5IE475
Program Evaluation and Cost-Benefit Analysis

LECTURE 2
Introduction to Cost-Benefit Analysis

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Outline of today’s lecture

• What is cost-benefit analysis?
• What are the main steps when conducting cost-benefit analysis of a certain policy?
• How to measure ‘social’ cost and benefits?
• Shortcomings of cost-benefit analyses

• Readings for this week:
  – Boardman book: Chapter 1 and 2
SOCIAL COST-BENEFIT ANALYSIS
Cost-Benefit Analysis (CBA)

• Application of economic principles to analyze impacts of various actions

• We are studying “social” CBA

• Similar to market CBA undertaken by firms:
  – Compare benefits with costs, measured in monetary terms
  – Need to incorporate and value risk/uncertainty in the analysis
    • Future prices/market conditions
    • All other factors that may affect outcomes in the future
Market vs. social costs and benefits

• But, social CBA is also different in important ways:
  – Can you think of likely differences between CBA conducted by firms and CBA conducted to evaluate public policies?
Market vs. social costs and benefits

• But, social CBA is also different in important ways:
  – Considers **all costs and benefits to a society**!
  – Thus, in social CBA, we must decide whose interests count in the calculation
    • Which individuals/groups may be affected by the policy?
    • Are there some distribution impacts (redistribution of resources from one individual to another)?
  – Social CBA **does not always use market prices**
    • Non-marketed goods, externalities
Government vs. social costs and benefits

- Social benefits and costs ≠ government revenue and expenditure
- There are costs and benefits to other stakeholders (individuals affected by policy) that need to be taken into account in social CBA, but are not part of budgetary impacts
- Analysis of budgetary impacts is usually an (important) component of CBA, but not CBA itself!
Example: Philip Morris study

- Philip Morris study: **Public Finance Balance of Smoking in the Czech Republic**
- Purpose: to determine whether costs imposed on public finance by smokers are offset by tobacco-related tax contributions and external positive effects of smoking
- Method: data from scientific journals, reports by international and national health institutions, statistics by the Czech Statistical Office, interviews with experts in health care, smoking, epidemiology and economics
- “The effect of smoking on the public finance balance in the Czech Republic in 1999 was positive, estimated at +5815 mil. CZK“
  - The most controversial statement: Average smoker dies 5.23 years sooner than the average non-smoker -> By dying early, smokers saved the Czech government 1193 million CZK in 1999 because of reduced costs for health care, pensions and housing for the elderly.
### Philip Morris study: results

**Income and positive external effects**  
- Savings on housing for elderly: 28 mil CZK  
- Pension & soc. expenses savings due to early mortality: 196 mil CZK  
- Health care costs savings due to early mortality: 968 mil CZK  
- Customs duty: 354 mil CZK  
- Corporate income tax: 747 mil CZK  
- VAT: 3521 mil CZK  
- Excise tax: 15648 mil CZK  

**Smoking related public finance costs**  
- Fire induced costs: 49 mil CZK  
- Lost income tax due to higher mortality: 1367 mil CZK  
- Days out of work related public finance costs: 1667 mil CZK  
- ETS related health care costs: 1142 mil CZK  
- Smoking (first hand) related health care costs: 11422 mil CZK  

**NET BALANCE**: +5815 mil. CZK

Source: Philip Morris study, http://hspm.sph.sc.edu/courses/Econ/Classes/cbacea/czechsmokingcost.html
Philip Morris study: discussion

• Can we say that government should thus promote smoking?
• What are the *social* costs and benefits of smoking? What is missing in their analysis?
Social vs. Government CBA: Conclusion

• When evaluating policy proposals we should always consider social costs and benefits, not only government expenditures and revenues!
CONDUCTING CBA
Major Steps in CBA

