CAPITAL BUDGETING

Net Present Value and Other Investment Criteria
Net Present Value (NPV)

• *Net present value* is the difference between an investment’s market value (in today’s dollars) and its cost (also in today’s dollars).

• Net present value is a measure of how much value is created by undertaking an investment.

• Estimation of the future cash flows and the discount rate are important in the calculation of the NPV.
Net Present Value

Steps in calculating NPV:

• The first step is to estimate the expected future cash flows.
• The second step is to estimate the required return for projects of this risk level.
• The third step is to find the present value of the cash flows and subtract the initial investment.
NPV Illustrated

<table>
<thead>
<tr>
<th>Time (t)</th>
<th>Initial Outlay</th>
<th>Revenues</th>
<th>Expenses</th>
<th>Cash Flow</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-$1100.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>$1000</td>
<td>500</td>
<td>$500</td>
<td>+454.55</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>$2000</td>
<td>1000</td>
<td>$1000</td>
<td>+826.45</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$181.00</td>
</tr>
</tbody>
</table>

NPV = $181.00
NPV

• An investment should be accepted if the NPV is positive and rejected if it is negative.

• NPV is a direct measure of how well the investment meets the goal of financial management—to increase owners’ wealth.

• A positive NPV means that the investment is expected to add value to the firm.
Payback Period

- The amount of time required for an investment to generate cash flows to recover its initial cost.

- Estimate the cash flows.

- Accumulate the future cash flows until they equal the initial investment.

- The length of time for this to happen is the payback period.

- An investment is acceptable if its calculated payback is less than some prescribed number of years.
# Payback Period Illustrated

Initial investment = −$1000

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$200</td>
</tr>
<tr>
<td>2</td>
<td>400</td>
</tr>
<tr>
<td>3</td>
<td>600</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$200</td>
</tr>
<tr>
<td>2</td>
<td>600</td>
</tr>
<tr>
<td>3</td>
<td>1200</td>
</tr>
</tbody>
</table>

Payback period = 2 2/3 years
Advantages of Payback Period

- Easy to understand.
- Adjusts for uncertainty of later cash flows.
- Biased towards liquidity.
Disadvantages of Payback Period

• Time value of money and risk ignored.

• Arbitrary determination of acceptable payback period.

• Ignores cash flows beyond the cut-off date.

• Biased against long-term and new projects.
Discounted Payback Period

• The length of time required for an investment’s discounted cash flows to equal its initial cost.

• Takes into account the time value of money.

• More difficult to calculate.

• An investment is acceptable if its discounted payback is less than some prescribed number of years.
Example—Discounted Payback

Initial investment = $1000
R = 10%

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash flow</th>
<th>PV of Cash flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$200</td>
<td>$182</td>
</tr>
<tr>
<td>2</td>
<td>400</td>
<td>331</td>
</tr>
<tr>
<td>3</td>
<td>700</td>
<td>526</td>
</tr>
<tr>
<td>4</td>
<td>300</td>
<td>205</td>
</tr>
</tbody>
</table>
Example—Discounted Payback (continued)

<table>
<thead>
<tr>
<th>Year</th>
<th>Discounted cash flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$182</td>
</tr>
<tr>
<td>2</td>
<td>513</td>
</tr>
<tr>
<td>3</td>
<td>1039</td>
</tr>
<tr>
<td>4</td>
<td>1244</td>
</tr>
</tbody>
</table>

Discounted payback period is just under three years
Ordinary and Discounted Payback

Initial investment = –$300
$R = 12.5$

<table>
<thead>
<tr>
<th>Year</th>
<th>Undiscounted</th>
<th>Discounted</th>
<th>Undiscounted</th>
<th>Discounted</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$100</td>
<td>$89</td>
<td>$100</td>
<td>$89</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
<td>79</td>
<td>200</td>
<td>168</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
<td>70</td>
<td>300</td>
<td>238</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
<td>62</td>
<td>400</td>
<td>300</td>
</tr>
<tr>
<td>5</td>
<td>100</td>
<td>55</td>
<td>500</td>
<td>355</td>
</tr>
</tbody>
</table>

• Ordinary payback?
• Discounted payback?
Advantages and Disadvantages of Discounted Payback

- **Advantages**
  - Includes time value of money
  - Easy to understand
  - Does not accept negative estimated NPV investments
  - Biased towards liquidity

- **Disadvantages**
  - May reject positive NPV investments
  - Arbitrary determination of acceptable payback period
  - Ignores cash flows beyond the cutoff date
  - Biased against long-term and new products
Accounting Rate of Return (ARR)

- Measure of an investment’s profitability.

\[ ARR = \frac{\text{average net profit}}{\text{average book value}} \]

- A project is accepted if ARR > target average accounting return.
# Example—ARR

<table>
<thead>
<tr>
<th></th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Sales</td>
<td>$440</td>
</tr>
<tr>
<td>Expenses</td>
<td>220</td>
</tr>
<tr>
<td>Gross profit</td>
<td>220</td>
</tr>
<tr>
<td>Depreciation</td>
<td>80</td>
</tr>
<tr>
<td>Taxable income</td>
<td>140</td>
</tr>
<tr>
<td>Taxes (25%)</td>
<td>35</td>
</tr>
<tr>
<td>Net profit</td>
<td>$105</td>
</tr>
</tbody>
</table>

Assume initial investment = $240
Example—ARR (continued)

Average net profit = \frac{\$105 + \$30 + \$0}{3} = \$45

Average book value = \frac{\text{Initial investment} + \text{Salvage value}}{2} = \frac{\$240 + \$0}{2} = \$120
Example—ARR (continued)

\[
ARR = \frac{\text{Average net profit}}{\text{Average book value}} = \frac{\$45}{\$120} = 37.5\%
\]
Disadvantages of ARR

• The measure is not a ‘true’ reflection of return.

