

CHAPTER

5

Net Present Value and Other Investment Rules

Key Concepts and Skills

- Be able to compute payback and discounted payback and understand their shortcomings
- Understand accounting rates of return and their shortcomings
- Be able to compute the internal rate of return and profitability index, understanding the strengths and weaknesses of both approaches
- Be able to compute the net present value and understand why it is the best decision criterion

Chapter Outline

5.0 Evaluation Criteria for Investment Rules

5.1 Why Use Net Present Value (NPV)?

5.2 The Payback Period Method

5.3 The Discounted Payback Period Method

The Average Accounting Return Method

5.4 The Internal Rate of Return

5.5 Problems with the IRR Approach

5.6 The Profitability Index

5.7 The Practice of Capital Budgeting

5.0 Evaluation Criteria for Decision Rules

- A. Consider ALL RELEVANT CASH FLOWS ; NOT accounting earnings.
- B. Recognize the time value of money.
- C. Discount cash flows at the appropriate required rate of return (or cost of capital).
- D. Select the most value creating project among mutually exclusive alternatives according to the value maximization objective of the firm.

Mutually Exclusive vs. Independent Project

- Mutually Exclusive Projects: only ONE of several potential projects can be chosen, e.g. acquiring an accounting system.
 - RANK all alternatives and select the best one.
- Independent Projects: accepting or rejecting one project does not affect the decision of the other projects.
 - Must exceed a MINIMUM acceptance criteria.

5.0 Information for Numerical Example

Here are the net cash flows (in \$M) of two projects:

Expected after-tax net cash flows

| Year (t) | Project S | Project L |
|----------|-----------|-----------|
| 0 | (9) | (9) |
| 1 | 7 | 2 |
| 2 | 4 | 4 |
| 3 | 2 | 8 |

Assume that the discount rate for both projects is 10%.

Determine whether one or both of these two projects are acceptable, and which one should be accepted, according to the various decision rules.


5.1 Why Use Net Present Value?

- Accepting positive NPV projects benefits shareholders.
 - WHY? Because $NPV > 0 \rightarrow$ the project is adding value to the company!
 - ✓ NPV uses cash flows
 - ✓ NPV uses all the cash flows of the project
 - ✓ NPV discounts the cash flows properly
- ✓ NPV provides a direct measure of how much the project is contributing to the firm's value
- Reinvestment assumption: the NPV rule assumes that all cash flows can be reinvested at the (appropriate) discount rate.

The Net Present Value (NPV) Rule

- How much value does this project add to the firm?
- Net Present Value (NPV) =
Total PV of future CF's + Initial Investment Outlay
(which is a cash outflow!)
- Estimating NPV:
 1. Estimate future cash flows: how much? and when?
 2. Estimate discount rate
 3. Estimate initial costs
- Minimum Acceptance Criteria: Accept if $NPV > 0$
- Ranking Criteria: Choose the highest $NPV > 0$

Calculating NPV with Spreadsheets

- Spreadsheets are an excellent way to compute NPVs, especially when you have to compute the cash flows as well. 
- Using the NPV function:
 - The first component is the required return entered as a decimal.
 - The second component is the range of cash flows *beginning with year 1*.
 - Add the initial investment after computing the NPV.

5.2 The Payback Period Method

- How long does it take the project to “pay back” its initial investment?
- Payback Period = number of years to recover initial costs
- Minimum Acceptance Criteria:
 - Set by management
- Ranking Criteria:
 - Set by management

The Payback Period Method

- Disadvantages:
 - Ignores the time value of money
 - Ignores cash flows after the payback period
 - Biased against long-term projects
 - Requires an arbitrary acceptance criteria
 - A project accepted based on the payback criteria may not have a positive NPV
- Advantages:
 - Easy to understand
 - Biased toward liquidity

5.3 The Discounted Payback Period

- How long does it take the project to “pay back” its initial investment, taking the time value of money into account?
- Decision rule: Accept the project if it pays back on a discounted basis within the specified time.
- By the time you have discounted the cash flows, you might as well calculate the NPV.

