

Module 6

How to Choose Projects

FINE 3010, Financial Management
Prof. Renping Li, Tulane University

What Is Financial Management?

Recall from **Module 1**

- How do businesses achieve shareholder value maximization?
- Small (coffee shop) or large (Tesla), success requires ***sound financial management***, good decisions involving money
- Financial management = **Investment decisions** + **Financing decisions**



How to Maximize Shareholder Value?

Recall from **Module 1**

- Investment Decision
 - Choose investments whose returns are higher than any other alternative use of cash
- Financing Decision
 - Choose the cheapest source of funding

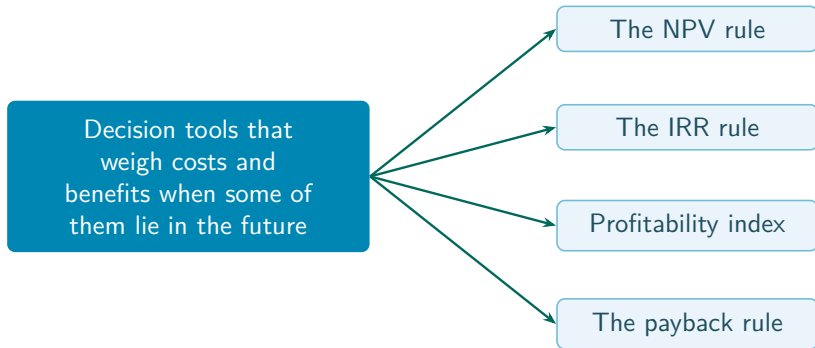


Outline

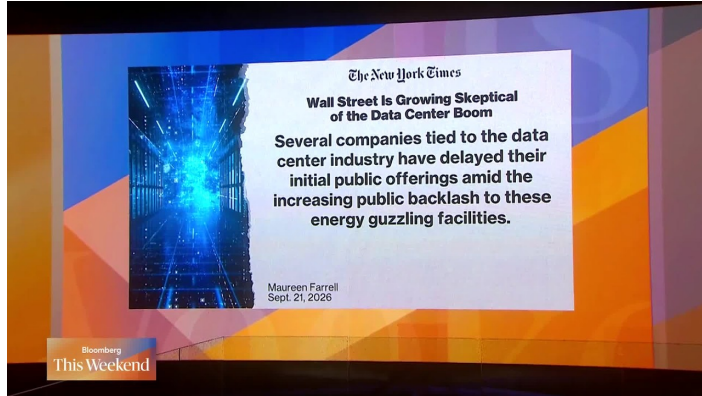
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- What capital expenditure should we make?



Motivating Example, Data Centers



Bloomberg, September 27, 2026 (5:55), “Data Center Boom Meets Wall Street Skepticism”

Module 6, Part 1

Net Present Value

Investment Decision-Making Rules

- **Net present value (NPV),**

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- “Net” because we evaluate the difference between benefits and costs
- Often (but not necessarily),
 - The main cost is immediate (e.g., build a factory, develop a product), so it needs no discounting
 - Most benefits occur in the future,

$$\text{NPV} = -\text{Initial investment} + \text{PV of future cash flows}$$

The NPV Rule

- **NPV rule,**
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- **NPV rule,**
 - Take all decisions with $NPV > 0$
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- For a business, accepting a project with an NPV of x changes the shareholder value of the business by x

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3. Discount all cash flows to their present value,

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4. Pursue the project if the NPV is positive

Example, Net Present Value

- You are a commercial landlord with the opportunity to buy a new office building
- A tenant is lined up who will generate \$25,000 per year in cash flows for three years
- At the end of three years you expect to sell the building for \$450,000
- The building costs \$375,000, and the opportunity cost of capital is 7%



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- Should you buy the building?

