Session 2.2
Project Alternatives, Least Cost and Cost Effectiveness Analyses

Introductory Course on Economic Analysis of Investment Projects
30 June 2009
Cost Effectiveness Analysis - 1

- An appraisal and program monitoring technique used primarily in social programs and projects
  - Example:
    Health, nutrition and education where identification and quantification of benefits in money terms is not straightforward but, at the same time, the desirability of the activity is not in question.

- The objective is to compare costs per unit of outcome of two programs for purposes of capital budgeting
Cost Effectiveness Analysis - 2

This approach is very useful where aim is to choose from a set of alternative technologies and approaches that will provide the same service.

Examples:

- Choosing from two school systems that give same educational benefits
  - Centralized schools that require bus transportation and more expensive smaller schools to which students can walk
- Two systems of electricity generation
  - Thermal versus hydro
- Two types of court systems with same disposal of cases
  - More court rooms at the headquarters or mobile courts
- Choosing amongst alternative ways of supplying potable water to communities
- Two or more kinds of health treatment to save lives
Cost Effectiveness Analysis - 3

- Cost effectiveness analysis involves a series of steps similar to those of a normal investment appraisal except that the benefits are not measured as monetary values, but as quantitative impacts.
- The focus is on evaluating the costs of the alternatives.
- Comparison of economic costs of alternatives - cost per unit outcome of a program.
Cost effectiveness Analysis Can be Used in Two Forms:

Method 1: Constant Effects

- Uses least-cost analysis to determine the lowest cost alternative for meeting the same level of benefits.
- Example:
  - choosing from two water pipes of different sizes that yield the same quality of water per day (smaller pipe has lower investment cost but higher operating or pumping costs)
  - Selecting from two alternatives for generating the same amount of electricity (thermal and hydro generation units, the former with a lower investment and higher operating cost compared to the latter)
Discounting

- Addresses value of time
- Discount factor in year $t$
- $DF_t = \frac{1}{(1 + i)^t}$
- Reduces future values of costs and benefits
- Calculated simply in Excel
  =$\text{npv}(\text{guess}, \text{values1}..\text{n})$
## Case 1

### Least Cost Method

#### Drinking Water: Alternative Delivery System

<table>
<thead>
<tr>
<th></th>
<th>Years</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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</thead>
<tbody>
<tr>
<td><strong>Installation Cost</strong></td>
<td></td>
<td>3000</td>
<td></td>
<td></td>
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<tr>
<td><strong>Operating Cost</strong></td>
<td></td>
<td>700</td>
<td>700</td>
<td>700</td>
<td>700</td>
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<td>700</td>
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<tr>
<td><strong>Total Cost</strong></td>
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<td>3000</td>
<td>700</td>
<td>700</td>
<td>700</td>
<td>700</td>
<td>700</td>
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<tr>
<td><strong>PV of Total Cost (at 12%)</strong></td>
<td></td>
<td>$4,932</td>
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**Alternative B**

<table>
<thead>
<tr>
<th></th>
<th>Years</th>
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<th>1</th>
<th>2</th>
<th>3</th>
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<th>5</th>
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<td>4200</td>
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<tr>
<td><strong>Operating Cost</strong></td>
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<td>400</td>
<td>400</td>
<td>400</td>
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<td>400</td>
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<td><strong>PV of Total Cost (at 12%)</strong></td>
<td></td>
<td>$5,037</td>
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</table>
Method 2: Cost-Effectiveness Ratio

- Calculates the cost per unit of benefit
  - Example:

  *Benefits are simply measured as effectiveness (the number of Premature Deaths Prevented)*

  - Two different health programs: DPT-BCG vaccination campaign for children or AIDS treatment program.
  - The cost per child vaccination and per patient will be computed in this case. Here the purpose is to see which programs yield more value per dollar of expenditure.
## Case 2
### Cost of health Project: Immunization Against DPT and BCG

<table>
<thead>
<tr>
<th>Year</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premature Deaths Prevented</td>
<td>-</td>
<td>8000</td>
<td>12000</td>
<td>18000</td>
<td>25000</td>
<td>30000</td>
</tr>
</tbody>
</table>

### Capital Costs

<table>
<thead>
<tr>
<th>Item</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilities</td>
<td>2500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipments</td>
<td>8500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicles</td>
<td>5000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Training</td>
<td>2000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TA</td>
<td>6000</td>
<td></td>
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</table>

### Recurrent Costs

<table>
<thead>
<tr>
<th>Item</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personnel</td>
<td>10000</td>
<td>16000</td>
<td>25000</td>
<td>36000</td>
<td>42500</td>
<td></td>
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<tr>
<td>Supplies</td>
<td>15000</td>
<td>24000</td>
<td>37500</td>
<td>55000</td>
<td>64000</td>
<td></td>
</tr>
<tr>
<td>Training</td>
<td>500</td>
<td>800</td>
<td>1250</td>
<td>1800</td>
<td>2100</td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td>2000</td>
<td>3200</td>
<td>4500</td>
<td>7200</td>
<td>8000</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>3300</td>
<td>5500</td>
<td>8200</td>
<td>12000</td>
<td>14500</td>
<td></td>
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<tr>
<td><strong>Total Costs</strong></td>
<td>24000</td>
<td>30800</td>
<td>49500</td>
<td>76450</td>
<td>112000</td>
<td>131100</td>
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</table>

