A First Encounter with Capital Budgeting Rules

Lecture Slides 4

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Capital budgeting in the real world

Video 1

- Definition: process in which a bussiness determines which projects are worth pursuing.
  - Assessment of a project's lifetime cash inflows and outflows: target benchmark.
- Ideally: pursue all projects which increase shareholder value.
- Real world: limited amount of capital for new projects $\Rightarrow$ use capital budgeting: projects with higest return (on a given period). How?

How do Executives Decide? Most popular methods

Source: Graham and Campbell Harvey, 2001

Method	CFO Usage	Yields Correct Answer
Internal Rate of Return (IRR)	(76%)	Often
Net Present Value (NPV)	(75%)	(Almost) Always
Payback Period	(57%)	Rarely
Earning Multiples (P/E Ratios)	(39%)	With Caution
Discounted Payback	(30%)	Rarely
Accounting Rate of Return	(20%)	Rarely
Profitability Index	(12%)	Often

Our benchmark

- Still in a world of:
  - Constant r.
  - Perfect foresight.
  - Perfect markets: no taxes, same info and opinion, infinite agents, no transaction costs.
- Have a closer look at capital budgeting:
  - Decision rules for accept or rejecting projects.
  - NPV is best (but)...

Net Present Value

Why is it the right rule to use? Video 2

- You translate cash flows in different periods into the same units: \$s today $\Rightarrow$ they can be compared and added. The most essential concept in finance.
- Why is NPV the right rule to use? (in our perfect world) a positive NPV = free money: borrowing + investing!!!
- You can buy or sell projects at will, see a few slides later.

NPV in a perfect world

IMPORTANT: In a perfect world, if you have all the right inputs to NPV, no other rule can make better decisions. Thus, it is the appropriate decision benchmark—and no other rule can beat it. This also means that information other than the NPV is redundant.

- In our perfect world without uncertainty: positive-NPV projects must be scarce. Arbitrage until r increases enough.
- Why consider other rules: application of NPV in real world -extremely- difficult:
  - Do you know cash flows? Do you know discount factors? Estimate!!!
  - Is the real world 100% "perfect"?
- Still the most important benchmark but... other rules may provide us with useful information and affect project choices.

Separating Investment and Consumption Decisions

Does Project Value Depend on When you Need Cash?

- Perfect world $\Rightarrow$shifting-at-will $\Rightarrow$ ownership does not matter, how much cash do you have does not matter:
- You can always shift money between periods at an "exchange rate" which reflects the time value of money:

You want to consume today, not next period

- You have \$150, and exclusive access to a project that costs \$100 and returns \$200 next year, r=10%.
- Two options:

1. Consume your \$150.
2. Take the project and sell it for its NPV: $-\$100 + \frac{\$200}{1.1} \approx \$81.82$, spend \$231.82 today.

You want to consume only next period

- You have \$150, and exclusive access to a project that costs \$100 and returns \$200 next year, r=10%.
- Two options:

1. Take your \$150 to the bank, consume \$165 next year.
2. Take the project and sell it for its NPV: get \$81.82, together with your \$150 $\rightarrow$ bank $\Rightarrow$ \$90+\$165 next year.

- $\Rightarrow$ You always take the project!!!

The Separation of Decisions 1

- Perfect market: you can make investment decisions without concern for your consumption preferences.
- In an imperfect market: Different borrowing and lending interest rates (Why?) $\Rightarrow$ separation of decisions does not -always- hold $\Rightarrow$
  - Ownership matters: you might take more projects if you have more cash! Why?

The separation of Decisions 2

- Generally, for firms and individuals: $r_l < r_b$. Example:
- You have to decide whether to take project A, facing the following interest rates:
  - $r_l = r_{lending} = 3\% \approx opportunity\ cost$ or discount rate.
  - $r_b = r_{borrowing} = 10\% \approx cost\ of\ capital$.
- $NPV(A, r_l) = -\$100 + \frac{\$110}{1.03} = \$6.79$.
- $NPV(A, r_l, r_b) = -100(1.1) + \frac{\$110}{1.03} = -\$3.20$.
- Do you take the project if you have the cash? Do you take the project if you do not have it?