Average Accounting Return

$$\text{AAR} = \frac{\text{Average Net Income}}{\text{Average Book Value of Investment}}$$

- Another attractive, but fatally flawed, approach
- Ranking Criteria and Minimum Acceptance Criteria set by management

Average Accounting Return

- Disadvantages:
 - Ignores the time value of money
 - Uses an arbitrary benchmark cutoff rate
 - Based on accounting earnings and book values, not cash flows and market values
- Advantages:
 - The accounting information is usually available
 - Easy to calculate

5.4 The Internal Rate of Return

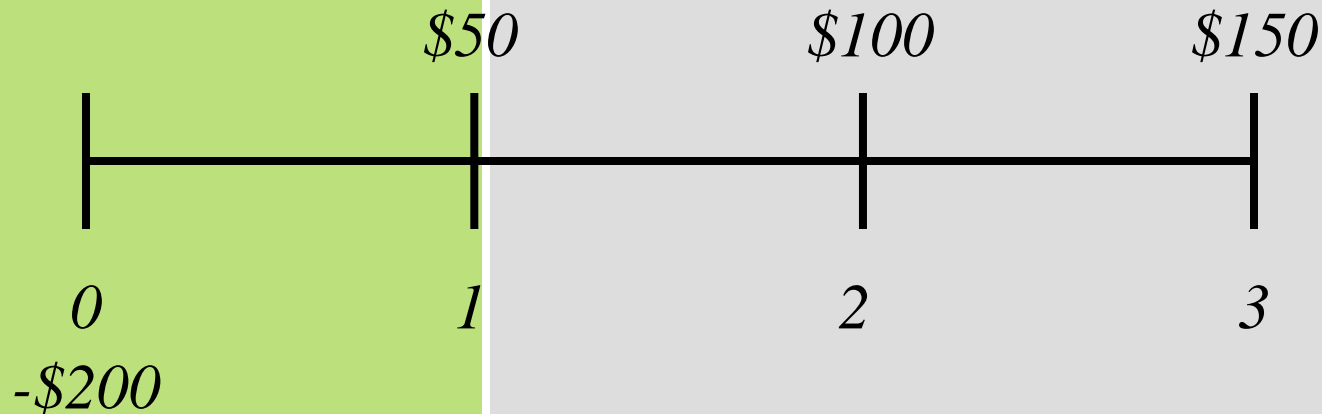
- How profitable is the project?
- IRR: the “magical” discount rate that sets NPV to zero; the return measure that is intrinsic to the project.
- Minimum Acceptance Criteria:
 - Accept if the IRR exceeds the required return (the cost of capital)
- Ranking Criteria:
 - Select alternative with the highest IRR that exceeds the required return (the cost of capital)
- Reinvestment assumption:
 - All future cash flows assumed reinvested at the IRR

Internal Rate of Return (IRR)

- Disadvantages:
 - Does not distinguish between investing and borrowing
 - IRR may not exist, or there may be multiple IRRs
 - Problems with mutually exclusive investments
 - Its ranking of projects does NOT guarantee the selection of the most value creating alternative!
- Advantages:
 - Easy to understand and communicate

IRR: Example

Consider the following project:



The internal rate of return for this project is 19.44%

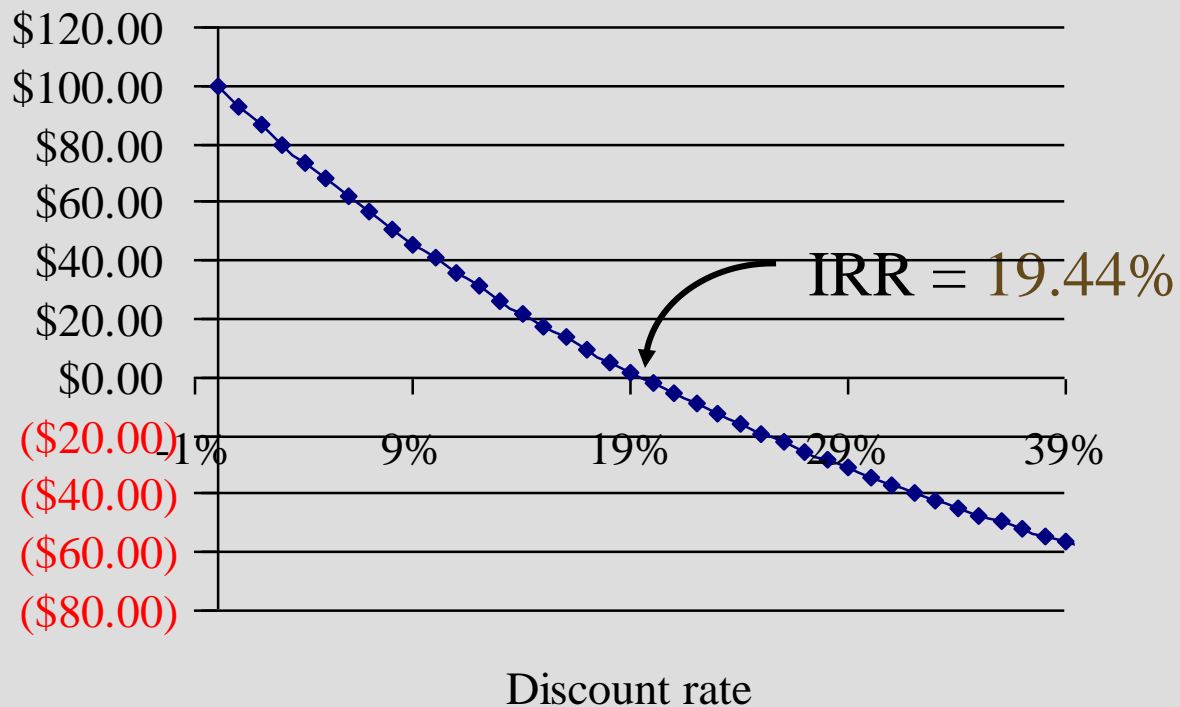
$$NPV = 0 = -200 + \frac{\$50}{(1 + IRR)} + \frac{\$100}{(1 + IRR)^2} + \frac{\$150}{(1 + IRR)^3}$$

