Prioritization of Climate Change Adaptation Options

The Role of Cost-Benefit Analysis

Session 7: Conducting CBA Step 6

Accra (or nearby), Ghana
October 25 to 28, 2016
Step 1: Define the scope of analysis.
Step 2: Identify all potential physical impacts of the project.
Step 3: Quantify the predicted impacts: With and without project.
Step 4: Monetize impacts.
Step 5: Discount to find present value of costs and benefits.
Step 6: Calculate net present value.
Step 7: Perform expected value and/or sensitivity analysis.
Step 8: Make recommendations.
Step 6: Calculate net present value

Net Present Value:

Net Present Value = PV of Benefits – PV of Costs

\[ \sum_{t=0}^{\infty} \frac{B_t}{(1 + r)^t} - \sum_{t=0}^{\infty} \frac{C_t}{(1 + r)^t} \]

\[ \sum_{t=0}^{\infty} \frac{(B_t - C_t)}{(1 + r)^t} \]

Decision rule:

Project is good if NPV is positive; or

Choose project (or option) with the largest NPV.
Different calculation: Internal rate of return

IRR is the value of the discount rate such that:

\[
\sum_{t=0}^{\infty} \frac{(B_t - C_t)}{(1 + \lambda)^t} = 0
\]

Decision rule:

If \( \lambda \) \( r \) then this is a good project;
If \( \lambda \) \( r \) then this is a bad project;
Choose the project with the largest \( \lambda \)
Step 6: Calculate net present value
Different calculation: Benefit-cost ratio:

B/C ratio is simply

\[
\frac{\sum_{t=0}^{\infty} \frac{B_t}{(1 + r)^t}}{\sum_{t=0}^{\infty} \frac{C_t}{(1 + r)^t}}
\]

Decision rule:

If B/C ratio is greater than 1, then this is a good project;
If B/C ratio is less than 1, then this is a bad project.
Net Present Value:
Net Present Value = PV of Benefits – PV of Costs

Decision rule:
Project is good if NPV is positive; or
Choose project (or option) with the largest NPV.

Cost Benefit Ratio:
Cost Benefit Ratio = PV of Benefits / PV of Costs

Decision rule:
Project is good if B/C is greater than 1;
Choose project (or option) with the largest B/C ratio.

Internal Rate of Return:
Internal Rate of Return is the discount rate such that NPV equals zero.

Decision rule:
Project is good if IRR is larger than some target rate of return;
Choose project (or option) with the largest IRR.
If there is only one project, or one activity to consider, then NPV, IRR, and B/C ratio will provide us with the same answer as to whether or not the project is ‘good’ or ‘not good’ for society.
Decision to make: Is this a good project or not?
All 3 criteria should give the same answer:

If

PV benefits > PV costs
i.e.
NPV > 0

Then it must be that
B / C > 1

All 3 criteria yield the same answer.

And it must be that
IRR > Discount rate
However, there could be problems with IRR. There could be more than one IRR.

**Descartes’ rule of signs**: The number of IRR depends on the number of times the net benefits change signs.

<table>
<thead>
<tr>
<th>Net benefits</th>
<th>-</th>
<th>-</th>
<th>-</th>
<th>-</th>
<th>+</th>
<th>+</th>
<th>+</th>
<th>+</th>
<th>+</th>
<th>+</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB change signs once: 1 IRR</td>
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<th>Net benefits</th>
<th>-</th>
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<th>+</th>
<th>+</th>
<th>+</th>
<th>-</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB change signs twice: 2 IRR</td>
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</table>
Step 6: Calculate net present value

You may then have two IRRs.

Better to use NPV
If more than one project (mutually exclusive projects):

If there is more than one project, or more than one activity, or more than one option and if we aim to rank these projects or activities or options to choose the best one(s), then it is better to use NPV.

IRR and B/C ratio could lead us to choose the wrong project.
### Decision to make: Which project to accept?

Consider the following situation:

<table>
<thead>
<tr>
<th></th>
<th>Project A</th>
<th>Project B</th>
</tr>
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<tbody>
<tr>
<td>PV of costs</td>
<td>100</td>
<td>20</td>
</tr>
<tr>
<td>PV of benefits</td>
<td>200</td>
<td>60</td>
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</table>

NPV vs. B/C ratio.

Better to use NPV
If more than one project (mutually exclusive projects):

Consider the following situation:

<table>
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<th>Year</th>
<th>Net Benefits Project A</th>
<th>Net Benefits Project B</th>
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<tr>
<td>0</td>
<td>-1000</td>
<td>-500</td>
</tr>
<tr>
<td>1</td>
<td>475</td>
<td>256</td>
</tr>
<tr>
<td>2</td>
<td>475</td>
<td>256</td>
</tr>
<tr>
<td>3</td>
<td>475</td>
<td>256</td>
</tr>
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NPV with $r = 5\%$  
$187.76$          $279.56$

IRR  
$25\%$          $20\%$
Step 6: Calculate net present value

If more than one project (mutually exclusive projects):
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NPV with \( r = 5\% \) $187.76 $279.56

IRR 25% 20%

Better to use NPV
Always better to use NPV.

NPV will always guide you to the correct decision.
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