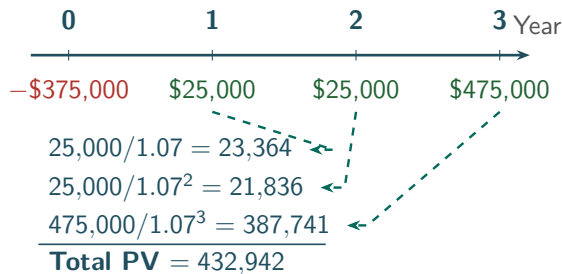


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- Cash flows in years 1–3, \$25,000
- Sale price ($t = 3$), \$450,000
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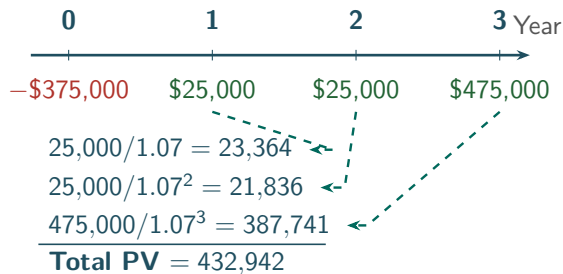
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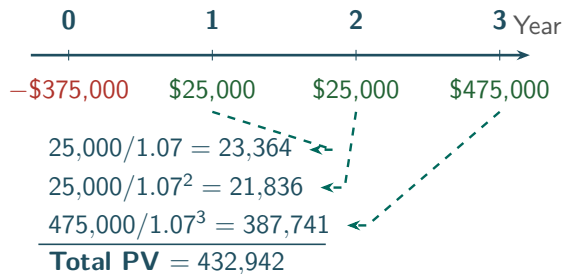
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- The NPV is positive, so go ahead and purchase the building

Example, NPV with a Financial Calculator (TI BA II Plus)

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25	ENTER , ↓ ↓
25	ENTER , ↓ ↓
475	ENTER
	NPV (the calculator asks for I)
7	ENTER , ↓
	CPT
<u>57.94</u>	

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- Opportunity cost of capital, 7%
- The NPV is \$57.94 thousand

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NPV Profile

- **NPV profile**, the graphical relation between NPV and r

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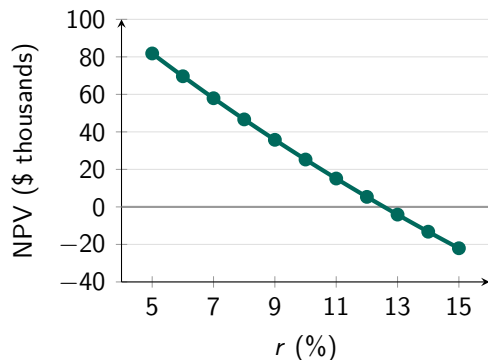
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- E.g., the building project, cost \$375,000, cash flows \$25,000 in years 1–3, sale price \$450,000. Plot the NPV profile
- Solution, list different values of r , compute the NPV for each, and plot



Example, Valuing Non-Constant Growth

Recall from **Module 5**

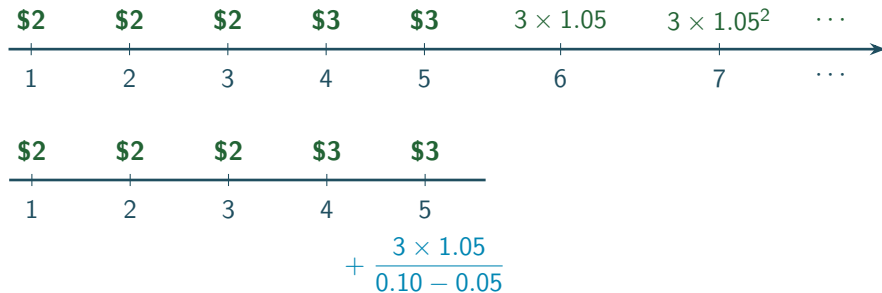
- A stock's expected dividends are in the table. Its required return on equity is 10%. Its dividends grow at 5% a year beginning in year 6. What is the value of the stock?