NPV Payoff Profile

If we graph NPV versus the discount rate, we can see the IRR as the x-axis intercept.

| | |
|-----|-----------|
| 0% | \$100.00 |
| 4% | \$73.88 |
| 8% | \$51.11 |
| 12% | \$31.13 |
| 16% | \$13.52 |
| 20% | (\$2.08) |
| 24% | (\$15.97) |
| 28% | (\$28.38) |
| 32% | (\$39.51) |
| 36% | (\$49.54) |
| 40% | (\$58.60) |
| 44% | (\$66.82) |

NPV



Calculating IRR with Spreadsheets

- You start with the cash flows the same as you did for the NPV.
- You use the IRR function:
 - You first enter your range of cash flows, beginning with the initial cash flow.
 - You can enter a guess, but it is not necessary.
 - The default format is a whole percent – you will normally want to increase the decimal places to at least two.



5.5 Problems with IRR

◆ Multiple IRRs

- ◆ A project may have multiple IRRs when its cash flows change sign more than once in its entire life.
 - ◆ One IRR for each change in sign!

◆ Are We Borrowing or Lending?

- ◆ For Borrowing, accept a project if $IRR < \text{discount rate}$

◆ The Scale Problem

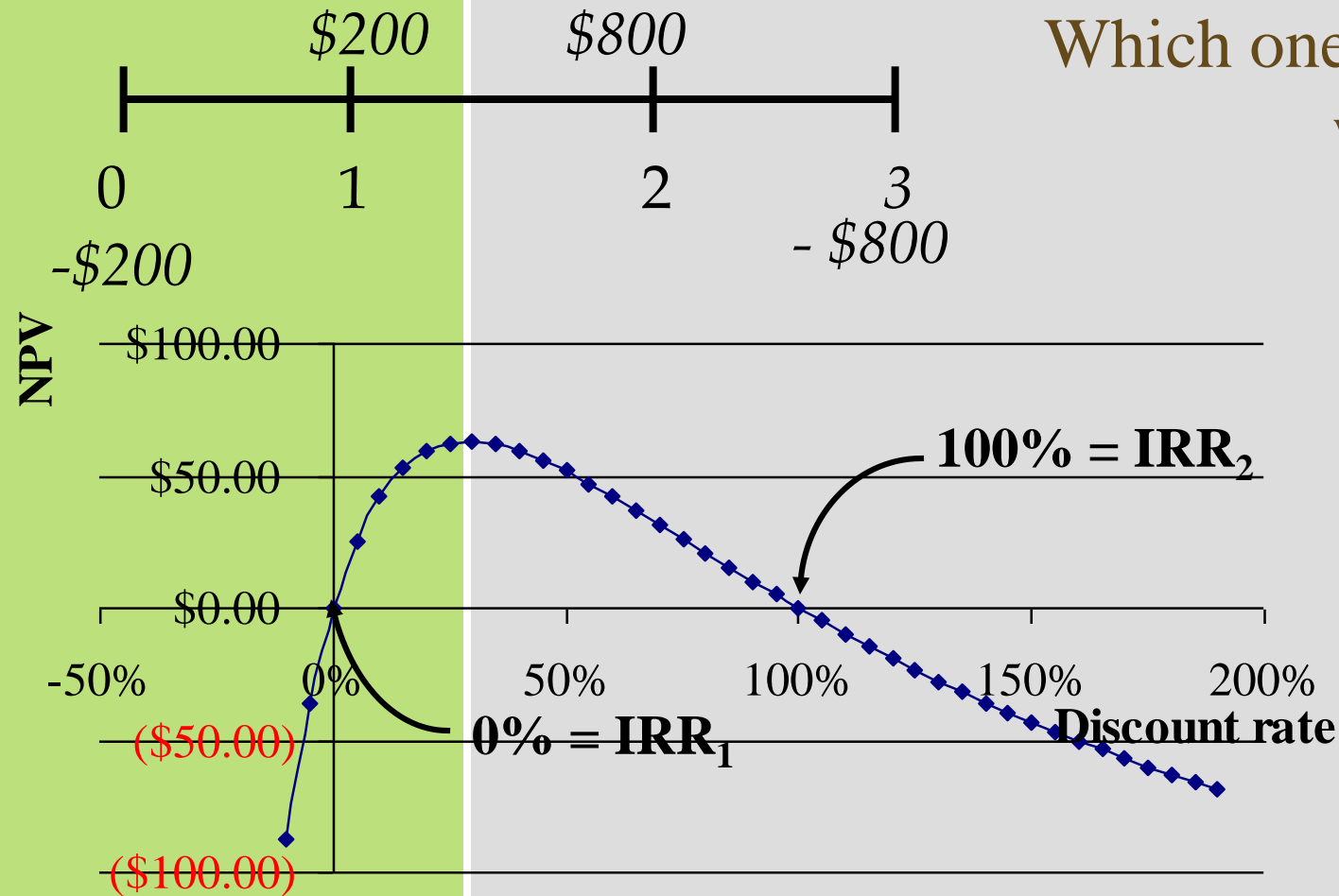
- ◆ In favor of smaller projects

◆ The Timing Problem

- ◆ In favor of projects that have most of their cash inflows coming in early, i.e., ‘earlier’ projects.

Multiple IRRs

There are two IRRs for this project:

