

FN 201 Business Finance

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Lecture 6: Net Present Value and other investment rules

Firm decision

- ▶ Budget – a plan that details projected cash flows during some future period
 - ▶ **Capital budgeting: Long-term budget**
 - ▶ The process of identifying which long-lived investment projects a firm should undertake.
 - ▶ Analyzing potential projects/fixed asset investments and deciding which ones to be included in capital budget
 - ▶ Long-term decision evolve large investment spending called “Capital Expenditures” in which often time the firms don’t have large amount of money available
 - ▶ Define strategic direction move into new products, markets.
 - ▶ **Cash budget: Short-term budget**

Independent and mutually exclusive projects

- ▶ Projects are;
 - ▶ Independent, if the cash flows of a project is unaffected by the acceptance of the other.
 - ▶ Mutually exclusive, if the cash flows of a project can be adversely impacted by the acceptance of the other.

▶ Capital Budgeting Decision Rules

1. Payback period
2. Discounted Payback period
3. Net present value (NPV)
4. Internal rate of return (IRR)
5. Modified internal rate of return (MIRR)
6. Profitability index

1. Payback Period

- ▶ The payback period is amount of time it takes to recover or pay back the initial investment. If the payback period is less than a pre-specified length of time, you accept the project. Otherwise, you reject the project.
- ▶ The payback rule is used by many companies because of its simplicity.

$$\text{PBP} = \text{Year before full recovery} + \frac{\text{Unrecovered cost at start of year}}{\text{Cash flow during year}}$$

- ▶ Payback period decision rules

Accept	Reject

Example

- ▶ Projects A, B, and C each have an expected life of 5 years. Given the initial cost and annual cash flow information below, what is the payback period for each project?

	A	B	C
Cost	\$80	\$120	\$150
Cash Flow	\$25	\$30	\$35



Example

- ▶ Cash flow (in millions) for Project F (Fast) and S (Slow)

Project	CF_0	CF_1	CF_2	CF_3	CF_4
F	-\$1,000	\$500	\$400	\$300	\$100
S	-\$1,000	\$100	\$300	\$400	\$600

The Payback Rule

- ▶ Pitfalls:

- ▶ Ignores the project's cost of capital and time value of money.
- ▶ Ignores cash flows after the payback period.
- ▶ Relies on an ad hoc decision criterion.



2. Discounted payback period

- ▶ The amount of time takes for a project's discounted cash flows to recover the initial investment

$$\text{DPBP} = \text{Year before full recovery} + \frac{\text{Unrecovered PV cost at start of year}}{\text{PV Cash flow during year}}$$

- ▶ Payback period decision rules

Accept	Reject

Example: Discounted Payback period

- ▶ Cash flow (in millions) for Project F (Fast) and S (Slow)

Project	CF ₀	CF ₁	CF ₂	CF ₃	CF ₄
F	-\$1,000	\$500	\$400	\$300	\$100
S	-\$1,000	\$100	\$300	\$400	\$600

3. Net Present Value (NPV)

- ▶ The sum of the present value of all of a given project's cash flow, both inflows and outflows, discounted at a rate consistent with the project's risk.

$$\text{NPV} = \text{PV}(\text{Cash inflows}) - \text{PV}(\text{Cash outflows})$$

$$\text{NPV} = \text{CF}_0 + \frac{\text{CF}_1}{(1+i)} + \frac{\text{CF}_2}{(1+i)^2} + \frac{\text{CF}_3}{(1+i)^3} + \dots + \frac{\text{CF}_n}{(1+i)^n}$$

$$\text{NPV} = \sum_{t=0}^n \frac{\text{CF}_t}{(1+i)^t}$$

Accept

Reject

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Example: Net Present Value

- ▶ Cash flow (in millions) for Project F (Fast) and S (Slow), given the discount rate of 10 percent

Project	CF_0	CF_1	CF_2	CF_3	CF_4
F	-\$1,000	\$500	\$400	\$300	\$100
S	-\$1,000	\$100	\$300	\$400	\$600

Step in Capital Budgeting - NPV

- ▶ Estimate the expected cash flows from the project, including the salvage value
- ▶ Assess the risk of cash flows – given project's risk, determine the cost of capital at which the cash flows should be discounted (WACC)
- ▶ Expected cash flows are put on a present value basis to obtain an estimate of the asset's value
- ▶ Present value of the expected cash flows is compared with the required outlay