Year	1	2	3	4	5
Dividend	\$2	\$2	\$2	\$3	\$3

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- We discounted the year-5 price of the constant-growth stream, then the five dividends, term by term,

$$PV_{\text{Price in year 5}} = \frac{3 \times 1.05}{0.10 - 0.05} \times \frac{1}{1.10^5} = \$39.12$$

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- Total, $PV_{\text{Stock}} = 39.12 + 8.89 = \48.00

Example, Non-Constant Growth with a Financial Calculator

\$2	\$2	\$2	\$3	\$3
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$$+ \frac{3 \times 1.05}{0.10 - 0.05}$$

Example, Non-Constant Growth with a Financial Calculator



- Enter the cash flows one by one, 0, 2, 2, 2, 3, 66
- In year 5, enter the dividend plus the price, $3 + 63 = 66$

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0	ENTER, ↓
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- **No need to discount each cash flow and sum by hand!**

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- On the calculator, the same worksheet with -50 entered as the first cash flow (instead of 0)

Back to Data Centers, Each Dollar Must Earn 40 Cents a Year

- Amazon, Alphabet, Microsoft, Meta, and Oracle spent \$381 billion on capital expenditure in 2025, about double that is forecast for 2026

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- **“These firms risk bankruptcy unless expected profits grow commensurately”**

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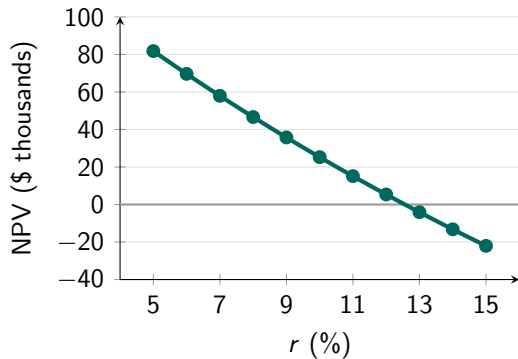
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Module 6, Part 2

Internal Rate of Return

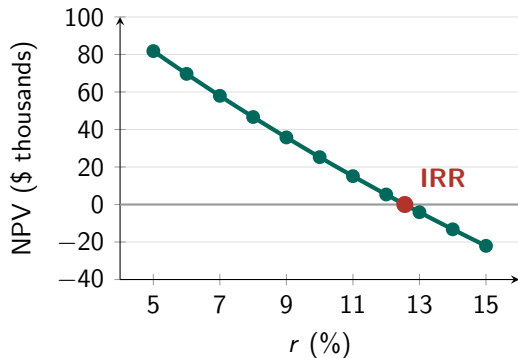
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- On the NPV profile, the IRR is where the curve crosses zero, here around 12.5%



Internal Rate of Return

- Find the IRR by solving the equation

$$\text{NPV} = 0 = CF_0 + \frac{CF_1}{(1 + \text{IRR})^1} + \frac{CF_2}{(1 + \text{IRR})^2} + \cdots + \frac{CF_T}{(1 + \text{IRR})^T}$$

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- This is a cubic equation, hard to solve by hand, but financial calculators and Excel help. It is the same setting as solving for the yield of a bond in **Module 5**

Example, IRR with a Financial Calculator (TI BA II Plus)

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 - Happens when the sign of the cash flows flips more than once (an advance payment at the start, or a large cost at the end of a project)

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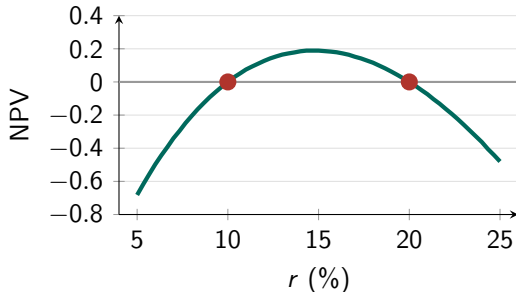
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- Two IRRs, at 10% and 20%



The IRR Rule

- **IRR rule**, a decision rule (like the NPV rule) about which projects to accept and which to reject,
 - If $IRR > \text{opportunity cost of capital } r$, accept the project
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- The IRR rule often gives the same answer as the NPV rule, but not always (e.g., with multiple IRRs), and whenever they disagree, the NPV rule is usually the correct one

Example, the IRR Rule

- Apply the IRR rule to the building project if,
 - A. the opportunity cost of capital is 7%
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 - B. $IRR (12.56\%) < \text{opportunity cost of capital } (14\%)$, reject the project
- The NPV rule gives the same answers here, $NPV > 0$ in A and $NPV < 0$ in B

Recap of Part 2

- **Internal rate of return (IRR)**, the discount rate at which $NPV = 0$, where the NPV profile crosses zero