1. Specify all alternative projects (or actions)
2. Decide whose benefits and costs count
3. Catalogue impacts and select measurement indicators for each impact
4. Predict the impacts quantitatively over the life of the project
5. Assign money values to all impacts
6. Discount benefits and costs to get present values
7. Compute net present value (NPV) of each alternative
8. Perform sensitivity analysis
9. Make recommendation for action
Example

- Government wants to reduce traffic jams between two cities and thus considers building a highway connecting them.
- How would you evaluate this proposal with CBA? Go through main steps in CBA and apply them to this example.
Major Steps in CBA: Highway

Cost-benefit analysis for a new highway:

1. Specify all alternative projects (or actions)
   - Highway with/without tolls
   - Type of road surface, size, routing, timing, ...

2. Decide whose benefits and costs count
   - Global, national, province, or local perspective

3. Catalogue impacts and select measurement indicators for each impact
   - Benefits:
     - Time saved for travellers on the new highway (person-hours of travel time)
     - Accidents avoided (number of lives saved per year)
     - Reduced congestion on existing routes (gasoline saved, person-hours saved)
     - Revenues from tolls (dollars)
Major Steps in CBA: Highway

3. Catalogue impacts and select measurement indicators for each impact
   – Costs:
     • Construction costs (dollars)
     • Maintenance costs (dollars)
     • Toll collection costs (dollars)

4. Predict the impacts quantitatively over the life of the project
   – Calculate how many lives, how many person-hours of travel, etc. will be saved over the life of the project

5. Assign monetary values to all impacts
   – E.g. Value of time saved is calculated as 25% of average wage times the average number of passengers
   – Use previous research for more complicated estimates (e.g. value of live saved)
Major Steps in CBA: Highway

6. Discount benefits and costs to get present values
   – A cost or benefit that occurs in year t is converted to the present value by dividing it by \((1+s)^t\), where s is the social discount rate (more on discounting later on)

7. Compute NPV of each alternative specified in 1.
   – Difference between the present value of the benefits and the present value of the costs

8. Perform Sensitivity Analysis
   – Alternative predictions of cost and benefits and their monetary values, ...

9. Make recommendation for action
   – Choose project with the highest NPV (if all NPV negative, status quo is the best option)
   – Consider results of sensitivity analysis
## Results of a highway CBA

### Table 1.3 Coquihalla Highway CBA (1986 $ Million)

<table>
<thead>
<tr>
<th></th>
<th>No Tolls</th>
<th></th>
<th>With Tolls</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>Global Perspective</td>
<td>Provincial Perspective</td>
<td>Global Perspective</td>
<td>Provincial Perspective</td>
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<tr>
<td>Project Benefits:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time and Operating Cost Savings</td>
<td>389.8</td>
<td>292.3</td>
<td>290.4</td>
<td>217.8</td>
</tr>
<tr>
<td>Terminal Value of Highway</td>
<td>53.3</td>
<td>53.3</td>
<td>53.3</td>
<td>53.3</td>
</tr>
<tr>
<td>Safety Benefits (Lives)</td>
<td>36.0</td>
<td>27.0</td>
<td>25.2</td>
<td>18.9</td>
</tr>
<tr>
<td>Alternative Routes Benefits</td>
<td>14.6</td>
<td>10.9</td>
<td>9.4</td>
<td>7.1</td>
</tr>
<tr>
<td>Toll Revenues</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Users</td>
<td>0.8</td>
<td>0.6</td>
<td>0.3</td>
<td>0.2</td>
</tr>
<tr>
<td>Total Benefits</td>
<td>494.5</td>
<td>384.1</td>
<td>378.6</td>
<td>334.7</td>
</tr>
<tr>
<td>Project Costs:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction</td>
<td>338.1</td>
<td>338.1</td>
<td>338.1</td>
<td>338.1</td>
</tr>
<tr>
<td>Maintenance</td>
<td>7.6</td>
<td>7.6</td>
<td>7.6</td>
<td>7.6</td>
</tr>
<tr>
<td>Toll Collection</td>
<td></td>
<td></td>
<td>8.4</td>
<td>8.4</td>
</tr>
<tr>
<td>Toll Booth Construction</td>
<td></td>
<td></td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>Total Costs</td>
<td>345.7</td>
<td>345.7</td>
<td>354.4</td>
<td>354.4</td>
</tr>
<tr>
<td>Net Social Benefits</td>
<td>148.8</td>
<td>38.4</td>
<td>24.2</td>
<td>−19.7</td>
</tr>
</tbody>
</table>

What do we count in social CBA?

