Capital Budgeting
and
Cost Analysis
Two Dimensions of Cost Analysis

- period-by-period dimension
- project-by-project dimension

- Capital budgeting deals with the project-by-project dimension
  - Projects are analyzed over their entire life span
  - Analysis is typically based on cash flows
Stages of Capital Budgeting

- **Stage 1: Identification Stage**
  - Which types of investments are necessary?
- **Stage 2: Search Stage**
  - Explore alternative investments
- **Stage 3: Information Acquisition Stage**
  - Consider costs and benefits
- **Stage 4: Selection Stage**
  - Choose projects to be implemented
- **Stage 5: Financing Stage**
  - Obtain necessary funding
- **Stage 6: Implementation and Control Stage**
  - Implement projects and monitor performance
Capital Budgeting Methods

- Net Present Value (NPV)
- Internal Rate of Return (IRR)
- Payback
- Accrual Accounting Rate of Return (AARR)

NPV and IRR are Discounted Cash Flow (DCF) Methods
- Analysis is based on Cash Flows
- Time Value of money is taken into consideration
Investment Project - Replacement decision

- **Old Machine**
  - Useful life: 3 years
  - Depreciation per period: 10,000
  - Book value: 30,000
  - Cash flow from disposing old machine (after tax): 12,000

- **New Machine**:
  - Useful life: 3 years
  - Cost: 210,000
  - Additional working capital needs: 10,000
  - Depreciation per period: 70,000
  - Cost savings per period: 90,000 (after tax)
  - Estimated terminal disposal value: 0

- **Applied Discount Rate**: 0.10
Net Present Value method

- Decision Rule: Replace the old machine if the NPV of the replacement is positive:

\[
NPV = -208,000 + \frac{90,000}{1.1} + \frac{90,000}{1.1^2} + \frac{100,000}{1.1^3} = 23,329.83
\]

- NPV is consistent in the sense that the NPV is positive if and only if the investment increases the firm value.

- Problems occur when NPV is used to compare projects with different useful lifes !!!!
Example- Second Option

- **New Machine:**
  - Useful life: 6 years
  - Cost: 372000
  - Additional working capital needs: 10,000
  - Depreciation per period: 62,000
  - Cost savings per period: 90,000
  - Estimated terminal disposal value: 0

\[
NPV = -370,000 + \frac{90,000}{1.1} + ... + \frac{100,000}{1.1^6} = 27,618.2
\]

- Does that mean option 2 is preferable???

\[
2 \cdot NPV1 = -208,000 + \frac{90,000}{1.1} + \frac{90,000}{1.1^2} - \frac{120,000}{1.1^3} ... - \frac{100,000}{1.1^6} = 31,842.09
\]
Annuity

- Definition: An Annuity is the constant payment that can be received from an investment project with some given NPV.
- The annuity of a project with positive (negative) NPV is always positive (negative).
  - A project with positive annuity increases firm value.
- Annuity:
  \[ An = NPV \times \frac{r(1+r)^n}{(1+r)^n - 1} \]

- Replacement example: Annuity of net cash savings
  \[ An = 23,329.83 \times \frac{0.1 \cdot 1.1^3}{1.1^3 - 1} = 9,381.27 \quad NPV(cash\ savings) = 23,329.83 \]
Internal Rate of Return

- IRR is the discount rate that makes NPV=0

\[
NPV = 0 = -208,000 + \frac{90,000}{1 + IRR} + \frac{90,000}{(1 + IRR)^2} + \frac{100,000}{(1 + IRR)^3}
\]

- IRR=16.15%

- Easy calculations only in special cases:
  - CF are constant and useful life $n \rightarrow \infty$
  - CF are constant and useful life is $n=2$

- Decision rule: Choose replacement if IRR> RRR=0.1

- If the alternative is to either replace the old machine or to keep it (do nothing), IRR-Method and NPV-Method lead to identical decisions
Problems with IRR

- Choice of alternative projects:

\[
NPV_2 = -100,000 + \frac{45,000}{1.1} + \frac{45,000}{1.1^2} + \frac{45,000}{1.1^3} = 11,908.34
\]

\[
IRR_2 = 16.65\%
\]

\[
NPV_1 = 23,329.83 \quad IRR_1 = 16.15\%
\]

- IRR-Method leads to sub-optimal decision!!
- There can be more than one IRR if some of the CF are negative
- There might be only a complex IRR
Payback Method

- Measures the time it will take to recoup the initial investment in a project.
- Uniform Cash Flows
  
  \[
  \text{Payback period} = \frac{\text{Net initial Investment}}{\text{Uniform increase in annual future cash flow}}
  \]

- Highlights liquidity issues.
- Reflects increasing uncertainty over time.
- Main weaknesses:
  - Does not consider payments after the payback period.
  - Fails to incorporate time value of money.
Payback Method with Nonuniform Cash Flows

- Replacement example:

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash savings</th>
<th>Net Investment unrecovered at year end</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>208,000</td>
</tr>
<tr>
<td>1</td>
<td>90,000</td>
<td>118,000</td>
</tr>
<tr>
<td>2</td>
<td>90,000</td>
<td>28,000</td>
</tr>
</tbody>
</table>

\[
\text{Payback period} = 2 + \frac{28,000}{100,000} = 2.28
\]

- Simplifying assumption: cash savings occur uniformly throughout the final year
Accrual accounting Rate-of-Return Method

