Lecture 6.
Investment Decision Rules

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Three keys points to remember about capital budgeting decisions include:

1. Typically, *a* go or no-go decision on a product, service, facility, or activity of the firm.
2. Requires sound estimates of the timing and amount of cash flow for the proposal.
3. The capital budgeting model has a predetermined accept or reject criterion.

Investment Decision Rules or Models for Capital Budgeting Decisions

1. Payback period
2. Discounted payback period (Modified from payback period)
3. Net present value (NPV)
4. Profitability index (PI, modified from NPV)
5. Internal rate of return (IRR)

1. PAYBACK PERIOD

- Payback period: the time period needed to recover the initial investment.
- If the payback period is of an acceptable length of time to the firm, the project will be selected.
- When comparing two or more projects, the projects with shorter payback periods are preferred. However, accepted projects should meet the target payback period, which should be set in advance.

1. PAYBACK PERIOD

Illustration:

The ABC Co. plans to invest in a project that has a $3700 initial investment.

It is estimated that a project will provide regular cash inflows of $1000 in a year 1, $2,000 in a year 2, $1500 in a year 3, and $1000 in a year4.

If the company has a target payback period of 3 years, do you recommend that this project be accepted?

1. PAYBACK PERIOD

Year	Cash flow	Yet to be recovered	Notes
0	$ -3 700	$ -3 700	After 2 years the firm will have recovered $3000 (1000 +2000) of its $3700 investment.
1	$ 1 000	-3700 + 1000= $ <u>-2 700</u>	Then, compute the proportion of the 3rd year the company will need to recover the remaining $700 of initial investment:
2	$ 2 000	-2700 + 2000= $ <u>-700</u>	**$ 700 / $ 1500 = 0.47**
3	$ 1 500	-700 + 1500 = $ **<u>800</u>**	In round terms, 0.47 of a year is approximately 24 weeks (0.47×52 weeks = 24 weeks or 6 months)
4	$ 1 000	Not used in decision	Thus, payback period is around 2.5 years.

1. PAYBACK PERIOD

The payback period method has two major flaws:

1. It ignores all cash flow after the initial cash outflow has been recovered.
2. It ignores the time value of money.

2. DISCOUNTED PAYBACK PERIOD

- Discounted payback method is a modified version of the payback method.
- It calculates the time it takes to recover the initial investment **in current or discounted currency.**
- The discounted payback method recognizes the time value of money.
- However, it does not recognize cash returns in excess of the calculated payback period.

2. DISCOUNTED PAYBACK PERIOD

Illustration

Year	Cash flow	Discounted Cash Flow	Yet to be recovered	Notes
0	\$ -3 700	\$ -3 700	\$ -3 700	After 2 years the firm will have recovered \$2600.79 (917.43 + 1683.36) of its \$3700 investment.
1	\$ 1 000	$\frac{\$1000}{(1+0.09)^1} = 917$	-3700 + 917 = \$ **-2 783**	Then, compute the proportion of the 3rd year the company will need to recover the remaining \$1100 of initial investment:
2	\$ 2 000	$\frac{\$2000}{(1+0.09)^2} = 1683$	-2783 + 1683 = \$ **-1100**	
3	\$ 1 500	$\frac{\$1500}{(1+0.09)^3} = 1158$	-1100 + 1158 = \$ **58**	**\$ 1100 / \$ 1158 = 0.95** In round terms, 0.95 of a year is approximately 49 weeks (0.95×52 weeks = 49 weeks or 11 months)
4	\$ 1 000	Not used in decision		Thus, payback period is around 2 years and 11 months.

3. NET PRESENT VALUE (NPV)

Discounts all the cash flows from a project back to time 0 using an appropriate discount rate, *r*:

$$NPV = -CF_0 + \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \frac{CF_3}{(1+r)^3} + \cdots + \frac{CF_n}{(1+r)^n}$$

$$\text{accept if } NPV > 0 \qquad \text{reject if } NPV < 0$$

A positive NPV implies that the project is adding value to the firm's bottom line. Therefore, when comparing projects, the higher the NPV the better.

3. NET PRESENT VALUE (NPV)

3.1 Stand-alone project

Illustration

A small commercial property is for sale near your university. Given its location, you believe a student oriented business would be very successful there. You consider an option of opening Coffee Shop and you come up with the following cash flow estimates:

0	1	2	3	4
- 400,000	60,000	80,000	105,000	130,000

Calculate NPV of this project and indicate whether the investment should be undertaken or not. Cost of capital is 5%.