• If a government provides subsidy to people, it is a cost to government, but also a benefit to individuals!

• Transfers are not taken into account in social CBA if both the sending and receiving groups are part of our target population
  – Or we have to take the transfer into account twice (as a cost to someone and as a benefit to someone else)

• Example:
  1. Government subsidizes childcare (pays half of a kindergarten fee instead of parents) –> Is it a transfer or just a government cost?
  2. Government plants new trees to a public park –> Is it a transfer or just a government cost?
Major Steps in CBA: Olympics

• Conduct CBA for hosting Olympic games
• Specify major steps in CBA for the Olympics
Major Steps in CBA: Olympics

1. Specify all alternative projects (or actions)
   – Host Olympics or not
2. Decide whose benefits and costs count
   – National, global?
3. Catalogue impacts and select measurement indicators for each impact
   – Costs:
     • Application costs
     • Transport infrastructure, accommodation, sports infrastructure
     • Operation expenditures (management, security, staff)
   – Benefits:
     • Sponsor, ticketing, licensing, and media revenues
     • Economic boost from construction phase, event itself, and long-term legacy effect
Major Steps in CBA: Olympics

4. Predict the impacts quantitatively over the life of the project
   – New jobs created (short-term, long-term)
   – Utility from new facilities, infrastructure,...

5. Assign money values to all impacts
   – ??

6. Discount benefits and costs to get present values

7. Compute net present value (NPV) of each alternative

8. Perform sensitivity analysis

9. Make recommendation for action
Major Steps in CBA: Olympics

Table 3
Direct Revenues and Hosting Costs from Olympic Games
($ millions)

<table>
<thead>
<tr>
<th></th>
<th>IOC 2009–12</th>
<th>Vancouver 2010 organizing committee</th>
<th>London 2012 organizing committee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue source</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Broadcast rights</td>
<td>$2,723</td>
<td>$414</td>
<td>$713</td>
</tr>
<tr>
<td>International sponsors</td>
<td>$475</td>
<td>$175 (est.)</td>
<td>$300 (est.)</td>
</tr>
<tr>
<td>Domestic sponsors</td>
<td>$0</td>
<td>$688</td>
<td>$1,150</td>
</tr>
<tr>
<td>Ticketing</td>
<td>$0</td>
<td>$250</td>
<td>$988</td>
</tr>
<tr>
<td>Licensing</td>
<td>$0</td>
<td>$51</td>
<td>$119</td>
</tr>
<tr>
<td>Total</td>
<td>$3,198</td>
<td>$1,578</td>
<td>$3,270</td>
</tr>
<tr>
<td>Hosting costs</td>
<td></td>
<td>$7,556</td>
<td>$11,401</td>
</tr>
</tbody>
</table>

Source: IOC (2014b).
Notes: Table 3 shows data on revenues generated by the International Olympic Committee and the organizing committees for the Vancouver and London Games over the 2009–2012, the most recent IOC budget cycle. It also shows hosting costs for the Vancouver and London Games.