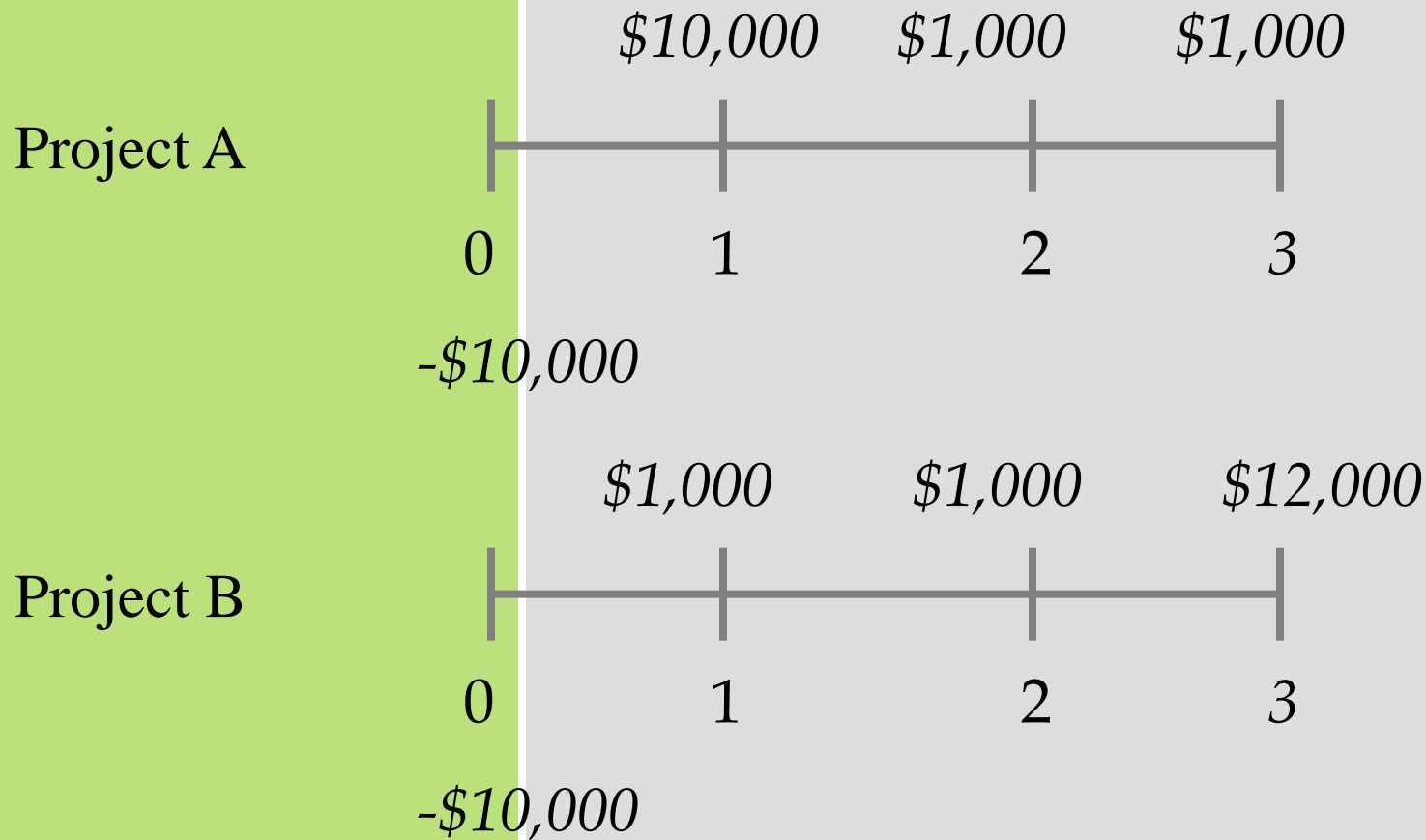


The Scale Problem