Risky Mistake 4.1.a

Errors in Cash Flows vs. Errors in the Cost of Capital

- In the real world: need to estimate cash flows and interest rates!
- Short term project: $PV_{correct} = \frac{\$200}{1+8\%} \approx \$185.19$, comparing a 10% error in cash flow or in r.
  - $PV_{CF\ error} = \frac{\$220}{1+8\%} \approx \$203.7 \Rightarrow Error_1 = \$203.7 - \$185.19 = \$18.5 \rightarrow$ 10% of PV.
  - $PV_{r\ error} = \frac{\$220}{1+8.8\%} \approx \$183.82 \Rightarrow Error_2 < \$2 \approx 1\%$ of PV.
- Long term project, the cash flow will occur in 30 years: $PV_{correct} = \frac{\$200}{(1.08)^{30}} \approx \$19.88$.
  - $PV_{CF\ error} = \frac{\$220}{1.08^{30}} \approx \$21.86 \Rightarrow Error_3 < 2 \approx 10\%$.
  - $PV_{r\ error} = \frac{\$200}{1.088^{30}} \approx \$15.93 \Rightarrow Error_4 \approx \$4 \approx 20\%$.

Errors in estimation and NPV

IMPORTANT:

- For short-term projects, errors in estimating correct interest rates are less problematic in computing NPV than are errors in estimating future cash flows.
- For long-term projects, errors in estimating correct interest rates and errors in estimating future cash flows are both problematic in computing NPV. Nevertheless, in reality, you will tend to find it more difficult to estimate far-away future cash flows (and thus you will face more errors) than you will find it to estimate the appropriate discount rate demanded by investors today for far-away cash flows.

- In general: over the long-term estimating cash flows is more difficult than estimating r.

Questions 4.1.a

1. What is the main assumption that allows you to consider investment choices without regard to when you need wealth?
2. You have \$300, and you really want to go to the Superbowl tonight (which would consume all your cash). You cannot wait until your project completes: it would cost \$250 and offer a rate of return of 20%, although equivalent interest rates are only 15%. If the market is perfect, what should you do?

The Internal Rate of Return I

- An important alternative: Internal Rate of Return. Video 3.
- It tends to give similar recommendations and good intuition about projects. Why should we use it?
- Do you remember the rate of return? $r = \frac{C_1 - C_0}{C_0}$.
- How do you computer rates of return for projects with T payments in different periods?

The Internal Rate of Return II

(Or Yield to Maturity) Definition

IMPORTANT:

- The **internal rate of return** is the quantity **IRR**, which, given a complete set of cash flows, is the equation that solves the NPV formula set to zero,

