what is cba?

• a tool to aid decision making

what is cba?

• a tool used either to rank projects

or

• to choose the most appropriate option
what is cba?

• cost-benefit analysis provides an organizational framework for identifying, quantifying, and comparing the costs and benefits of a proposed policy action. The final decision is informed (though not necessarily determined) by a comparison of the total costs and benefits.

what is cba?

• an economic assessment tool that can be used to quantitatively rank alternative proposals:
  • -between a given proposal and the status quo
  • -between competing proposals
**what is cba?**

- Cost-benefit methods summarize the *tradeoffs* that people make in giving up time, money, or goods to get something else.
- It provides information that can be used to evaluate the implications of different choices.

**WHY USE CBA?**

- CBA provides decision makers a consistent basis for decision-making.
- It imposes discipline, accountability, and transparency on the decision-making process.
WHY USE CBA?

• Scarcity of resources implies that resources devoted to one end are not available to meet another; hence there is an *opportunity cost* of any action.

☞ example: funds used to create/maintain a marine protected area cannot also be used to build new schools

WHAT IS CBA?
OUTLINE OF STEPS

*As a quick summary:*

• initially create a *projection* of cash flows (benefits and costs) over time,
• then *discount* these flows,
• then apply a *decision rule* to provide a ranking
OUTLINE OF STEPS

• identify/define the project. Confirm the desired outcomes of the proposal.
• determine the assumptions and scope underlying the analysis
• determine an appropriate time frame (appraisal period)
• identify all significant benefits and costs, and time period of realization
• assign monetary values to benefits and costs, whenever possible

OUTLINE OF STEPS

• (optional) adjust (assign weights to) cost and benefit streams to reflect distributional concerns
• discount the cost and benefit streams
• assess risk, and uncertainty
• apply decision rules based on quantifiable costs and benefits
• consider the effects of intangibles that could not be reliably estimated
• conduct sensitivity analysis
STEPS OF A CBA (in more detail)

• Identify/define the project.
  Confirm the desired outcomes of the proposal.

☞ point is: CBA is multi-disciplinary.

STEPS OF A CBA (in more detail)

• determine the assumptions and scope underlying the analysis
STEPS OF A CBA (in more detail)
---some default assumptions

• *apply a general equilibrium viewpoint* (consider inter-relations between sectors)

• example:
  Subsidy to beef industry $\rightarrow$ lower beef price $\rightarrow$ lower demand for *chicken* as people switch to beef

---

**set borders:**

typically exclude international impacts
(unless have explicit reason to consider them)
STEPS OF A CBA (in more detail)
---some default assumptions

• consider all intangible costs and benefits:

  - when they can be reliably estimated, do so

  - if not, conduct qualitative assessment

STEPS OF A CBA (in more detail)

• determine period of analysis:

  • What will be economic life of underlying proposal or assets?
  • often subject to 20 year maximum (due to discounting effects).

  Lifespan can be expanded where benefits or costs emerge slowly
STEPS OF A CBA  (in more detail)  
---identifying costs and benefits

CBA is usually **ex ante**: must **anticipate** benefits and costs

It can be difficult to identify and obtain information necessary to identify and quantify costs and benefits

Assigning monetary value to costs and benefits

- Costs/benefits often estimated from:
  - Market data
  - Engineering studies
  - Industry surveys
Assigning monetary value to costs and benefits

---costs---

• Opportunity costs are used.

• Market prices are usually a good approximation of opportunity costs

---

Assigning monetary value to costs and benefits

• Rework what follows: allude to when mkt doesn’t work and need for shadow prices

• Distorted mkts

• Missing mkts
Assigning monetary value to costs and benefits
---some more difficult costs

• externalities

benefits received or costs borne by those not associated with the originating activity and for which payment is neither given nor received

General Rule: include if they can be quantified and are of sufficient size that they are capable of altering the decision

If the externalities can't be quantified, they should still be identified and explained to decision makers

Discounting

• So far, have created projections of benefit and cost cash flows over time.

• Now, future cash flows must be discounted
Discounting

• in general, future costs and benefits will be discounted by a weighting factor called a discount factor $DF$:

$$DF = \frac{1}{(1 + r)^t}$$

with $r =$ discount rate

$t =$ time period

First a numerical example of growth:

- **Receive 100 at end of year 0, earn 10% per year**: 

<table>
<thead>
<tr>
<th>Year 0</th>
<th>Year 1</th>
<th>Year 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>110</td>
<td>121</td>
</tr>
</tbody>
</table>

  So initial 100 has grown to 121 after 2 years

  **SO:** Future value = present value $\times (1 + r)^t$

  $$121 = 100 \times (1.10)^2$$
Discounting

- Discounting simply works backward. With the base year as year 0, 121 received after 2 years is equivalent to 100 received now:

  \[
  \text{Present value} = (\text{future value}) \times \text{discount factor}
  \]

  \[
  \text{Present value} = (\text{future value}) \times \frac{1}{(1 + r)^t}
  \]

  \[
  100 = 121 \times \frac{1}{(1.10)^2}
  \]

Discounting

- **Why discount?**

- **Time preference:** most people prefer receiving a unit of money now rather than later
  - impatience, risk aversion
  - receiving money later reduces options of spending/saving without offering compensating advantages
Discounting
Why discount?