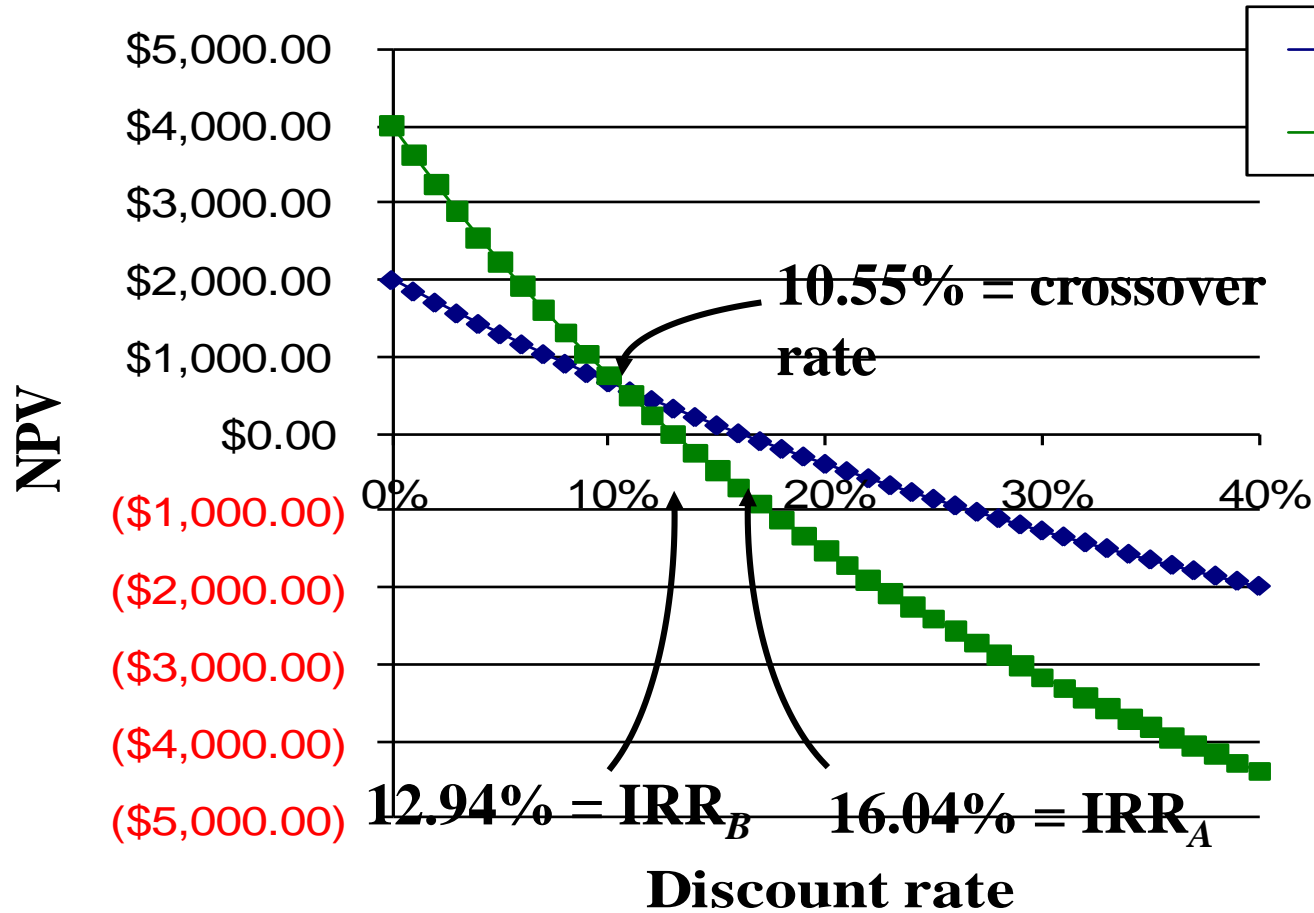
Would you rather make 100% or 50% on your investments?