### PV of Total Benefits

| PV of Total Benefits | 12% | 62,431.00 |

### PV of Total Costs

| PV of Total Costs | 12% | $259,771.77 |

### Cost per unit of Premature Deaths Prevented

| Cost per unit of Premature Deaths Prevented | $4.16 |
# Case 3

## Cost of Health Project: AIDS Program

<table>
<thead>
<tr>
<th>Year</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premature Deaths Prevented</td>
<td>-</td>
<td>8000</td>
<td>12000</td>
<td>18000</td>
<td>25000</td>
<td>30000</td>
</tr>
</tbody>
</table>

### Capital Costs

- Facilities: 200
- Equipments: 1000
- Vehicles: 300
- Training: 500
- TA: 1500

### Recurrent Costs

- Personnel: 2000, 2500, 4000, 5000, 6000
- Supplies: 40000, 65000, 90000, 120000, 150000
- Training: 100, 100, 100, 100, 100
- Maintenance: 250, 300, 450, 600, 800
- Others: 300, 500, 800, 1250, 1500

### Total Costs

- 3500, 42650, 68400, 95350, 126950, 158400

### PV of Total Benefits

- 12%: 62,431.99

### PV of Total Costs

- 12%: $298,692.95

### Cost per unit of Deaths Prevented

- $4.78
Incremental (or Marginal) Cost-Effectiveness Ratio

- The decision makers need to compute marginal cost-effectiveness ratios.
- This need arises when a new alternative is compared with existing situation.
- The numerator now contains the difference between the cost of the new and old alternatives, and the denominator is also the difference between the effectiveness of the new and old alternatives:

\[
\text{Marginal CE}_i = \frac{C_i - C_0}{E_i - E_0}
\]

- This ratio can be interpreted as the incremental cost per unit of effectiveness. When there are several alternatives available, the marginal cost-effectiveness ratio can be used to rank the new measures versus the existing one.
Case 4
Marginal Cost-Effectiveness Ratios in Prevention of Traffic Fatalities

<table>
<thead>
<tr>
<th>Policy Measures</th>
<th>Total Lives Saved</th>
<th>Incremental Effectiveness (Deaths Prevented in a Year)</th>
<th>Total Cost (M $)</th>
<th>Incremental Cost (Rand per Year) (M $)</th>
<th>Marginal CE Ratios ($)</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing</td>
<td>500</td>
<td>20.0</td>
<td>20.0</td>
<td>40,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B Existing plus Enforcement</td>
<td>600</td>
<td>100</td>
<td>25.5</td>
<td>5.5</td>
<td>55,000</td>
<td>2</td>
</tr>
<tr>
<td>C Existing plus Road Safety</td>
<td>1000</td>
<td>500</td>
<td>31.5</td>
<td>11.5</td>
<td>23,000</td>
<td>1</td>
</tr>
<tr>
<td>D Existing plus Public Campaign</td>
<td>585</td>
<td>85</td>
<td>25.0</td>
<td>5.0</td>
<td>58,824</td>
<td>3</td>
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</tbody>
</table>
Limitations of CEA

1. Does not measure WTP
   - Cost-effectiveness ratios are a poor measure of consumers’ WTP.
   - The taxpayers, most probably, would be happy to pay for additional number of deaths prevented on the roads, as a measure of effectiveness.
   - What is the WTP for additional “drug addicts treated’?
   - The number of addicts treated may not be the best approximation of the value of the final outcome.
   - The link between the intermediate measure of effectiveness and final output, such as reduction in crime, is not explicitly stated.
   - Faced with this kind of situation, the analyst must make sure that this link is properly established.
Limitations of CEA

2. Excludes some external benefits

- The concept of cost-effectiveness analysis excludes most externalities on the benefit side.
- An improvement in education will not only increase lifetime earnings of the students but also likely to contribute to a reduction in the rates of unemployment and crime.
- In healthcare, there are external benefits due to such treatments as the vaccination of children, i.e., other people do not catch the infectious diseases.
- If a complete cost-benefit analysis does not seem possible, the analyst doing the evaluation should be careful not to exclude important benefits arising from a particular project.
3. Excludes some external costs

- While computing the cost-effectiveness ratio for a particular project, attention should be paid to the treatment of costs, which may include not only financial but also social costs.

- In the education sector, the enhancement of primary schooling is sometimes viewed in terms of the additional number of school blocks and improvement of their physical condition. Many other costs must be included to get the desired outcome.

- Different types of projects often have some of the costs in non-monetary terms, such as waiting time, coping costs, enforcement costs, regulatory costs, compliance costs, etc.

- The economic cost-effectiveness analysis carried out for such projects must account for all costs, and should also be based on the economic instead of financial prices of goods and services.
Limitations of CEA

4. Does not account for scale of project
   - Scale difference may distort the choice of an “optimal” decision.
   - A project with smaller size but higher efficiency level may get accepted, while another project may provide more quantity of output at a reasonable cost.
   - A strict cost effectiveness analysis fails to overcome this problem.
   - A complete cost benefit analysis does not have this problem because the net present value already accounts for the difference in size among alternatives.
Scale and implicit valuation

- Alternative A costs $1 mill saves 10 lives
- Alternative B costs $ 0.4 mill saves 5 lives
- A = $0.1 mill/life and B = 0.08 mill/life
- But accepting B means saving $0.6 mill at cost of 5 lives or $0.12 per life.
Thank you.