

# FN201: Lecture Note 8

## Net Present Value and Other Investment Criteria

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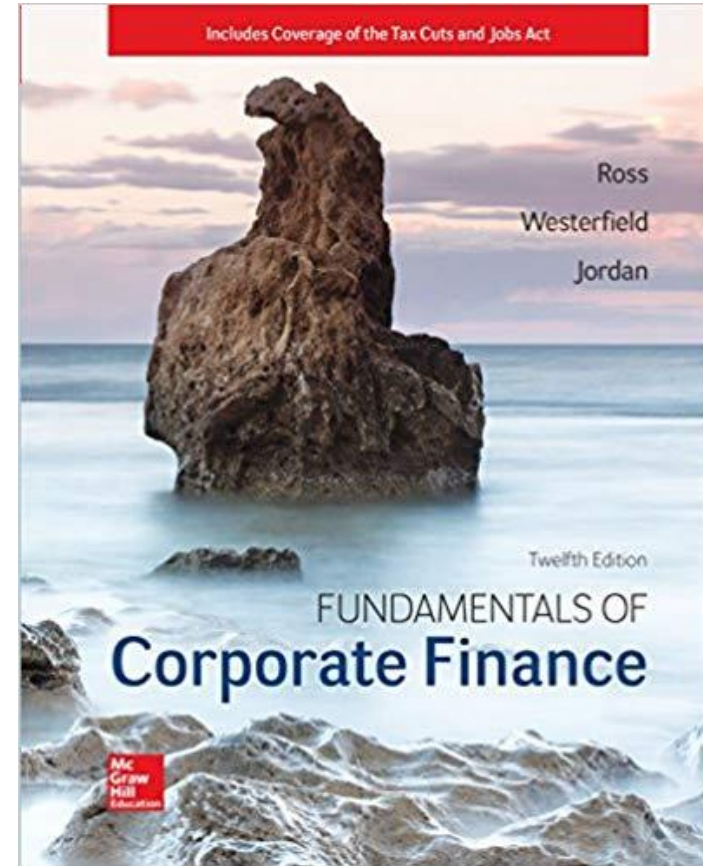
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# Reading

- Ross, S.A., Westerfield, R.W., Jordan, B.D., (2012). Fundamentals of Corporate Finance. 10th Edition. New York: McGraw-Hill/Irwin.