What if the 100% return is on a \$1 investment, while the 50% return is on a \$1,000 investment?

The Timing Problem



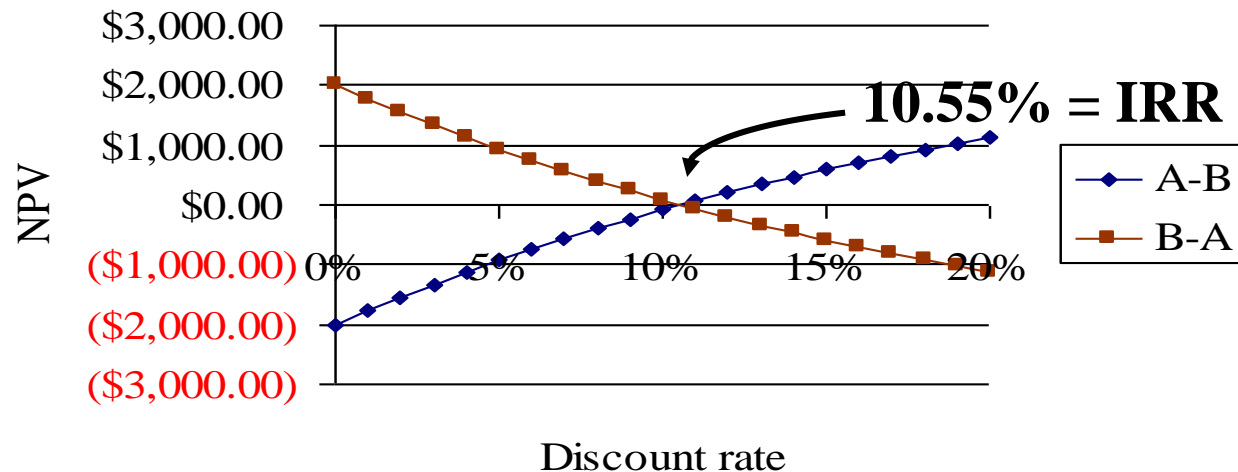
The Timing Problem



Calculating the Crossover Rate

Compute the IRR for either project “A-B” or “B-A”

| Year | Project A | Project B | Project A-B | Project B-A |
|------|------------|------------|-------------|-------------|
| 0 | (\$10,000) | (\$10,000) | \$0 | \$0 |
| 1 | \$10,000 | \$1,000 | \$9,000 | (\$9,000) |
| 2 | \$1,000 | \$1,000 | \$0 | \$0 |
| 3 | \$1,000 | \$12,000 | (\$11,000) | \$11,000 |



Resolving Scale and Timing Problems

- Always apply the NPV rule on original projects.
- Apply NPV and IRR rules to incremental projects
 - For Scale Problem: an incremental project is constructed by subtracting the cash flow stream of the smaller project from that of the larger project
 - Accept the larger project over the smaller project if the incremental project is acceptable per NPV and IRR rules!
 - For Timing Problem: an incremental project is usually constructed by subtracting the cash flow stream of the 'earlier' project from that of the 'later' project such that the first nonzero cash flow is negative
 - Accept the 'later' project over the 'earlier' project if the incremental project is acceptable per NPV and IRR rules!

