Net Present Value and Other Investment Rules

http://www2.gsu.edu/~fnccwh/pdf/rwjch5v3overview.pdf

Key Concepts and Skills

- Be able to compute payback, internal rate of return, profitability index, and net present value, understanding the strengths and weaknesses of each approach
- Understand why net present value is the best decision criterion
- Not responsible for discounted payback and unlikely to be tested on MIRR

Chapter Outline

5.1 Why Use Net Present Value?
5.2 The Payback Period Method
5.3 The Discounted Payback Period 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

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 and Modified 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
  - PI is unreliable with non-conventional cash flows

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

Mutually Exclusive vs. Independent

- 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
Normal Versus Non-Normal Cash Flows
- Normal = Only a single sign change
  - + + + +
  - - + + +
- Non-Normal = More than one sign change
  - + + + -
  - - + + -

Acceptable Criteria
- Normal and Independent
  - NPV, IRR, PI, MIRR
- Non-Normal and Independent
  - NPV, PI, MIRR
- Normal and Mutually Exclusive
  - NPV
- Non-normal and Mutually Exclusive
  - NPV

5.1 Why Use Net Present Value?
- Accepting positive NPV projects benefits shareholders.
  - NPV uses cash flows
  - NPV uses all the cash flows of the project
  - NPV discounts the cash flows properly

The Net Present Value (NPV) Rule
- Net Present Value (NPV) = Total PV of future CF’s + Initial Investment
- 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

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

5.4 The Internal Rate of Return
- IRR: the discount rate that sets NPV to zero
- Minimum Acceptance Criteria:
  - Accept if the IRR exceeds the required return
- Ranking Criteria:
  - Select alternative with the highest IRR
  - Reinvestment assumption:
    - All future cash flows are assumed to be 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
- **Advantages:**
  - Easy to understand and communicate

**IRR: Example**

Consider the following project:

<table>
<thead>
<tr>
<th>Time</th>
<th>Cash Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-200</td>
</tr>
<tr>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>150</td>
</tr>
</tbody>
</table>

The internal rate of return for this project is 19.44%

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

**NPV Payoff Profile**

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

**5.5 Problems with IRR**

- Multiple IRRs
- Are We Borrowing or Lending
- The Scale Problem
- The Timing Problem

**Multiple IRRs**

There are two IRRs for this project:

- IRR₁ = 0%
- IRR₂ = 100%

Which one should we use?

**Modified IRR**

- Calculate the net present value of all cash outflows using the borrowing rate.
- Calculate the net future value of all cash inflows using the investing rate.
- Find the rate of return that equates these values.
- Benefits: single answer and specific rates for borrowing and reinvestment
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

<table>
<thead>
<tr>
<th>Project A</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>$10,000</td>
<td>$1,000</td>
<td>$1,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$10,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project B</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>$10,000</td>
<td>$1,000</td>
<td>$12,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$10,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The Timing Problem

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)

\[
\text{PI} = \frac{\text{Total PV of Future Cash Flows}}{\text{Initial Investment}}
\]

- Can also be written as
  - PI = (NPV/ Initial Investment) + 1

Minimum Acceptance Criteria:

- Accept if PI > 1

Ranking Criteria:

- Select alternative with highest PI

Example of Investment Rules

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

<table>
<thead>
<tr>
<th>Year</th>
<th>Project A</th>
<th>Project B</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-$200</td>
<td>-$150</td>
</tr>
<tr>
<td>1</td>
<td>$200</td>
<td>$50</td>
</tr>
<tr>
<td>2</td>
<td>$800</td>
<td>$100</td>
</tr>
<tr>
<td>3</td>
<td>-$800</td>
<td>$150</td>
</tr>
</tbody>
</table>
Example of Investment Rules

<table>
<thead>
<tr>
<th>Project</th>
<th>Project A</th>
<th>Project B</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_0$</td>
<td>-$200.00</td>
<td>-$150.00</td>
</tr>
<tr>
<td>$PV_0$</td>
<td>$241.92</td>
<td>$240.80</td>
</tr>
<tr>
<td>NPV</td>
<td>$41.92</td>
<td>$90.80</td>
</tr>
<tr>
<td>IRR</td>
<td>0%, 100%</td>
<td>36.19%</td>
</tr>
<tr>
<td>PI</td>
<td>1.2096</td>
<td>1.6053</td>
</tr>
</tbody>
</table>

Payback Period:

<table>
<thead>
<tr>
<th>Time</th>
<th>Project A</th>
<th>Project B</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-200</td>
<td>-200</td>
</tr>
<tr>
<td>1</td>
<td>200</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>800</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>-800</td>
<td>150</td>
</tr>
</tbody>
</table>

Payback period for project B = 2 years.
Payback period for project A = 1 or 3 years?

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