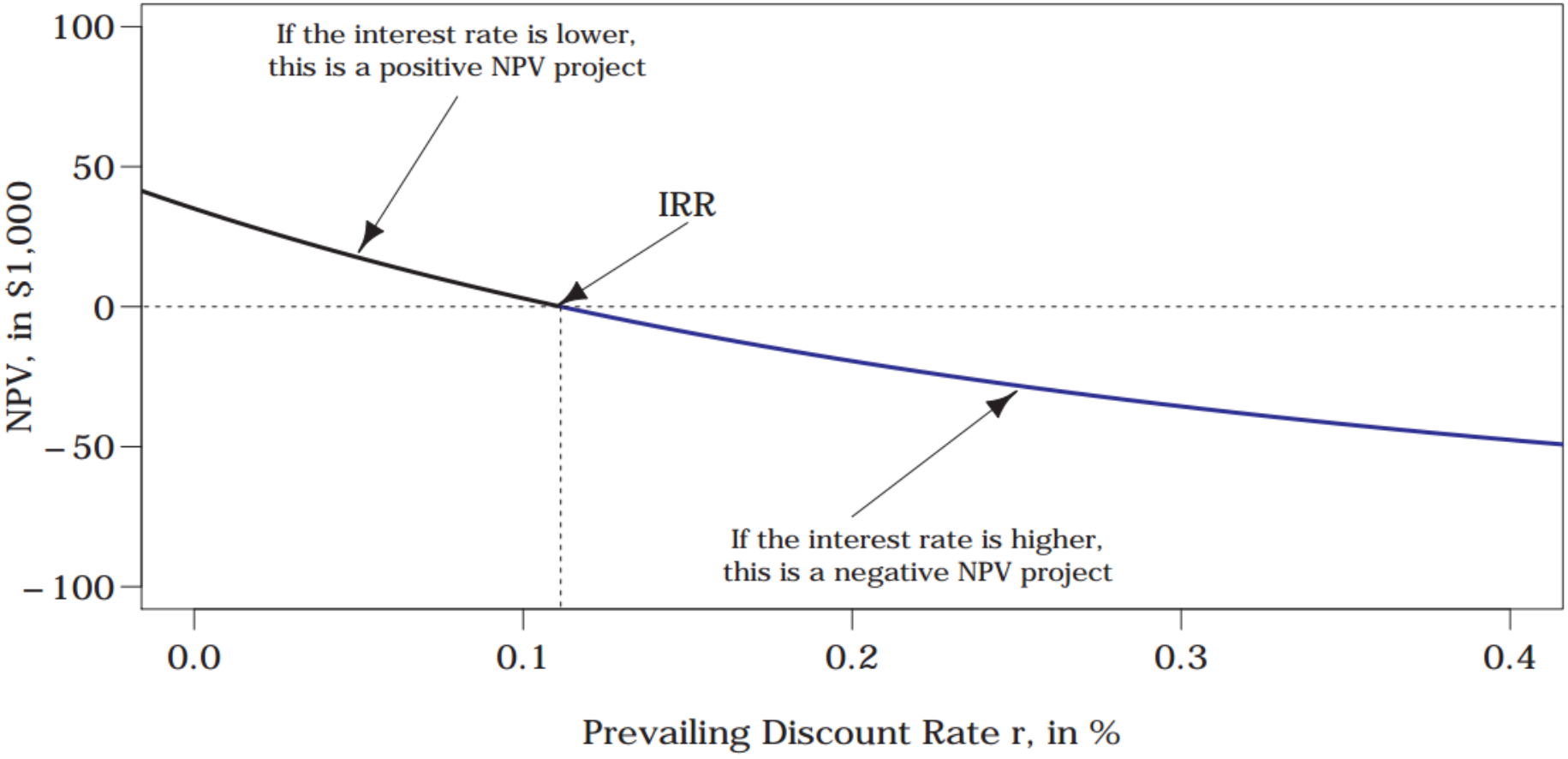
$$0 = C_0 + \frac{C_1}{1 + \text{IRR}} + \frac{C_2}{(1 + \text{IRR})^2} + \frac{C_3}{(1 + \text{IRR})^3} + \cdots \qquad (4.1)$$

- If there are only two cash flows, the IRR is the rate of return. Thus, the IRR generalizes the concept of rate of return to multiple cash flows. Every rate of return is an IRR, but the reverse is not the case.
- The IRR itself is best thought of as a characteristic of project cash flows.

