Chapter 9: Benefit/Cost Analysis and Public Sector Economics

Session 25
Dr Abdelaziz Berrado
Topics to Be Covered in Today’s Lecture

Section 9.1: Public Sector Analysis
Section 9.2: Benefit Cost Analysis
Section 9.3: Alternative Selection
Section 9.4: Multiple Alternatives

Using the B/C Ratio Approach
Section 9.1: Public Sector Projects

- Public Sector:
  - Ownership – by citizens- the public

- Public Sector Projects:
  - Provide needed services to the public at “no profit”
9.1 Types of Projects

• Hospitals
• Parks and recreation facilities
• Highways, Dams, Bridges
• Courts, schools, prisons
• Public Housing
• Many other types
## 9.1 Characteristics - compared

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Public Sector</th>
<th>Private Sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size of Investment</td>
<td>Larger</td>
<td>Some Large; medium to small</td>
</tr>
<tr>
<td>Life Estimates</td>
<td>Quite Long 30 – 50 years</td>
<td>Shorter: 2-25 years</td>
</tr>
<tr>
<td>Annual Cash Flow estimates</td>
<td>No Profit: costs and benefits and disbenefits are estimated</td>
<td>Revenues – profit cost estimates</td>
</tr>
</tbody>
</table>
9. 1 Attributes

• Public Sector Projects do not have “profits”
• Projects can have certain undesirable consequences associated—Should be estimated in monetary terms.
• Thus, can be controversial in nature
• Draw media attention – debated on pros and cons
9. 1 Estimating for Public Projects COSTS

• Basic elements for public projects:
  • Costs
    • Construction, operations, maintenance less any expected salvage values
    • Initial costs fairly well know
    • Future O&M are less known and must be estimated
9.1 Estimating: Benefits

- **BENEFITS** to the public (users) must be estimated in terms of periodic dollar values.
- Very difficult to do.
- Benefits = the advantage's to the public stated in $$
- Owners – generally the public
9.1 Estimating **DISBENEFITS**

- **Disbenefits**
  - Expected undesirable (negative) consequences to the owners (public)
  - Assuming the project is undertaken
  - May be indirect economic disadvantages to the public
  - Very hard to estimate and convert to $ amounts
9.1 General Principle

For public projects we find:

It is very difficult to estimate and reach agreement on the economic impacts of benefits and disbenefits for public sector projects.
## 9. 1 Funding Sources - compared

<table>
<thead>
<tr>
<th>Characteristic</th>
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<th>Private Sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Funding</td>
<td>Taxes, fees, bonds, Private funds</td>
<td>Sale of new stock, bonds, loans, Returns earnings</td>
</tr>
<tr>
<td>Interest Rate</td>
<td>Tends to be lower</td>
<td>Higher: At market cost</td>
</tr>
</tbody>
</table>
9.1 Funding Public Projects

- Generally low interest charges
- Public entities do not pay taxes
- Project investments basically backed by public agencies
- Cost sharing arrangements often exist
- Less perceived risk with public projects
9. 1 Determination of an Interest Rate

• Determined differently than in the private sector
• Called the social discount rate
• Discount rate often in range of 4% to 8% per year
• For Federal Projects a current working rate (2001) is 10% per year
9. 1 Additional Comparisons

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<tr>
<th>Characteristic</th>
<th>Public Sector</th>
<th>Private Sector</th>
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</thead>
<tbody>
<tr>
<td>Selection Criteria</td>
<td>Multiple criteria</td>
<td>Rate of Return or Present Value</td>
</tr>
<tr>
<td>Environment of the evaluation</td>
<td>Political Arena (debated, pressure groups)</td>
<td>Primarily economic</td>
</tr>
</tbody>
</table>
9.1 Selection Process

• Not as “clean” as in the private sector
• Involves interest and pressure groups
• Often draw media attention
• Involve many different viewpoints
9. 1 Evaluation Process

•The viewpoint finally adopted will:
  •Determine the estimates of..
    •Costs
    •Benefits
    •Disbenefits
•Thus, the viewpoint must be established before the economic evaluation
9.1 See Example 9.1

- This is a common problem
- Define the viewpoints
- A given viewpoint will drive the analysis
- Multiple views = multiple results!
- Read Example 9.1
Section 9.2: B/C Analysis – Single Project

- **Historical Point**
  - B/C analysis philosophy was instituted and promoted in 1936 in the US.
  - Relied upon as a fundamental analysis method for public sector projects
  - Introduced to promote a sense of objectivity in an analysis
9.2 B/C Formulations

• Assignable life, N - years
• Estimate costs ($)
• Estimate benefits in ($)
• Estimate disbenefits in ($)
• Assign an interest rate – i (%/year)
9.2 B/C formulations

• Then convert all amounts to either a
  • Present Worth - PW(i\%)  
• Annual Worth – AW(i\%)

• Then calculate a B/C ratio in one of three ways…..
9. 2 B/C Ratios: 3 formats

• **Three acceptable formats are:**

\[
B / C = \frac{PW (benefits)}{PW (costs)} = \frac{AW (benefits)}{AW (costs)} = \frac{FW (benefits)}{FW (costs)}
\]
9.2 Notes regarding signs