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- Found on the financial calculator's cash flow worksheet, the same problem as a bond's yield
- **IRR rule**, accept if $IRR > r$, reject if $IRR < r$
- Cash flows that change sign more than once can have multiple IRRs, when the rules disagree, trust the NPV rule

Module 6, Part 3

Choosing among Projects

Mutually Exclusive Projects

- What if you must choose between mutually exclusive projects (you can only choose **one**)? Then,
 1. Calculate the NPV of each project
 2. Among the options with a positive NPV, choose the one with the highest NPV

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- Picking on the highest IRR instead can go astray, the IRR ignores the size of a project
- NPV captures “dollars”, IRR captures “percentage returns”, and with mutually exclusive projects you care about maximizing dollars

Example, Mutually Exclusive Projects

- You choose between Project A and Project B, only one. Both have an opportunity cost of capital of 10%

Cash flows	CF_0	CF_1	CF_2	CF_3
Project A	-100,000	60,000	60,000	60,000
Project B	-500,000	250,000	250,000	250,000

- Calculate the NPV and IRR of each project
- Under the NPV rule and the IRR rule, are these good projects?
- Which project should you pick if you can only pick one?

Example, Mutually Exclusive Projects

- Solution,

	NPV	IRR
Project A	\$49,211	36%
Project B	\$121,713	23%

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- Solution,

	NPV	IRR
Project A	\$49,211	36%
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- b. Both projects are good under both rules ($NPV > 0$ and $IRR > r$ for both)
- c. Pick Project B, its NPV is higher (even though the IRR is higher for Project A)

Profitability Index

- What if you have multiple good projects, can pick *several* of them, but have only limited dollars to invest?

Profitability Index

- What if you have multiple good projects, can pick *several* of them, but have only limited dollars to invest?
- **Decision rule with limited dollars**, rank projects by their profitability index in descending order, and go down the ranking until you run out of funds, or run out of positive-NPV projects

$$\text{Profitability index} = \frac{\text{Net present value}}{\text{Initial investment}}$$

Example, Profitability Index

- You choose among Projects C, D, and E, all with an opportunity cost of capital of 10%
- But you only have \$10,000 in total to invest

Cash flows	CF_0	CF_1	CF_2
Project C	-10,000	30,000	5,000
Project D	-5,000	5,000	20,000
Project E	-5,000	5,000	15,000

- Calculate the NPV, IRR, and profitability index of each project
- Under the NPV rule and the IRR rule, are these good projects?
- Which project(s) should you pick if you can only invest \$10,000?

Example, Profitability Index

- Solution,

	NPV	IRR	PI
Project C	\$21,405	216%	2.1
Project D	\$16,074	156%	3.2
Project E	\$11,942	130%	2.4

Example, Profitability Index

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	NPV	IRR	PI
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- b. All are good projects under both rules, $NPV > 0$ and $IRR > r$ (10%)

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- b. All are good projects under both rules, $NPV > 0$ and $IRR > r$ (10%)
- c. With only \$10,000, rank on the profitability index and go down the list,
 - First pick Project D (highest PI), \$5,000 left

Example, Profitability Index

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	NPV	IRR	PI
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 - First pick Project D (highest PI), \$5,000 left
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 - Project C is also good, but we have to leave it

Capital Rationing

- **Capital rationing**, a limit on the amount of funds available for investment

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Capital Rationing

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- **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

Recap of Part 3

- Among mutually exclusive projects, take the positive-NPV project with the highest NPV, not the highest IRR (the IRR ignores the size of a project)

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- Among mutually exclusive projects, take the positive-NPV project with the highest NPV, not the highest IRR (the IRR ignores the size of a project)
- **Profitability index**, Net present value / Initial investment
- Under capital rationing (limited funds), rank projects by their profitability index and go down the ranking

Module 6, Part 4

Payback Period and Payback Rule

Payback Period

- **Payback period**, the time (usually in years) until the cash flows recover the initial investment of the project

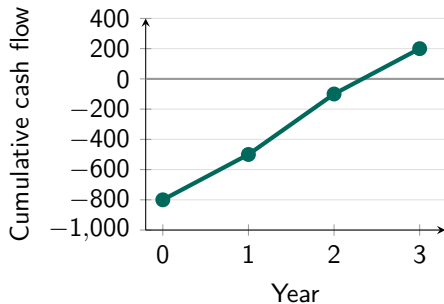
Payback Period

- **Payback period**, the time (usually in years) until the cash flows recover the initial investment of the project
- E.g., consider Project X, what is its payback period?