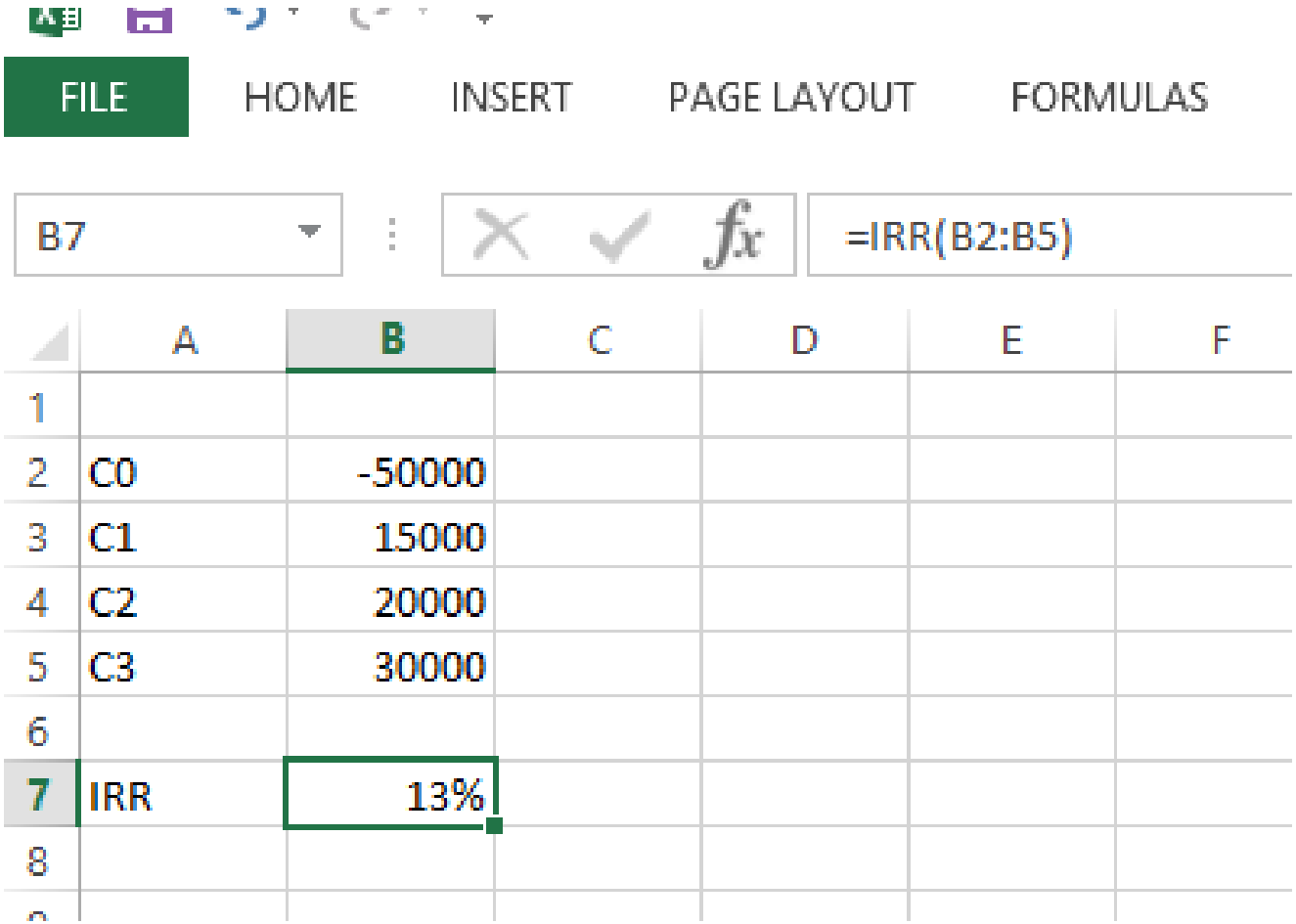
- You can think of the IRR as a sort of average rate of return embedded in the project's cash flows.

The IRR III

The relation between IRR and NPV: NPV as a function of the prevailing interest rate