4. Internal rate of return (IRR)

- ▶ The compound annual rate of return on a project, given its up-front costs and subsequent cash flows.
- ▶ Discount rate that equates the present value of a project's expected cash inflows to the present value of the project's costs
- ▶ Same concept as yield-to-maturity

$$PV(\text{Cash inflows}) = PV(\text{Cash outflows})$$

$$CF_0 + \frac{CF_1}{(1+i)} + \frac{CF_2}{(1+i)^2} + \frac{CF_3}{(1+i)^3} + \dots + \frac{CF_n}{(1+i)^n} = 0$$

$$NPV = \sum_{t=0}^n \frac{CF_t}{(1+IRR)^t} = 0$$

Accept

Reject

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Example: IRR

- ▶ Cash flow (in millions) for Project F (Fast) and S (Slow), given the discount rate of 10 percent

Project	CF ₀	CF ₁	CF ₂	CF ₃	CF ₄
F	-\$1,000	\$500	\$400	\$300	\$100
S	-\$1,000	\$100	\$300	\$400	\$600

IRR

- ▶ One important assumption in the internal rate of return (IRR) Calculation
 - ▶ Interim cash flows are reinvested at the IRR rate
 - ▶ Mathematically, the NPV and IRR methods will always lead to the same accept/reject decision for independent projects
 - ▶ The NPV and IRR can give conflict rankings for mutually exclusive projects

Problem with IRR (1) - Multiple IRR

▶ Logic of multiple IRR

1. At very low discount rate, the PV of CF_2 is large and negative, so $NPV < 0$
2. At the very high discount rates, the PV of both CF_1 and CF_2 are low, so CF_0 dominates and again $NPV < 0$
3. In between, the discount rate hits CF_2 harder than CF_1 so $NPV > 0$

4. Result: 2 IRRs

- ▶ The multiple IRRs can arise when the IRR criterion is used with a project that has non-normal cash flows
- ▶ Use of the IRR method on projects having non-normal cash flows could produce other problems such as no IRR or an IRR that leads to an incorrect accept/reject decision
- ▶ The NPV criterion should be applied rather than IRR

Problem with IRR (1) - Multiple IRR

- ▶ Find IRR of the following cash flows (in millions USD)

	CF_0	CF_1	CF_2
Project CF	-1,600	10,000	-10,000

Problem with IRR (2) – nonexistent IRR

- ▶ Find IRR of the following cash flows (in millions USD)

	CF_0	CF_1	CF_2
Project CF	-1,500	3,000	-2,000



Problem with IRR (3) – Delayed projects/Borrowing project

- ▶ Delayed Investments - Assume you have just retired as the CEO of a successful company. A major publisher has offered you a book deal. The publisher will pay you \$1 million upfront if you agree to write a book about your experiences. You estimate that it will take three years to write the book. The time you spend writing will cause you to give up speaking engagements amounting to \$500,000 per year. You estimate your opportunity cost to be 10%.

Problem with IRR (3) – Delayed projects/Borrowing project

- ▶ Make a decision at 10% using NPV and IRR.