Cash flows	$t = 0$	$t = 1$	$t = 2$	$t = 3$
Project X	-800	300	400	300

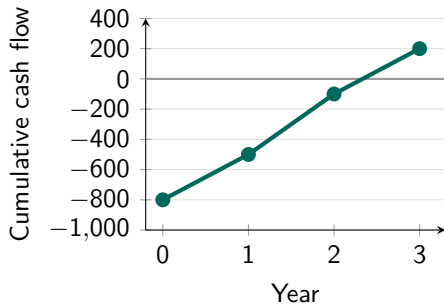
Example, Payback Period

- Solution, find the time until the cumulative cash flows (CCF) turn positive,
 - After $t = 0$, $CCF = -800$
 - After $t = 1$, $CCF = -500$
 - After $t = 2$, $CCF = -100$
 - After $t = 3$, $CCF = +200$



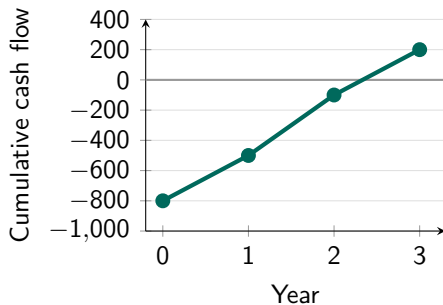
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- The CCF turns positive between $t = 2$ and $t = 3$



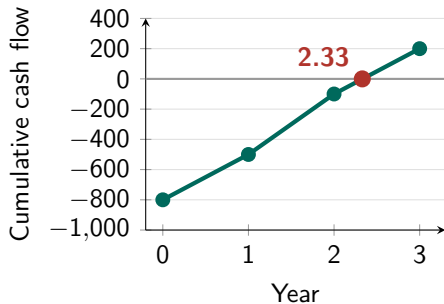
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- The CCF turns positive between $t = 2$ and $t = 3$
- The third year starts at $CCF = -100$ and brings a cash flow of 300, so the CCF turns positive $100/300 = 0.33$ into the year



Example, Payback Period

- Solution, find the time until the cumulative cash flows (CCF) turn positive,
 - After $t = 0$, $CCF = -800$
 - After $t = 1$, $CCF = -500$
 - After $t = 2$, $CCF = -100$
 - After $t = 3$, $CCF = +200$
- The CCF turns positive between $t = 2$ and $t = 3$
- The third year starts at $CCF = -100$ and brings a cash flow of 300, so the CCF turns positive $100/300 = 0.33$ into the year
- The payback period is 2.33 years



Payback Rule

- **Payback rule**, first define a maximum allowed payback period as a cutoff,
 - If payback period $<$ maximum cutoff, accept the project
 - If payback period $>$ maximum cutoff, reject the project

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- E.g., Project X again. The company's cutoff is 2 years. Accept or reject under the payback rule?

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Cash flows	CF ₀	CF ₁	CF ₂	CF ₃
Project X	-800	300	400	300

- Solution, payback period (2.33) $>$ maximum cutoff (2), reject the project!
- What if the maximum cutoff had been 3 years instead? Then accept

Payback Rule, Pros and Cons

Pros

- Easy to understand and compute

Cons

- Does not consider the time value of money, all cash flows before the cutoff count equally
- Only considers cash flows up to the cutoff date, what if really large cash flows come after it?
- The maximum cutoff is arbitrary
- No help when choosing among projects with the same payback period

Payback Rule Ignores the Time Value of Money

- Consider Projects A, B, and C. The company's payback cutoff is 2 years, and the opportunity cost of capital for all projects is 10%

Cash flows	$t = 0$	$t = 1$	$t = 2$	$t = 3$
Project A	-2,000	500	1,000	3,000
Project B	-2,000	2,000	0	0
Project C	-2,000	0	4,000	0

- Calculate the payback period, NPV, and IRR of each project
- Under the payback rule, which project(s) should the company take?
- Why is the payback rule's choice wrong?