Calculating IRR in a Computer Spreadsheet



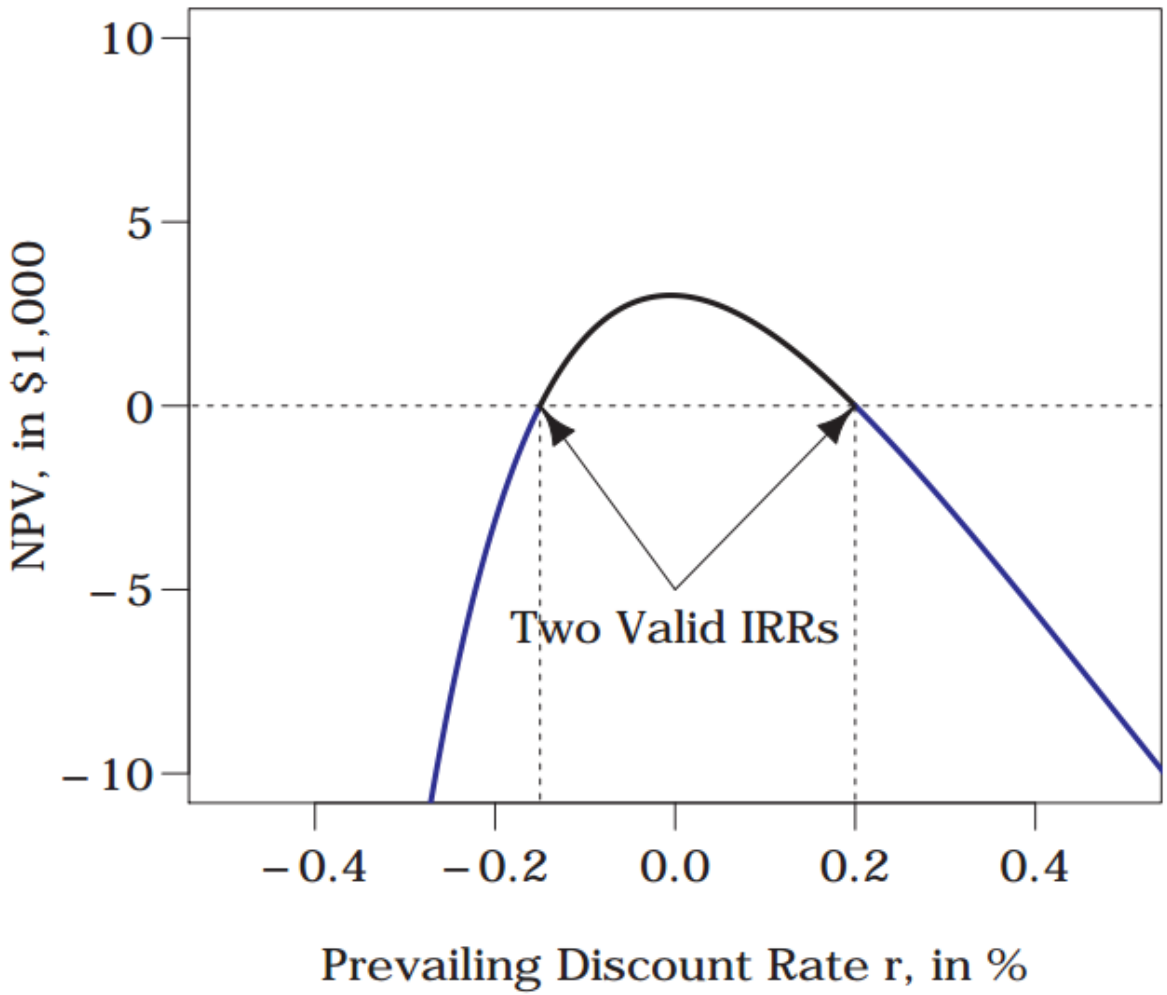
- Alternative for few periods: trial and error.

Questions 4.1.b

1. What is the IRR of a project that costs \$2,000 now and produces \$2,000 next year?
2. What is the IRR of a project that costs \$2,000 now and produces \$1,000 next year and \$1,000 the year after?
3. What is the YTM of a 5-year zero-bond that costs \$2,000 today and promises to pay \$3,222?
4. Compute the yield-to-maturity of a two-year bond that costs \$20,000 today and pays \$800 at the end of each of the two years. At the end of the second year, it also repays \$20,000.