Modified IRR (McKinsey's Approach)

- Two-Step Procedures -
- First, calculate the total value of all non-initial cash flows using the appropriate discount rate (or cost of capital).
- Second, find the “discount rate” that equates the total value of all non-initial cash flows with the initial cash flow.
- Address the IRR problems concerning multiple IRRs and mutually exclusive projects with timing differences.

NPV versus IRR

- NPV and IRR will generally give the same decision.
- Exceptions:
 - Non-conventional cash flows – cash flow signs change more than once
 - Mutually exclusive projects
 - Initial investments are substantially different
 - Timing of cash flows is substantially different

5.6 The Profitability Index (PI)

$$PI = \frac{\text{Total PV of Future Cash Flows}}{\text{Initial Investent}}$$

- Minimum Acceptance Criteria:
 - Accept if $PI > 1$
- Ranking Criteria:
 - Select alternative with highest PI

The Profitability Index

- Disadvantages:
 - Problems with mutually exclusive investments
- Advantages:
 - May be useful when available investment funds are limited
 - Easy to understand and communicate
 - Correct decision when evaluating independent projects

5.7 The Practice of Capital Budgeting (Ref.: JACF 2002)

- Varies by industry:
 - Some firms use payback, others use accounting rate of return.
- The most frequently used technique for large corporations is IRR or NPV.

Example of Investment Rules

Compute the IRR, NPV, PI, and payback period for the following two projects. Assume the required return is 10%.

| Year | Project A | Project B |
|------|-----------|-----------|
| 0 | -\$200 | -\$150 |
| 1 | \$200 | \$50 |
| 2 | \$800 | \$100 |
| 3 | -\$800 | \$150 |

Example of Investment Rules

| | Project A | Project B |
|----------------------|-----------|-----------|
| CF_0 | -\$200.00 | -\$150.00 |
| PV_0 of CF_{1-3} | \$241.92 | \$240.80 |
| NPV = | \$41.92 | \$90.80 |
| IRR = | 0%, 100% | 36.19% |
| PI = | 1.2096 | 1.6053 |

Example of Investment Rules

Payback Period:

| Time | <i>Project A</i> | | <i>Project B</i> | |
|------|-------------------------|---------|-------------------------|---------|
| | CF | Cum. CF | CF | Cum. CF |
| 0 | -200 | -200 | -150 | -150 |
| 1 | 200 | 0 | 50 | -100 |
| 2 | 800 | 800 | 100 | 0 |
| 3 | -800 | 0 | 150 | 150 |