MONETARIZING COSTS AND BENEFITS
Measuring costs and benefits

• CBA – uses money as means for measuring all costs and benefits
  – But assigning monetary values to some costs or benefits is sometimes very difficult
• Fundamental measure of benefits – increase in individuals’ well-being:
  – Willingness to Pay (WTP)
• Fundamental measure of costs – loss in individuals’ well-being:
  – Opportunity cost
CBA decision rule

• Any project where benefits (WTP) are greater than costs (opportunity costs) has the potential to provide Pareto improvement to economy.
  – i.e, positive NPV of a project gives the opportunity for Pareto improvement
  – *Pareto improvement:*
CBA decision rule

• Any project where benefits (WTP) are greater than costs (opportunity costs) has the potential to provide Pareto improvement to economy.
  – i.e, positive NPV of a project gives the opportunity for Pareto improvement
  – *Pareto improvement*: At least one person is made better off without making anyone else worse off.

• Rank projects according to net benefits.
• Invest scarce resources in the project with the highest net benefits.
• If projects are not mutually exclusive (and budgetary constraints allow for that), invest in all projects with positive net benefits.
Willingness to pay (WTP)

- WTP is a maximum amount an individual would be willing to pay to have the policy project implemented.
  - The person should be indifferent between status quo (no new policy) and the new policy with the payment.

- What would be your WTP for a new underpass that would lead directly from Hlavni nadrazi railway station to University of Economics?
  - How and why do the WTPs differ across different individuals?
Willingness to pay (WTP)

• Example (project with no costs):
  – WTP of person A = $100
  – WTP of person B = $200
  – WTP of person C = -$250 (negative WTP, harmed by the policy)
  – Net benefits: $50 -> the policy has potential for Pareto improvement
  – How a Pareto improving situation can be achieved?
Opportunity Costs

• Most policy projects require some inputs to be implemented
  – A construction of new highway requires the use of labor, concrete, steel, machinery, ... that could be used elsewhere if the highway is not built

• The opportunity costs of using the required inputs to implement a policy is *their value in the best alternative use*.

• Example:
  – A project with sum of WTP equal to $50.
  – If opportunity costs of such a project are $75, the net benefits of project are -$25 and there is no potential for Pareto improvement (net benefits are negative).
SHORTCOMINGS OF CBA
Complications in CBA (1)

• Aggregation of benefits and costs across individuals

  “Only individuals matter, and all individuals matter equally”
  
  *Steven Landsburg: Armchair Economist*

• In social CBA, we usually place the same value of one dollar of income to all individuals
Complications in CBA (2)

• Risk and uncertainty
  – Model and parameter uncertainty
  – Calculate expected values (use sensitivity analysis)

• Market costs may not reflect “social” costs
  – Reasons?
    • Non-competitive markets
    • Externalities
    • Market distortions from government policies (taxes, subsidies)
      – Farmers pay $1 for fertilizer, but government provides subsidy of $0.50, so true cost to economy is $1.50

• Non-marketed goods (do not have market price)
  – Value of providing defense
  – Value of public amenities
  – Value of transport network
Complications in CBA (3)

• Some policies address efficiency objectives:
  – Examples:
    • Provision of public goods
    • Correcting effects of positive or negative externalities
    • Policies providing health and life-saving benefits

• Some policies address non-efficiency objectives:
  – Examples:
    • Income redistribution
    • Employment creation
    • Development of priority regions
    • National security

➢ CBA only addresses efficiency objectives!
SUMMARY OF TODAY’S LECTURE
Summary (1)

• Cost-benefit analysis of public policies needs to consider all costs and benefits to a society as a whole

• Major steps in CBA include:
  – Specify all alternative actions
  – Decide whose benefits and costs count
  – Calculate monetary values of all costs and benefits over the whole life of the project and discount them to present value
  – Compute net present value (NPV) of each alternative
  – Choose alternative with the highest (positive) NPV
Summary (2)

• A project with positive NPV has the potential for Pareto improvement
  – Making at least one person better off without making anyone else worse off
• Measuring costs and benefits:
  – Willingness to pay
  – Opportunity costs
• Weaknesses of CBA:
  – It only takes into account efficiency concerns
  – In reality, it is often hard to monetarize some costs and benefits, but providing at least a lower/upper bound for estimates can be most useful