3. NET PRESENT VALUE (NPV)

3.1 Stand-alone project

Illustration

$$-\$400{,}000+\frac{\$60{,}000}{(1+0.05)}+\frac{\$80{,}000}{(1+0.05)^2}+\frac{\$105{,}000}{(1+0.05)^3}+\frac{\$130{,}000}{(1+0.05)^4}=-\$72{,}640.5$$

This investment should not be undertaken as NPV is negative.

3.2. NPV: MUTUALLY EXCLUSIVE vs INDEPENDENT PROJECTS

NPV approach useful for independent as well as mutually exclusive projects.

A choice between mutually exclusive projects arises when:

- There is a need for only one project, and both projects can fulfill that need.
- There is a scarce resource that both projects need, and by using it in one project, it is not available for the second.

NPV rule considers whether or not discounted cash inflows outweigh the cash outflows emanating from a project. Higher positive NPVs are preferred to lower or negative NPVs.

3. NET PRESENT VALUE (NPV)
3.2 Mutually Exclusive Projects

Illustration

You have a dilemma: to open a coffee shop or a book store. In either case, the cost of capital will be 10%. The relevant annual cash flows with each option are as follows:

Project	Initial investment	CF_1	CF_2	CF_3
Coffee Shop	$400,000	$80,000	$170,000	$300,000
Book Store	$300,000	$140,000	$160,000	$190,000

3. NET PRESENT VALUE (NPV)
3.2 Mutually Exclusive Projects

Coffee Shop

$$NPV_{Coffee\_Shop} = -\$400{,}000 + \frac{\$80{,}000}{(1+0.1)} + \frac{\$170{,}000}{(1+0.1)^2} + \frac{\$300{,}000}{(1+0.1)^3} = \$38{,}618$$

Book Store

$$NPV_{Book\_Store} = -\$300{,}000 + \frac{\$140{,}000}{(1+0.1)} + \frac{\$160{,}000}{(1+0.1)^2} + \frac{\$190{,}000}{(1+0.1)^3} = \$102{,}254$$

$$\boxed{NPV_{Book\_Store} > NPV_{Coffee\_Shop}}$$

Thus, you will better off if you invest in a Book Store

3. NET PRESENT VALUE (NPV)

3.3 Unequal Lives of Projects

Firms often have to decide between alternatives that are:

- mutually exclusive,
- cost different amounts,
- have different useful lives, and
- require replacement once their productive lives run out.

In such cases, using the traditional NPV (single life analysis) as the evaluation criterion can lead to incorrect decisions, since the cash flows will change once replacement occurs.

3. NET PRESENT VALUE (NPV)

3.3 Unequal Lives of Projects

Under the NPV approach, mutually exclusive projects with unequal lives can be analyzed by using one of the following modified approaches:

1. **Replacement Chain Method**
2. **Equivalent Annual Annuity (EAA) Approach**

3. NET PRESENT VALUE (NPV)

3.3 Unequal Lives of Projects

Illustration

Let's say that there are two tanning beds available, one lasts for 3 years while the other for 4 years.

The owner realizes that she will have to replace either of these two beds with new ones when they are at the end of their productive lives, as she plans on being in the business for a long time.

3. NET PRESENT VALUE (NPV)

3.3 Unequal Lives of Projects

Illustration (cont.)

Using the cash flows listed below, and a cost of capital of 10%, help the owner decide which of the two tanning beds she should choose.

Project	Initial investment	CF_1	CF_2	CF_3	CF_4
Bed A	$ 10 000	$ 4 000	$ 4 500	$ 10 000	$ 8 000
Bed B	$ 5 750	$ 4 000	$ 4 500	$9 000	-

3. NET PRESENT VALUE (NPV)
3.3 Unequal Lives of Projects

3.3.1. REPLACEMENT CHAIN METHOD

STEP 1. **Calculate the NPV of each tanning bed for a single life**

$$NPV_{BedA} = -\$10{,}000 + \frac{\$4{,}000}{(1+0.1)} + \frac{\$4{,}500}{(1+0.1)^2} + \frac{\$10{,}000}{(1+0.1)^3} + \frac{\$8{,}000}{(1+0.1)^4} = \$10{,}332.62$$

$$NPV_{BedB} = -\$5{,}750 + \frac{\$4{,}000}{(1+0.1)} + \frac{\$4{,}500}{(1+0.1)^2} + \frac{\$9{,}000}{(1+0.1)^3} = \$8{,}367.21$$

NET PRESENT VALUE (NPV)
Unequal Lives of Projects: Example

3.3.1. REPLACEMENT CHAIN METHOD

STEP 2. Calculate the Total NPV of each bed using 3 repetitions for A and 4 for B, i.e. We assume Bed A will be replaced at the end of Years 4 and 8, lasting 12 years. We also assume Bed B will be replaced in Years 3, 6, and 9, also lasting for 12 years in total.