Payback Rule Is Often Not Good at Ranking Projects

- Solution,

	Payback period	NPV	IRR
Project A	2.17	1,535	39%
Project B	1.00	−182	0%
Project C	1.50	1,306	41%

Payback Rule Is Often Not Good at Ranking Projects

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- b. The payback period is shortest for Project B, which looks best on that metric
- c. The payback rule is wrong, on NPV Project A is the best and Project C is also good, while Project B should be rejected because its NPV is negative

Recap of Part 4

- **Payback period**, the time until the cumulative cash flows recover the initial investment

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- **Payback period**, the time until the cumulative cash flows recover the initial investment
- **Payback rule**, accept if the payback period is shorter than a maximum cutoff

Recap of Part 4

- **Payback period**, the time until the cumulative cash flows recover the initial investment
- **Payback rule**, accept if the payback period is shorter than a maximum cutoff
- Easy to compute, but it ignores the time value of money and every cash flow after the cutoff, so it can rank projects wrongly

Module 6, Part 5

Capital Budgeting in Practice

Capital Budgeting Techniques, Summary

Criterion	Definition	Investment rule
Net present value (NPV)	Present value of cash flows minus initial investment	Accept project if NPV is positive. For mutually exclusive projects, choose the one with the highest (positive) NPV
Internal rate of return (IRR)	The discount rate at which project NPV equals zero	Accept project if IRR is greater than the opportunity cost of capital
Profitability index	Ratio of net present value to initial investment	Accept project if the profitability index is greater than 0. Under capital rationing, accept the projects with the highest profitability index
Payback period	Time until the sum of project cash flows equals the initial investment	Accept project if the payback period is less than some specified number of years

Source, Brealey, Myers, and Marcus, Table 8.2

Capital Budgeting Techniques, Use in Practice

Investment criterion	% of firms that always or almost always use it	Average score (0 never, 4 always)		
		All firms	Small firms	Large firms
Internal rate of return	76	3.1	2.9	3.4
Net present value	75	3.1	2.8	3.4
Payback period	57	2.5	2.7	2.3
Profitability index	12	0.8	0.9	0.8

Source, J. R. Graham and C. R. Harvey, "The Theory and Practice of Corporate Finance, Evidence from the Field," *Journal of Financial Economics*, 2001 (Brealey, Myers, and Marcus, Table 8.3)

Practice Problem

- When managers select correctly from among mutually exclusive projects, they,
 - A. may give up rate of return for NPV
 - B. may give up NPV for rate of return
 - C. have a tendency to select the largest project
 - D. focus on the payback method to avoid conflicting signals

Practice Problem

- When managers select correctly from among mutually exclusive projects, they,
 - A. may give up rate of return for NPV
 - B. may give up NPV for rate of return
 - C. have a tendency to select the largest project
 - D. focus on the payback method to avoid conflicting signals
- Answer, **A**

Practice Problem

- Which of the following investment criteria takes the time value of money into consideration?
 - A. Net present value only
 - B. Profitability index and net present value only
 - C. Internal rate of return and net present value only
 - D. Profitability index, internal rate of return, and net present value

Practice Problem

- Which of the following investment criteria takes the time value of money into consideration?
 - A. Net present value only
 - B. Profitability index and net present value only
 - C. Internal rate of return and net present value only
 - D. Profitability index, internal rate of return, and net present value
- Answer, **D**

Practice Problem

- When calculating a project's payback period, cash flows are,
 - A. discounted at the opportunity cost of capital
 - B. discounted at the internal rate of return
 - C. discounted at the risk-free rate of return
 - D. not discounted at all

Practice Problem

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 - D. not discounted at all
- Answer, **D**

Practice Problem

- A project's payback period is determined to be 4 years. If it is later discovered that additional cash flows will be generated in years 5 and 6, then the project's payback period will,
 - A. be reduced
 - B. be increased
 - C. be unchanged
 - D. change, but the discount rate must be known to determine the nature of the change

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 - D. change, but the discount rate must be known to determine the nature of the change
- Answer, **C**

Practice Problem

- A project that costs \$3,900 to install will provide annual cash flows of \$1,250 for each of the next 6 years
 - a. What is the NPV if the discount rate is 13%?
 - b. How high can the discount rate be before you reject the project?