• Time value is ignored.

• Arbitrary determination of target average return.

• Uses profit and book value instead of cash flow and market value.
Advantages of ARR

- Easy to calculate and understand.
- Accounting information almost always available.
Internal Rate of Return (IRR)

• The discount rate that equates the present value of the future cash flows with the initial cost.

• Generally found by trial and error.

• A project is accepted if its IRR is > the required rate of return.

• The IRR on an investment is the required return that results in a zero NPV when it is used as the discount rate.
Example—IRR

Initial investment = −$200

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash flow</th>
</tr>
</thead>
<tbody>
<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>

Find the IRR such that NPV = 0

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

\[
200 = \frac{50}{(1+IRR)^1} + \frac{100}{(1+IRR)^2} + \frac{150}{(1+IRR)^3}
\]
*Example—IRR (continued)*

**Trial and Error**

<table>
<thead>
<tr>
<th>Discount rates</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>$100</td>
</tr>
<tr>
<td>5%</td>
<td>68</td>
</tr>
<tr>
<td>10%</td>
<td>41</td>
</tr>
<tr>
<td>15%</td>
<td>18</td>
</tr>
<tr>
<td>20%</td>
<td>–2</td>
</tr>
</tbody>
</table>

IRR is just under 20%—about **19.44%**
NPV Profile

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>- $275</td>
</tr>
<tr>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
</tr>
</tbody>
</table>

**Discount rate**

2%  6%  10%  14%  18%  22%

**Net present value**

120  100  80  60  40  20  0  -20  -40

Discount rate

IRR 18%

Qafqaz University • Economics and Administrative Sciences • Finance Department
http://fi.qu.edu.az/~faliyev
Problems with IRR

- More than one negative cash flow → multiple rates of return.

- Project is not independent → mutually exclusive investments. Highest IRR does not indicate the best project.

Advantages of IRR

- Popular in practice
- Does not require a discount rate
## Multiple Rates of Return

Assume you are considering a project for which the cash flows are as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash flows</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>−$252</td>
</tr>
<tr>
<td>1</td>
<td>1431</td>
</tr>
<tr>
<td>2</td>
<td>−3035</td>
</tr>
<tr>
<td>3</td>
<td>2850</td>
</tr>
<tr>
<td>4</td>
<td>−1000</td>
</tr>
</tbody>
</table>
Multiple Rates of Return

What’s the IRR? Find the rate at which the computed NPV = 0:

- at 25.00%: \( \text{NPV} = 0 \)
- at 33.33%: \( \text{NPV} = 0 \)
- at 42.86%: \( \text{NPV} = 0 \)
- at 66.67%: \( \text{NPV} = 0 \)

Two questions:

1. What’s going on here?
2. How many IRRs can there be?
Multiple Rates of Return

NPV

Discount rate

IRR = 25%
IRR = 33.33%
IRR = 42.86%
IRR = 66.67%
IRR and Non-conventional Cash Flows

- When the cash flows change sign more than once, there is more than one IRR.
- When you solve for IRR you are solving for the root of an equation and when you cross the x axis more than once, there will be more than one return that solves the equation.
- If you have more than one IRR, you cannot use any of them to make your decision.
IRR, NPV and Mutually-exclusive Projects

- **Discount rate**
  - 2%
  - 6%
  - 10%
  - 14%
  - 18%

- **Net present value**
  - 60
  - 40
  - 20
  - 0
  - -20
  - -40
  - -60
  - -80

- **Year**
  - 0
  - 1
  - 2
  - 3
  - 4

- **Project A**
  - Initial investment: -$350
  - Cash flows: 50, 100, 150, 200

- **Project B**
  - Initial investment: -$250
  - Cash flows: 125, 100, 75, 50

- **Crossover Point**

- **IRR**
  - \( IRR_A \)
  - \( IRR_B \)

- **IRR**
  - 22%

- **Qafqaz University • Economics and Administrative Sciences • Finance Department**
  - http://fi.qu.edu.az/~faliyev
Present Value Index (PVI)

• Expresses a project’s benefits relative to its initial cost.

\[
PVI = \frac{PV \text{ of inflows}}{\text{Initial cost}}
\]

• Accept a project with a PVI > 1.0.
Example—PVI

Assume you have the following information on Project X:

Initial investment = –$1100  Required return = 10%

Annual cash revenues and expenses are as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Revenues</th>
<th>Expenses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$1000</td>
<td>$500</td>
</tr>
<tr>
<td>2</td>
<td>2000</td>
<td>1000</td>
</tr>
</tbody>
</table>
Example—PVI (continued)

\[
NPV = \frac{500}{1.10} + \frac{1000}{(1.10)^2} - 1100 \\
= \$181
\]

\[
PVI = \frac{181 + 1100}{1100} \\
= 1.1645
\]

Net Present Value Index
\[
= \frac{181}{1100} \\
= 0.1645
\]
Example—PVI (continued)

Is this a good project? If so, why?

• *This is a good project because the present value of the inflows exceeds the outlay.*

• *Each dollar invested generates $1.1645 in value or $0.1645 in NPV.*
Advantages and Disadvantages of PVI (and NPVI)

• Advantages
  - Closely related to NPV, generally leading to identical decisions.
  - Easy to understand.
  - May be useful when available investment funds are limited.

• Disadvantages
  - May lead to incorrect decisions in comparisons of mutually exclusive investments.
We should consider several investment criteria when making decisions.

- NPV and IRR are the most commonly used primary investment criteria.

- Payback is a commonly used secondary investment criteria.