We assume that the annual cash flows are the same for each replication.

$$Total\_NPV_{BedA} = \$10{,}332.62 + \frac{\$10{,}332.62}{(1+0.1)^4} + \frac{\$10{,}332.62}{(1+0.1)^8} = \$22{,}210.18$$

$$Total\_NPV_{BedB} = \$8{,}367.21 + \frac{\$8{,}367.21}{(1+0.1)^3} + \frac{\$8{,}367.21}{(1+0.1)^6} + \frac{\$8{,}367.21}{(1+0.1)^9} = \$22{,}925.20$$

Decision: Bed B with its higher Total NPV should be chosen.

3. NET PRESENT VALUE (NPV)

3.3 Unequal Lives of Projects

3.3.2 Equivalent Annual Annuity (EAA) method

The equivalent annual annuity (EAA) approach calculates the constant annual cash flow generated by a project over its lifespan if it was an annuity. The present value of the constant annual cash flows is exactly equal to the project's net present value (NPV).

$$EAA = \frac{NPV}{\dfrac{1-[1/(1+r)^n]}{r}} = \frac{NPV}{PVIFA_{n,r}}$$

The project with a higher EAA is considered the best choice

NET PRESENT VALUE (NPV)
Unequal Lives of Projects: Example

3.3.2 EAA Method

$EAA_{bed\ a} = NPV_A / (PVIFA, 10\%, 4) = \$10{,}332.62/(3.1698)$
$= \$3{,}259.56$

$EAA_{bed\ b} = NPV_B / (PVIFA, 10\%, 3) = \$8{,}367.21/(2.48685)$
$= \$3{,}364.58$

Decision:

Bed B's EAA = $3,364.58 > Bed A's EAA = $3,259.56

□ Accept Bed B

4. PROFITABILITY INDEX (PI)

Profitability Index (PI) measures the value created per dollar of an investment.

$$\text{Profitability Index } (PI) = \frac{PV\_of\_the\_expected\_cash\_flows}{Initial\_investment}$$

$$\text{Profitability Index } (PI) = \frac{NPV + Initial\_investment}{Initial\_investment}$$

Rules of Profitability Index

If PI > 1, Good Investment

If PI < 1, Bad Investment

4. PROFITABILITY INDEX (PI)

Illustration

Given the following cash flows for an investment, calculate the profitability index.

The required rate of return is 8%

Year	Cash Flows
0	- $ 10 000
1	$ 1 500
2	$ 2 500
3	$ 4 000
4	$ 3 000
5	$ 3 000
6	$ 3 000

4. PROFITABILITY INDEX (PI)

Step 1. Compute NPV of a project

$$NPV = -\$10{,}000 + \frac{\$1500}{(1+0.08)} + \frac{\$2500}{(1+0.08)^2} + \frac{\$4000}{(1+0.08)^3} + $$

$$+ \frac{\$3000}{(1+0.08)^4} + \frac{\$3000}{(1+0.08)^5} + \frac{\$3000}{(1+0.08)^6} = \$2845$$

Step 2. Compute PI $$PI = \frac{\$2845 + \$10000}{\$10000} = 1.2845$$

For every $1 invested in this project, the total value created is $1.285. Therefore, we have a net profit of 1.285 - 1 = $0.285 per every dollar invested.

4. PROFITABILITY INDEX (PI)

There is a linear relationship between NPV and PI.

Here it is:

If Profitability Index > 1, NPV is Positive (+)
If Profitability Index < 1, NPV is Negative (-)

5. INTERNAL RATE OF RETURN (IRR)

The Internal Rate of Return (IRR) is the discount rate that forces the sum of all the discounted cash flows from a project to equal 0 (discounted future cash flows = starting investment amount).

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

- The decision rule that would be applied is as follows:

Accept if IRR > hurdle rate (required rate of return)

Reject if IRR < hurdle rate (required rate of return)

Note that the IRR is measured as a percent, while the NPV is measured in dollars.

Hurdle rate is the minimum acceptable rate of return that an investor or firm should earn on a project, given its riskiness.

THE END