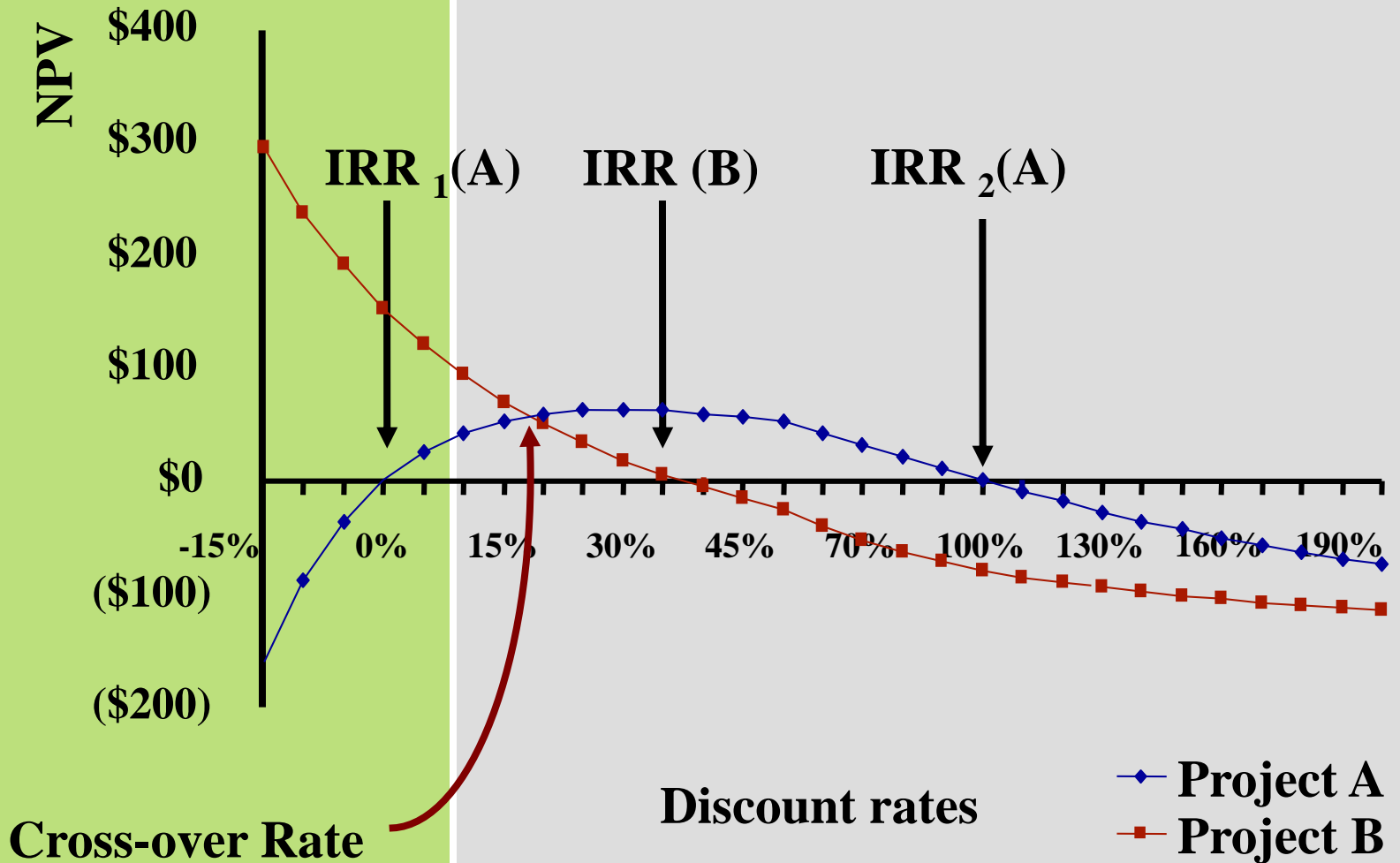
Payback period for project B = 2 years.

Payback period for project A = 1 or 3 years?

NPV and IRR Relationship

| <u>Discount rate</u> | <u>NPV for A</u> | <u>NPV for B</u> |
|----------------------|------------------|------------------|
| -10% | -87.52 | 234.77 |
| 0% | 0.00 | 150.00 |
| 20% | 59.26 | 47.92 |
| 40% | 59.48 | -8.60 |
| 60% | 42.19 | -43.07 |
| 80% | 20.85 | -65.64 |
| 100% | 0.00 | -81.25 |
| 120% | -18.93 | -92.52 |

NPV Profiles



Summary – Discounted Cash Flow

- Net present value
 - Difference between market value and cost
 - Accept the project if the NPV is positive
 - Has no serious problems
 - Preferred decision criterion
- Internal rate of return
 - Discount rate that makes $NPV = 0$
 - Take the project if the IRR is greater than the required return
 - Same decision as NPV with conventional cash flows
 - IRR is unreliable with non-conventional cash flows or mutually exclusive projects
- Profitability Index
 - Benefit-cost ratio
 - Take investment if $PI > 1$
 - Cannot be used to rank mutually exclusive projects
 - May be used to rank projects in the presence of capital rationing

Summary – Payback Criteria

- Payback period
 - Length of time until initial investment is recovered
 - Take the project if it pays back in some specified period
 - Does not account for time value of money, and there is an arbitrary cutoff period
- Discounted payback period
 - Length of time until initial investment is recovered on a discounted basis
 - Take the project if it pays back in some specified period
 - There is an arbitrary cutoff period

Summary – Accounting Criterion

- Average Accounting Return
 - Measure of accounting profit relative to book value
 - Similar to return on assets measure
 - Take the investment if the AAR exceeds some specified return level
 - Serious problems and should not be used

Quick Quiz

- Consider an investment that costs \$100,000 and has a cash inflow of \$25,000 every year for 5 years. The required return is 9%, and payback cutoff is 4 years.
 - What is the payback period?
 - What is the discounted payback period?
 - What is the NPV?
 - What is the IRR?
 - Should we accept the project?
- What method should be the primary decision rule?
- When is the IRR rule unreliable?