Problems with IRR 1

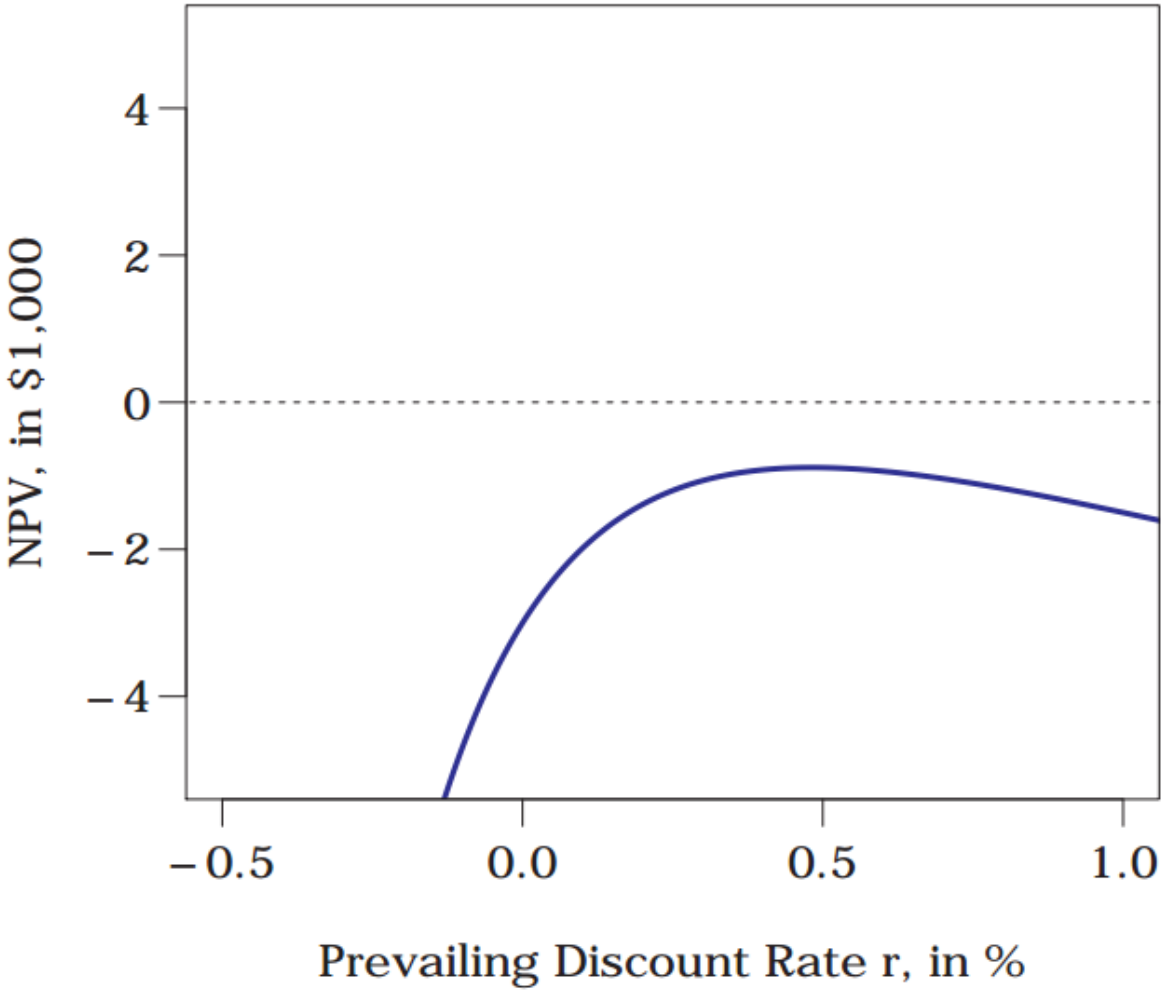
Projects with Multiple IRRs



- Attention! If multiple cash flows ∃, spreadsheet will give you only one! And not warning.

Problems with IRR 2

Projects without IRRs



- Generally obvious: do you want to take this project?

How to know if your project has a unique IRR

- When it has only:
  - A negative cash flow followed by positive ones (buying a machine).
  - A positive cash flow followed by negative ones (getting a mortgage).

IRR as a Capital-Budgeting Rule

The Hurdle Rate

IMPORTANT:

- The IRR capital budgeting rule states that if and only if an investment project's IRR (a characteristic of project cash flows) is above its appropriate discount rate (cost of capital), it should be taken. In this context, the cost of capital is often called the **hurdle rate**.

In many cases, the IRR capital budgeting rule gives the same correct answer as the NPV capital budgeting rule. However, there are some delicate situations in which this is not the case. This will be explained below.