	CF_0	CF_1
Project L	-1,000	1,500
Project B	1,000	-1,500

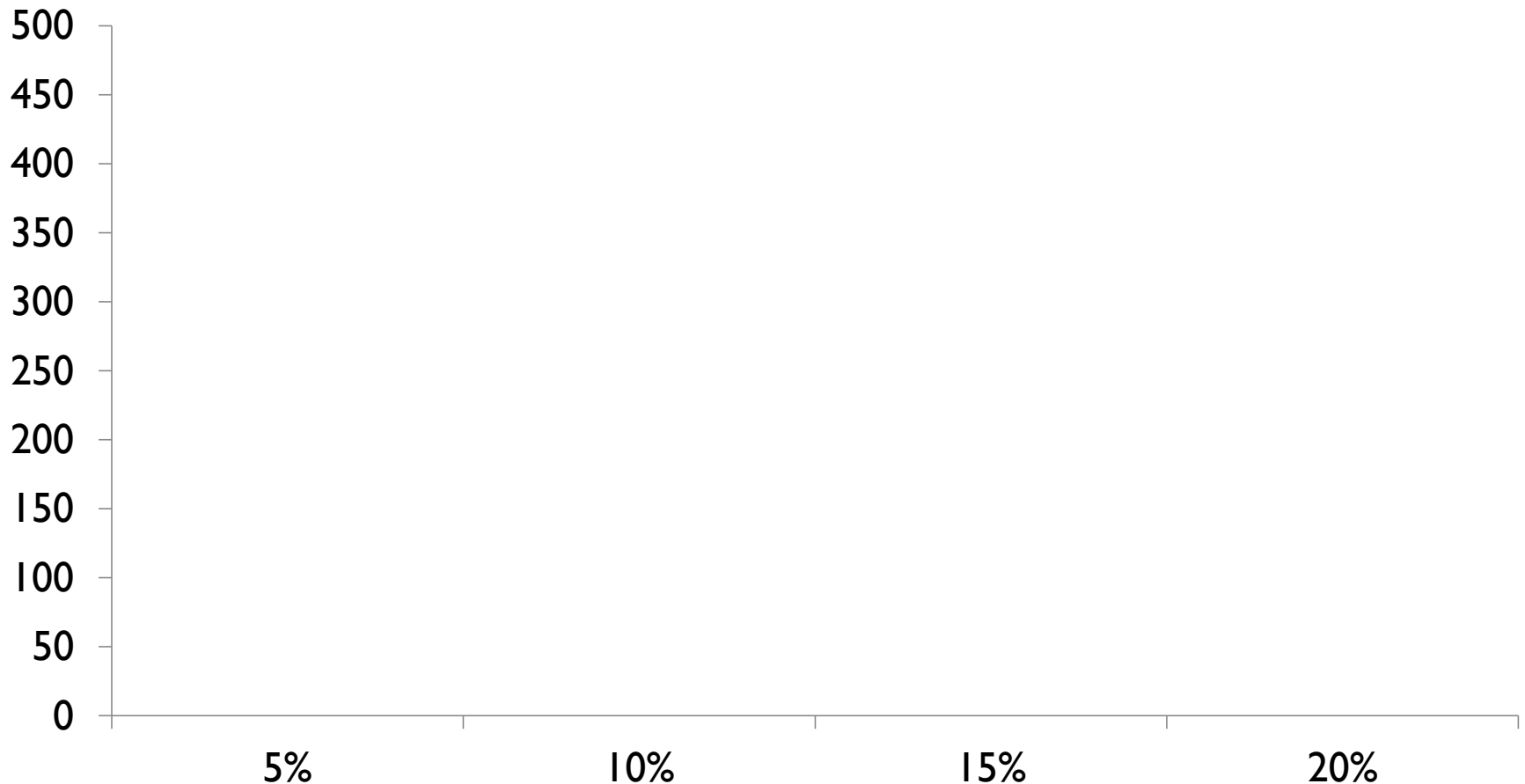
Comparison of the NPV and IRR

- ▶ Cash flow (in millions) for Project F (Fast) and S (Slow), given the discount rate of 10 percent

Project	CF ₀	CF ₁	CF ₂	CF ₃	CF ₄
F	-\$1,000	\$500	\$400	\$300	\$100
S	-\$1,000	\$100	\$300	\$400	\$600

Comparison of the NPV and IRR

- ▶ A plot of a project's NPV (on the y axis) against various discount rate (on the x axis). It is used to illustrate the relationship between NPV and the IRR for the typical project.



5. Modified Internal Rate of Return (MIRR)

- ▶ Interim cash flows are reinvested at firm's cost of capital

Accept

Reject

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Example: MIRR

- ▶ Cash flow (in millions) for Project F (Fast) and S (Slow), given the discount rate of 10 percent

Project	CF_0	CF_1	CF_2	CF_3	CF_4
F	-\$1,000	\$500	\$400	\$300	\$100
S	-\$1,000	\$100	\$300	\$400	\$600

6. Profitability Index

- ▶ The present value of a project's cash inflows divided by its initial cash outflows
- ▶ Ratio represent value of cash inflows to present value of initial investment

$$\text{Profitability index} = \frac{\text{PV}(\text{all cash inflows})}{\text{PV}(\text{all cash outflows})} = \frac{\sum_{t=0}^n \frac{\text{CIF}_t}{(1+i)^n}}{\sum_{t=0}^n \frac{\text{COF}_t}{(1+i)^t}}$$

Accept

Reject

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Example: PI

- ▶ Cash flow (in millions) for Project F (Fast) and S (Slow), given the discount rate of 10 percent

Project	CF_0	CF_1	CF_2	CF_3	CF_4
F	-\$1,000	\$500	\$400	\$300	\$100
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Alternative Rules Versus the NPV Rule

- ▶ Sometimes alternative investment rules may give the same answer as the NPV rule, but at other times they may disagree.
- ▶ When the rules conflict, the NPV decision rule should be followed. The IRR Investment Rule will give the same answer as the NPV rule in many, but not all, situations.
- ▶ In general, the IRR rule works for a stand-alone project if all of the project's negative cash flows precede its positive cash flows.



Reference

Berk and DeMarzo, Corporate Finance, 3th edition, 2013.

Chatuporn Tangkathach, Net present value and other investment rules, 2006.

Ross, Stephen A., Randolph W. Westerfield, Jeffrey F. Jaffe, and Bradford D. Jordan, Core Principles and Applications of Corporate Finance, 3th edition, 2010.