## Chapter 9

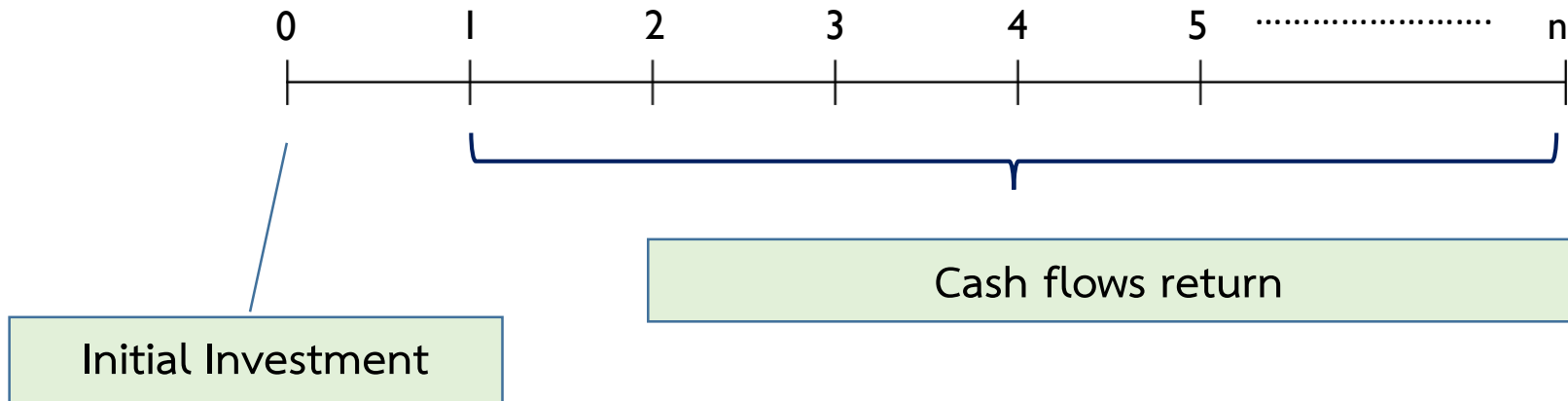


# Key Concepts and Skills

- Show the reasons why the net present value criterion is the best way to evaluate proposed investments
- Present the internal rate of return criterion and its strengths and weaknesses
- Calculate the modified internal rate of return
- Illustrate the profitability index and its relation to net present value
- Discuss the payback rule and some of its shortcomings
- Discuss the discounted payback rule and some of its shortcomings

# Overview

## Investment time line



# Project Decision

1. Replacement needed to continue profitable operations
2. Replacement to reduce costs
3. Expansion of existing products or markets
4. Expansion into new products or markets
5. Contraction decisions
6. Safety and/or environmental projects
7. Mergers
8. Others (i.e. catch-all items)

# Decision Tools

1. Net Present Value (NPV)
2. Internal Rate of Return (IRR)
  - Modified Internal Rate of Return (MIRR)
3. Profitability Index (PI)
4. Payback period (PP)
  - Regular PP
  - Discounted PP

# 1 Net Present Value (NPV)

= PV value of a project's cash inflows minus PV of its costs (cash outflows)

$$\begin{aligned} NPV &= CF_0 + \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \dots + \frac{CF_N}{(1+r)^N} \\ &= \sum_{t=0}^N \frac{CF_t}{(1+r)^t} \end{aligned}$$

# 1 Net Present Value (NPV)

Example: Find Net Present Value of these projects when cost of capital = 18%

|                    | Project A   | Project B |
|--------------------|-------------|-----------|
| Initial Investment | \$145,000   | \$150,000 |
| Year               | Cash Inflow |           |
| 1                  | \$45,000    | \$75,000  |
| 2                  | 45,000      | 60,000    |
| 3                  | 45,000      | 30,000    |
| 4                  | 45,000      | 30,000    |
| 5                  | 45,000      | 30,000    |
| 6                  | 45,000      | 30,000    |

# 1 Net Present Value (NPV)

## Decision criteria:

### 1. Independent projects

= cash flows of each project are not affected by the other

= **unlimited resources => can choose any profitable projects**

NPV exceeds zero

### 2. Mutually exclusive projects

= two different ways to accomplish the same result

= **limited resources => can choose only the most profitable one**

Highest NPV project  
from those exceed zero

## 2 Internal Rate of Return (IRR)

= the discount rate that forces the PV of cash inflows to equal the PV of cash outflows

$$\begin{aligned} NPV &= CF_0 + \frac{CF_1}{(1+IRR)^1} + \frac{CF_2}{(1+IRR)^2} + \dots + \frac{CF_N}{(1+IRR)^N} \\ &= \sum_{t=0}^N \frac{CF_t}{(1+IRR)^t} = 0 \end{aligned}$$

### Key Assumption

= Project cash flows can be reinvested at the same rate or at the IRR itself

## 2 Internal Rate of Return (IRR)

Trial and Error / Excel /  
Calculator

Example: Find the Internal Rate of Return (IRR) of these projects

|                    | Project A   | Project B |
|--------------------|-------------|-----------|
| Initial Investment | \$145,000   | \$150,000 |
| Year               | Cash Inflow |           |
| 1                  | \$45,000    | \$75,000  |
| 2                  | 45,000      | 60,000    |
| 3                  | 45,000      | 30,000    |
| 4                  | 45,000      | 30,000    |
| 5                  | 45,000      | 30,000    |
| 6                  | 45,000      | 30,000    |