Questions 4.1.d

1. A project has cash flows of -\$1,500, -\$2,500, +\$3,500, and +\$4,500 in consecutive years. Your cost of capital is 25% per annum. Use the IRR rule to determine whether you should take this project. Does the NPV rule recommend the same action? What if the cost of capital is 50% per annum?

Problems and advantages with IRR as Capital-Budgeting Rule

- Advantages:
  - It can be calculated before you know the appropriate r.
  - Useful in judging project profitability $\Rightarrow$ allows you to judge the performance of a manager: easier to hold her to her earlier promise of delievering IRR of 20% than to argue about the appropriate cost of capital for her project should be.
- Problems:
  - Need to make sure you get the sign of IRR right (not major problem). Use NPV as a check!
  - If the IRR is not unique: painful. If $r = 9\%$ and $IRR = 6\%,\ 8\%,\ 10\%$, should you take this project or not?
  - Even if unique:
    - ★ Misleading when projects are mutually exclusive: \$5 returning \$10 (IRR=100%) vs. \$1,000 returning \$1,100 (IRR=10%).
    - ★ Different costs of capital for long-run and short-run investments. Next chapter.
- If you have a project with multiple IRRs: use NPV!

Questions 4.1.e

- The prevailing interest rate is 20%. If the following two projects are mutually exclusive, which should you take? What does the NPV rule recommend? And IRR?

	Y0	Y1	Y2	Y3	Y4
A	+$50,000	–$250,000	+$467,500	–$387,500	+$120,120
B	–$50,000	+$250,000	–$467,500	+$387,500	–$120,120

- And among these two?

	Y0	Y1	Y2	Y3
A	+$500,000	–$200,000	–$200,000	–$200,000
B	+$50,000	+$25,000		

- Among these two, with a prevailing interest rate of the 8%?

	Y0	Y1	Y2
A	–$500	+$300	+$300
B	–$50	+$30	+$30
C	–$50	+$35	+$35

The Profitability Index

- It divides the present value of future cash flows by the project cost:

$$PI = \frac{PV}{C_0}$$

- When the first cash flow is a cash outflow: NPV>0 and PI>1 are equivalent rules.
- Advantage: gives information about NPV and relative performance.
- Disadvantage: the same one, for comparing projects really "likes" lower-upfront investment projects, as compared to NPV. (Same as IRR):
  - \$5 returning \$10 vs \$1000 returning \$1100.

Questions 4.1.f

- Given a prevailing interest rate of 8% and following the profitability rule, which project would you choose among these three?

	Y0	Y1	Y2
A	–\$500	+\$300	+\$300
B	–\$50	+\$30	+\$30
C	–\$50	+\$35	+\$35

- Compare the results under the three rules. Which one do you prefer and why?

The Payback Capital-Budgeting Rule

Why you should not fall for it

- "More practical" (or less theoretical) methods for making investing decisions: they usually result in bad choices. Eg:
- The payback rule: projects are better if you can recover their original investment faster.
- Advantages:
  - Easier for managers not trained in finance to understand: "you will get your money back in 2 years" than "the NPV is $2 million".
  - Helps firms set criteria when they do not trust their managers.
  - Entrepreneurs with limited capital and in -very- imperfect markets: you want your money back asap: assess your future liquidity.
  - When choice is pretty clear-cut: not huge mistakes.
- Disadvantages: it is wrong!

	Y1	Y2	Y3	Y4	Payback Period
A	–$5	+$8			1 year
B	–$5	+$4	$100		2 years
C	–$5	+$4	$0	$100,000	3 years

Again: how do CFOs decide:

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Summary

- NPV correct method to use if market if perfect and you have the correct inputs.
- In this context consumption and investment decisions can be made independently.
- IRR is computed from a project's cash flows by setting the NPV formula equal to zero.
- IRR does not depend on the prevailing cost of capital, it is project-specific.
- Projects can have multiple IRR solutions and no IRR solutions.
- The profitability index is often acceptable too.
- The payback measure, commonly used, is best avoided as a primary decision rule.
- NPV and IRR are the methods most popular with CFOs.

Keywords

CFO, payback rule, hurdle rate, IRR, profitability index, scenario analysis, sensitivity analysis, separation of decisions, YTM.