Practice Problem

- a. Cash flow worksheet, **CF**, **2nd CLR Work**, -3900 **ENTER** $\downarrow$, then 1250 **ENTER** $\downarrow$ $\downarrow$ for each of the 6 years, **NPV**, 13 **ENTER** $\downarrow$, **CPT**
 - Or, **PMT** = 1250 , **FV** = 0 , **N** = 6 , **I/Y** = 13 , **CPT** **PV** (change the sign to positive), then subtract 3900

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 - The NPV is \$1,097
- b. The same cash flow worksheet, then **IRR**, **CPT**
 - Or, **PMT** = 1250 , **PV** = -3900 , **N** = 6 , **FV** = 0 , **CPT** **I/Y**

Practice Problem

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 - Or, **PMT** = 1250 , **PV** = -3900 , **N** = 6 , **FV** = 0 , **CPT** **I/Y**
 - The IRR is 22.6%, reject once the discount rate exceeds it

Practice Problem

- An investment costs \$100,000 and provides a cash inflow of \$17,000 per year. If the discount rate is 13.1%, how long must the cash inflows last for it to be an acceptable investment?

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- Solution, **PMT** = 17,000, **PV** = -100,000, **I/Y** = 13.1, **FV** = 0,
CPT **N**
- $N = 12$ years

Practice Problem

- A proposed nuclear power plant will cost \$2.8 billion to build and then will produce cash flows of \$360 million a year for 15 years. After that period (in year 15), it must be decommissioned at a cost of \$960 million
 - a. What is the NPV of the project if the discount rate is 5%?
 - b. What is the NPV of the project if the discount rate is 15%?

Practice Problem

- a. On the TI BA II Plus cash flow worksheet (in \$ millions), **CF**, **2nd** **CLR Work**, -2800 **ENTER** ↓, then 360 **ENTER** ↓ ↓ for each of years 1–14, -600 **ENTER**, **NPV**, 5 **ENTER** ↓, **CPT**
 - In the final year, the cash flow is $360 - 960 = -\$600$ million

Practice Problem

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 - Or, **PMT** = 360 , **FV** = -960 , **N** = 15 , **I/Y** = 5 , **CPT** **PV** (change the sign to positive), then subtract 2800

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 - Or, **PMT** = 360 , **FV** = -960 , **N** = 15 , **I/Y** = 5 , **CPT** **PV** (change the sign to positive), then subtract 2800
 - The NPV is \$475 million
- b. The same worksheet with $I = 15$, the NPV is $-\$813$ million

Practice Problem

- A business believes its latest project, which will cost \$99,000 to install, will generate a perpetual growing stream of cash flows. Cash flow at the end of the first year will be \$7,000, and cash flows in future years are expected to grow indefinitely at an annual rate of 5%
- a. If the discount rate for this project is 10%, what is the project NPV?
- b. What is the project IRR?

Practice Problem

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- a. If the discount rate for this project is 10%, what is the project NPV?
- b. What is the project IRR?

a. Present value = Cash flow at the end of year + Discount rate – Growth rate = $\$7,000 + (0.10 - 0.05) = \$140,000$

$$\text{NPV} = -\$99,000 + \$140,000 = \$41,000$$

b. Recall that the IRR is the discount rate that makes NPV equal to zero:

$$(-\text{Investment}) + (\text{PV of cash flows discounted at IRR}) = 0$$

$$-\$99,000 + \$7,000 + (\text{IRR} - 0.05) = 0$$

$$\text{IRR} = (\$7,000 + \$99,000) + 0.05 = 0.1207, \text{ or } 12.07\%$$

Key Takeaways

- The NPV rule is the gold standard, take every project with $NPV > 0$, and among mutually exclusive projects take the highest NPV

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- Under capital rationing, rank projects by the profitability index

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- The NPV rule is the gold standard, take every project with $NPV > 0$, and among mutually exclusive projects take the highest NPV
- The IRR rule usually agrees with NPV, but it ignores project size and can break down with multiple IRRs
- Under capital rationing, rank projects by the profitability index
- The payback rule is quick but ignores discounting and later cash flows

Thank you!

Please let me know if you have any questions.