## 2 Internal Rate of Return (IRR)

### Decision criteria:

1. Independent projects

IRR exceeds cost of capital

2. Mutually exclusive projects

Highest IRR project  
from those exceed cost of capital

## 2 Internal Rate of Return (IRR)

*The assumption of reinvestment of project cash flows does not generally hold!*

### Modified Internal Rate of Return (MIRR)

$$\sum_{t=0}^N \frac{COF_t}{(1+r)^t} = \frac{\sum_{t=0}^N CIF_t (1+r)^{N-t}}{(1+MIRR)^N}$$

$$PV \text{ Costs} = \frac{\text{Terminal Value (TV)}}{(1+MIRR)^N}$$

## 2 Internal Rate of Return (IRR)

Example: Find the Modified Internal Rate of Return (MIRR) of these projects

when reinvestment rate = cost of capital at 18%

|                    | Project A   | Project B |
|--------------------|-------------|-----------|
| Initial Investment | \$145,000   | \$150,000 |
| Year               | Cash Inflow |           |
| 1                  | \$45,000    | \$75,000  |
| 2                  | 45,000      | 60,000    |
| 3                  | 45,000      | 30,000    |
| 4                  | 45,000      | 30,000    |
| 5                  | 45,000      | 30,000    |
| 6                  | 45,000      | 30,000    |

## 2 Internal Rate of Return (IRR)

### Decision criteria:

1. Independent projects

MIRR exceeds cost of capital

NPV, IRR, and MIRR reach the same conclusion.

2. Mutually exclusive projects

Highest MIRR project  
from those exceed cost of capital

NPV, IRR, and MIRR may result in conflicts!

# Net Present Value vs. Internal Rate of Return Decision for mutually exclusive projects

# NPV vs. IRR

A) when cost of capital = 18%

|     |                 |                 |
|-----|-----------------|-----------------|
| NPV | A = \$12,392.12 | B = \$14,609.20 |
|-----|-----------------|-----------------|

|     |            |            |
|-----|------------|------------|
| IRR | A = 21.28% | B = 22.71% |
|-----|------------|------------|