- Devides an accrual accounting measure of annual average income of a project by an accrual accounting measure of its investment

\[ AARR = \frac{\text{Increase in expected average annual after – tax operating income}}{\text{Net initial Investment}} \]

- Replacement example:

\[ AARR = \frac{90,000 - 60,000}{208,000} = 0.1442 \]
Accrual accounting Rate-of-Return Method

- **Problems:**
  - Similar to IRR a rate-of-return percentage is calculated
  - All weaknesses of the IRR persist
  - In addition time value of money is not considered
- **Accounting numbers are used rather than cash flows**
  - Easy to get from the accounting system
  - Due to timing differences in profit and loss recognition versus cash flows interest effects occur that lead to misspecification
  - Decisions made based on AARR possibly wrong
  - If manager’s are evaluated based on accounting profits AARR may be relevant for investment decisions though it does not maximize firm value
Relevant Cash Flows

- Which cash flows are relevant in making an investment decision?
- Relevant cash flows are the differences in expected future cash flows if an investment is made
- Two alternatives:
  - Estimate future cash flows with and without the investment under consideration and compare the results
  - Calculate the differences in a first step and determine the NPV of these differences
Replacement Example Continued:

- Additional information:
  - Applicable tax rate is 20%
  - Operating cash flow savings before tax are 97,500
  - Tax effects of cash in- and outflows occur at the same time as the cash flows themselves (simplifying assumption)

<table>
<thead>
<tr>
<th></th>
<th>Old machine</th>
<th>New machine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase price</td>
<td>-</td>
<td>210,000</td>
</tr>
<tr>
<td>Current book value</td>
<td>30,000</td>
<td>-</td>
</tr>
<tr>
<td>Current disposal value</td>
<td>7,500</td>
<td>-</td>
</tr>
<tr>
<td>Terminal disposal value</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual depreciation</td>
<td>10,000</td>
<td>70,000</td>
</tr>
<tr>
<td>Working capital required</td>
<td>5,000</td>
<td>15,000</td>
</tr>
</tbody>
</table>
Relevant After-Tax Flows: Differential Approach

- First Step:
  - Determine changes in net income per year from undertaking the replacement:

  Savings in costs: 97,500
  - Additional depreciation: 60,000
  Increase in operating income: 37,500
  - Income taxes: 7,500
  Increase in operating net income: 30,000

- Income effects are relevant as they determine tax effects!!!
Relevant After-Tax Flows: Differential Approach

- Categories of cash flows:
  - Net initial investment
    - Initial machine investment
    - Initial working capital investment
    - After tax cash flow from disposal of old machine
  - After tax cash flow from operations
    - Annual after-tax cash flow from operations
    - Income tax cash savings from annual depreciation deductions
  - After tax cash flow from terminal disposal
    - After tax cash flow from terminal disposal of machine
    - After tax cash flow from terminal recovery of working-capital investment
## Relevant After-Tax Flows: Differential Approach

<table>
<thead>
<tr>
<th>t</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>210,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial machine investment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial working capital investment</td>
<td>10,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>After tax cash flow from disposal</td>
<td>12,000*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net initial investment</td>
<td>208,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual after tax cash flow from operations</td>
<td>78,000**</td>
<td>78,000</td>
<td>78,000</td>
<td></td>
</tr>
<tr>
<td>Income tax savings from additional depreciation</td>
<td>12,000***</td>
<td>12,000</td>
<td>12,000</td>
<td></td>
</tr>
<tr>
<td>After tax cash flow recovering working capital</td>
<td></td>
<td></td>
<td></td>
<td>10,000</td>
</tr>
<tr>
<td>Total relevant cash flows</td>
<td>208,000</td>
<td>90,000</td>
<td>90,000</td>
<td>100,000</td>
</tr>
</tbody>
</table>
Relevant After-Tax Flows: Differential Approach

* Cash flow from disposal of old machine:
  - Sales price: 7,500
  - Tax savings: (7,500-30,000)0.2=4,500
  - Sales price+Tax savings=12,000

**After tax cash flow from operations:
  - Cost savings before tax: 97,500
  - Tax on cost savings:0.2*97,500=19,500
  - Cost savings after tax: 97,500-19,500=78,000

***Tax savings from additional depreciation:
  - 0.2*60,000=12,000
Strategic considerations in Capital Budgeting

- A machine replacement is an operating rather than a strategic decision
- Financial aspects drive such decisions
- Strategic capital budgeting decisions implement the firm’s strategy
  - Whether to invest in a new industry
  - Whether to invest in a new product line
  - Whether to invest in new technology
- For such decisions a broader range of factors need to be considered and long term effects need to be estimated
Rusty Pipe is considering a new capital investment. The following information is available on the investment. The cost of the machine will be $150,000. The annual cost savings if the new machine is acquired will be $40,000. The machine will have a 5-year life, at which time the terminal disposal value is expected to be $20,000. Rusty Pipe is assuming no tax consequences. If Rusty Pipe has a required rate of return of 10%, what is the net present value of the project?

- $1,604
- $12,418
- $14,050
- $150,000
True or False

- Managers using deferred cash flow methods to make capital budgeting decisions make the same decisions that they would make in using the accrual accounting rate-of-return methods.

- In determining whether to keep a machine or replace it, the original cost of the machine is always a relevant factor.

- The accrual accounting rate of return is the method that looks most like the information in the financial statements.