• By convention:
  • Revenues are assigned (+) signs
  • Costs are assigned (+) signs
  • Salvage values are subtracted from costs
  • Disbenefits are treated in more than one way
9. 2 Handling Disbenefits

1. Disbenefit values are subtracted from benefits
2. Disbenefit values are added to costs
3. Either approach will result in a consistent analysis – but be consistent throughout an analysis
9. 2 Decision Rule

- IF B/C ratio (=>) 1.00
  - Accept the alternative
- IF B/C ratio (<) 1.00, reject the alternative
- IF B/C ratio “close” to 1.00 then intangible factors may sway the decision to accept or reject
9.2 Conventional B/C Ratio

- The conventional B/C Ratio is:

\[ \frac{B}{C} = \frac{\text{Benefits} - \text{disbenefits}}{\text{Costs}} = \frac{B - D}{C} \]
9. 2 Modified B/C Ratio

- Modified B/C subtracts the Maintenance and operations costs in the numerator

\[
\frac{B}{C}_{\text{modified}} = \frac{\text{Benefits} - \text{disbenefits-M&O costs}}{\text{Costs}}
\]
9. 2 Convention vs. Modified?

• It makes no difference which approach is used

• However, the ratio values will differ (magnitude)

• But, the same absolute (accept/reject) decision will be the same
9. 2 Benefit-Cost Difference

• B-C Cost difference is not a ratio
• B-C cost difference is:
  • (Benefits – Costs) (as a PW or AW)
• The “B” represents the *Net Benefit*
  • Benefits - Disbenefits
9. 2  See Example 9-2

• Applies all three approaches to the same problem situation
  • B/C = 0.51 (reject)
  • Mod B/C = 0.39 (reject)
  • (B-C) = $-1.24 million (< 0…reject)

• Result: Same decision with varying magnitudes of the ratio
9.2 Example 9.3

• Given two alternatives
  • Bypass construction
  • Upgrade construction
• Note: Unequal lives .. use AW
• i is set to 8%
• Read at home
9.2 Example 9.3, continued

• Conventional B/C – Bypass = 1.17
• Conventional B/C – Upgrade = 1.13
• Both B/C ratios are > 1
• Both proposal are economically justified at 8%
• Which one would you select?
9. 2 Uncertain Discount Rate (??)

- What if the value of “i” is uncertain?
- Apply a spreadsheet analysis and play “what-if)
- What if federal funds are available for the upgrade and a 4% rate is applied to that option?
- Changing discount rates can impact on the ratio for that alternative!
Section 9.3: Alternative Selection using Incremental Analysis: 2 Alternatives

• This approach is similar to the material in chapter 8

• Requires a proper ordering of the alternatives

• Order alternatives on the basis of *Total Costs*
9. 3 Rank on Total Costs - Rules

1. Determine total **equivalent costs** for both alternatives;

2. Order by total costs: Smaller first then larger

Calculate the incremental cost for the larger alternative = $(\Delta C)$ – be the denominator in the B/C ratio
9. 3 $\Delta(B/C)$ Approach

3. For both alternatives determine:

- Total equivalent benefits and disbenefits.

- Calculate the $\Delta B$ for the larger cost alternative or $\Delta(B-D)$ if disbenefits are involved.

4. Calculate the $\Delta\{(B-D)/C\}$ ratio.
9. 3 $\Delta(B/C)$ Approach

5. If $\Delta(B/C)\ (=>)\ 1.00$ go with the higher cost alternative

else,

Go with lower cost alternative!
9. 3 Important Point

• If one is using a PW to determine equivalency, then you must have an equal life model or lowest common multiple of lives.

• Or, apply the annual worth on a typical cycle for the alternatives and the *repeatability assumption* applies.
Section 9. 4: Incremental B/C for Multiple Projects

• Select from three or more mutually exclusive alternatives

• Same approach as that in Chapter 8, Section 8.6

• Remember, the *Do Nothing* alternative always exists and should be evaluated as an alternative.
9. 4 Steps for Multiple Incremental Analysis

1. Using either PW or AW determine the total equivalent cost for all options. If unequal lives, apply AW

2. Create the rankings based upon lowest to highest total cost of the alternatives

3. Determine the total equivalent net benefits for each alternative
9. 4 Steps - continued

4. The lowest cost option is the first Defender and the next higher cost alternative is the first challenger

Compute the B/C ratio on the increment

If B/C < 1, eliminate the Challenger else eliminate the Defender.

Current winner becomes new Defender
9. 4 Multiple Alternatives….

5. Compare the new defender to the next higher cost challenger and repeat the analysis.

6. Continue through the alternative until there are no more challengers.

7. The last “champion” is the winner
9.4 Example 9.5

- 4 Alternatives \{1, 2, 3, and 4\}
- Ranked on total cost as shown
- Analysis Summary:
  - \((2-1) \frac{B}{C} = 2.24\) … Go with \{2\}
  - \((3-2) \frac{B}{C} = 0.62\) … Reject 3, stay with \{2\}
  - \((4-2) \frac{B}{C} = 1.83\) Go with 4, final winner
Assignments and Announcements

- Assignments for Chapter 9
  - Online Quizzes for chapter 9