C2	C3
-$12,000	0	+$7,500	+$8,500

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IRR (Contd)

	Calculating IRR by using a spreadsheet					
Year	Cash Flow				Formula	
0	(350,000.00)		IRR =	12.96%	=IRR(B3:B7)	
1	16,000.00					
2	16,000.00					
3	466,000.00					

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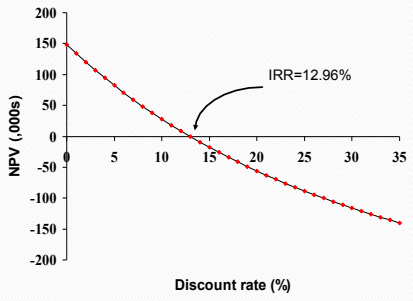
IRR (Contd)



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IRR (Contd)

HP-10B		EL-733A		BAII Plus
-350,000	CFj	-350,000	CFi	CF
16,000	CFj	16,000	CFi	2nd {CLR Work}
16,000	CFj	16,000	CFi	-350,000 ENTER ↓
466,000	CFj	466,000	CFi	16,000 ENTER ↓
{IRR/YR}		IRR		16,000 ENTER ↓
				466,000 ENTER ↓
				IRR CPT

All produce IRR=12.96

Using financial calculators to calculate IRR

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IRR (Contd)

Example

You have two proposals to choice between. The initial proposal has a cash flow that is different from the revised proposal. Using IRR, which do you prefer?

$$NPV = -350 + \frac{400}{(1+IRR)^1} = 0$$

$$IRR = 14.29\%$$

$$NPV = -350 + \frac{16}{(1+IRR)^1} + \frac{16}{(1+IRR)^2} + \frac{466}{(1+IRR)^3} = 0$$

$$IRR = 12.96\%$$

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IRR (Contd)

Example 2

You have two proposals to choice between. The initial proposal has a cash flow that is different from the revised proposal. Using IRR, which do you prefer?

Project	C_0	C_1	C_2	C_3	IRR	NPV@7%
Initial Proposal	-350	400				
Revised Proposal	-350	16	16	466		

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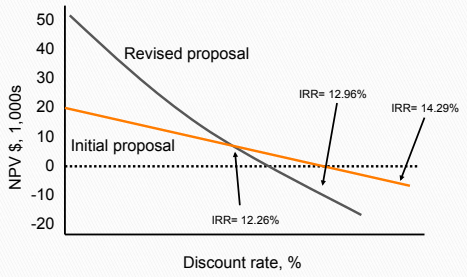
IRR (Contd)



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IRR (Contd)

Pitfall 1 - Mutually Exclusive Projects

- IRR sometimes ignores the magnitude of the project.
- The above two projects illustrate that problem.

Pitfall 2 - Lending or Borrowing?

- With some cash flows (as noted below) the NPV of the project increases as the discount rate increases.
- This is contrary to the normal relationship between NPV and discount rates.

Pitfall 3 - Multiple Rates of Return

- Certain cash flows can generate NPV=0 at two different discount rates because of the double change in the sign of the cash flows.

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IRR (Contd)

Example: Pitfall 2 - Lending or Borrowing?

	Cashflow, Dollars			
Project	**C_0**	**C_1**	**IRR, %**	**NPV at 10%**
D	-100	150	50	$36.40
E	100	-150	50	-$36.40

D: is equivalent to lending at 50%

E: is equivalent to borrowing at 50%

-> Should use NPV in this case

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Profitability Index (PI)

$$\text{Profitability Index} = \frac{\text{Net present value}}{\text{Initial cash outlay}}$$

- Ratio of net present value to initial investment.
- The solution is to pick the projects that give the highest net present value per dollar of investment. The ratio of net present value to initial investment is known as the profitability index

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Profitability Index (PI)

$$\text{Profitability Index} = \frac{\text{Net present value}}{\text{Initial cash outlay}}$$

- Accept: Index > 0 (NPV > 0)
- Reject: Index < 0 (NPV < 0)

Project	PV	Investment	NPV	Profitability Index
J	4	3	1	1/3 = .33
K	6	5	1	1/5 = .20
L	10	7	3	3/7 = .43
M	8	6	2	2/6 = .33
N	5	4	1	1/4 = .25

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Ex 1

- Consider the following projects:

Project	Co	C1	C2
A	-2,100	+2,000	+1,200
B	-2,100	+1,440	+1,728

a./ Calculate PI A,B assuming a 22% opportunity cost of capital
b./ Conclusion

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Use previous EX NPV , PBP

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PI (Contd)

- All 5 projects have a positive NPV. If there were no shortage of capital, 5 projects would be accepted. But with only $20 million available, the firm needs to find the package that gives the positive NPV within the budget.
- PI is useful for ranking projects in case of capital rationing.
- If there is no capital rationing, using PI to rank projects may leed to favour small projects over larger projects with higher NPVs.

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8.3.Mutually Exclusive Projects

- When you need to choose between mutually exclusive projects, the decision rule is simple. Calculate the NPV of each project, and, from those options that have a positive NPV, choose the one whose NPV is highest.

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Mutually Exclusive Projects (Contd)

Example

Select one of the two following projects, based on highest NPV.

System	C_0	C_1	C_2	C_3	*NPV*
Faster	−800	350	350	350	+118.5
Slower	−700	300	300	300	+87.3

assume 7% discount rate

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Equivalent Annual Annuity

- Equivalent Annual Annuity(EAA) – The cash flow per period with the same present value as the cost of buying and operating a machine.

$$\text{Equivalent annual annuity} = \frac{\text{present value of cash flows}}{\text{annuity factor}}$$

EAA = NPV. (r / 1-(1+r) ^{t})

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Equivalent Annual Annuity (Contd)

Example

Given the following costs of operating two machines and a 6% cost of capital, select the lower cost machine using equivalent annual annuity method.

	Year					
Mach.	0	1	2	3	PV@6%	E.A.A.
F	-15	-4	-4	-4	-25.69	- 9.61
G	-10	-6	-6		-21.00	-11.45

We could afford to set a lower annual charge for the use of F.
Rule: We thus have a rule for comparing assets with different lives: select the machine that has the lowest equivalent annual annuity.

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Ex 1

- A precision Car costs $10,000 and will cost $20,000 a year to operate and maintain . If the discount rate is 12% and the Car will last for 5 years, what is EAA cost of the tool?

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Comparing Mutually Exclusive Projects with Different Lives

Example: 2

Select one of the two following projects, based on highest "equivalent annual value" (r=9%).

Project	C_0	C_1	C_2	C_3	C_4	NPV	EAA
A	−15	4.9	5.2	5.9	6.2		
B	−20	8.1	8.7	10.4			

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8.4.Capital Rationing

- Capital Rationing – Limit set on the amount of funds available for investment.
- Soft Rationing – Limits on available funds imposed by management.
- Hard Rationing – Limits on available funds imposed by the unavailability of funds in the capital market.
- Rule: NPV, PI, PBP, IRR

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- **8.5.A Last Look**

Clear, NPV is the gold standard.

TABLE 8-3.
A comparison of investment decision rules

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Thanks for your attention

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