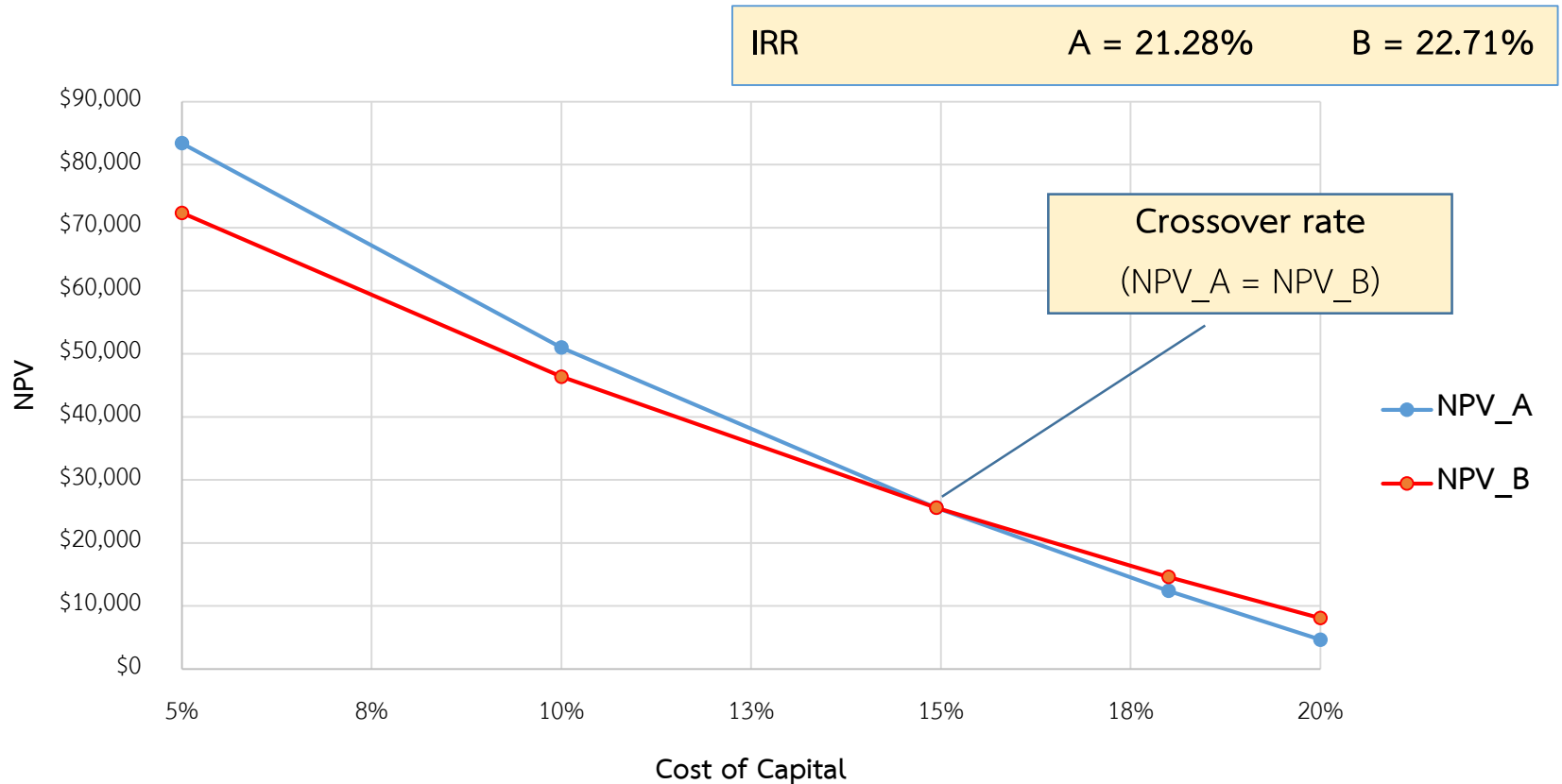
B) what if cost of capital = 5%

|     |                 |                 |
|-----|-----------------|-----------------|
| NPV | A = \$50,986.73 | B = \$46,360.30 |
|-----|-----------------|-----------------|

|     |            |            |
|-----|------------|------------|
| IRR | A = 21.28% | B = 22.71% |
|-----|------------|------------|

# NPV vs. IRR

## Net Present Value Profiles



# NPV vs. IRR

## Conflicts arise because:

1. Timing differences of project cash flows
2. Project size (initial investment) differences

Which one is better?

### 3 Profitability Index (PI)

$$PI = \frac{PV \text{ of future cash flow}}{\text{initial investment}} = \frac{\sum_{t=1}^N \frac{CF_t}{(1+r)^t}}{CF_0}$$

= relative profitability of the project

= present value per dollar of initial investment

### 3 Profitability Index (PI)

Example: Find the Profitability Index (PI) of these projects when cost of capital = 18%

|                    | Project A   | Project B |
|--------------------|-------------|-----------|
| Initial Investment | \$145,000   | \$150,000 |
| Year               | Cash Inflow |           |
| 1                  | \$45,000    | \$75,000  |
| 2                  | 45,000      | 60,000    |
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## 4 Payback Period

= the number of years required to recover the fund invested in a project from its operating cash flows

$$\text{Payback} = \text{Number of years prior to full recover} + \frac{\text{Unrecovered cost at start of year}}{\text{Cash flow during full recovery year}}$$

Regular vs. Discounted  
Payback Period ?

## 4 Payback Period

Example: Find the regular and discounted payback period of these projects given cost of capital = 18%

|                    | Project A   | Project B |
|--------------------|-------------|-----------|
| Initial Investment | \$145,000   | \$150,000 |
| Year               | Cash Inflow |           |
| 1                  | \$45,000    | \$75,000  |
| 2                  | 45,000      | 60,000    |
| 3                  | 45,000      | 30,000    |
| 4                  | 45,000      | 30,000    |
| 5                  | 45,000      | 30,000    |
| 6                  | 45,000      | 30,000    |

Question?