• **Opportunity cost of funds**

  --Funds received today can be profitably invested.
  --Interest is a premium paid to compensate for alternative possible uses
    --interest will include a premium to reflect risk

Discounting:
Discounting: a major source of controversy

• 2 major concerns:
  --should discounting future costs/benefits be done at all?
  --if discounting is done, what rate should be used?
Discounting

• The basic problem

--intergenerational equity:
    --Discounting makes future costs and benefits appear smaller in the present

Example: present value of $1.00 received in future
    (the discount factor \((1 + r)^{-t}\))

<table>
<thead>
<tr>
<th>Year</th>
<th>5</th>
<th>10</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>40</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>(r = 10%)</td>
<td>0.62</td>
<td>0.39</td>
<td>0.15</td>
<td>0.09</td>
<td>0.06</td>
<td>0.02</td>
<td>0.0085</td>
</tr>
<tr>
<td>(r = 5%)</td>
<td>0.30</td>
<td></td>
<td>0.09</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Discounting

In general, higher discount rates attach less importance to future

So

• potential future benefits may not be pursued

• potential future costs may be ignored
Discounting

• What rate should be used?
  -- zero rate?
    -- implies future generations are just as important to us
    -- raises problem of reverse infinite regress
    -- current generations continually impoverish themselves to
      provide for future generations

  No general consensus, generally discount rates vary
  from ~ 3-8 %

  Sensitivity analysis should be used

Discounting

Some considerations

• People tend to discount future benefits more than costs

• Society has lower rate of time preference than individuals

• Environmental projects:
  -- often long-term benefits, short term costs
  -- biases result that favor current generation
DECISION RULES

there are a variety of decision rules that may be applied in order to determine:

• if a project is acceptable
• in the case of competing projects, which project should be favored

We will consider the following decision rules:

• Maximum net present value
• Benefit-cost ratio
• Internal rate of return
DECISION RULES

**REMINDER:**

Present value = (future value) \times \frac{1}{(1 + r)^t}

---

DECISION RULES

**NET PRESENT VALUE**

- NPV = PV(B) - PV(C)

*Any project satisfying the condition NPV > 0 should be undertaken IF:*

- projects are independent of one another
- there are no constraints on project implementation (e.g., budget constraints)
DECISION RULES
NET PRESENT VALUE

WITH CONSTRAINTS

- *how to choose among competing (positive NVP) projects?*
  
  --choose the subset that **maximizes NPV**

EXAMPLE:  
*Budget = 4*

<table>
<thead>
<tr>
<th>project</th>
<th>cost</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>1</td>
<td>60</td>
</tr>
<tr>
<td>X</td>
<td>3</td>
<td>400</td>
</tr>
<tr>
<td>Y</td>
<td>2</td>
<td>150</td>
</tr>
<tr>
<td>Z</td>
<td>2</td>
<td>225</td>
</tr>
</tbody>
</table>

*Possible combinations:  WX  WY  WZ  YZ*

| NPV   | 460  | 210  | 285  | 375  |

*Decision: combination WX maximizes NPV*
FOR MUTUALLY EXCLUSIVE PROJECTS:

choose that which maximizes NPV

DECISION RULES
BENEFIT-COST RATIO

\[ \text{B/C ratio} = \frac{PV(B)}{PV(C)} \]

RULE: if B/C ratio > 1, accept

--WITH CONSTRAINTS:
rank projects by B/C, choose projects with highest B/C ratio until budget exhausted

--WITH MUTUAL EXCLUSIVITY:
choose project with maximum B/C
### Example

<table>
<thead>
<tr>
<th>project</th>
<th>benefits (PV)</th>
<th>costs (PV)</th>
<th>B – C (NPV)</th>
<th>B/C</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>200</td>
<td>100</td>
<td>100</td>
<td>2.0</td>
</tr>
<tr>
<td>Y</td>
<td>110</td>
<td>50</td>
<td>60</td>
<td>2.2</td>
</tr>
<tr>
<td>Z</td>
<td>120</td>
<td>50</td>
<td>70</td>
<td>2.4</td>
</tr>
</tbody>
</table>

**with no rationing constraints, plus no exclusivity:**

--both rules (NPV and B/C) show that all projects are desirable.

### Example

<table>
<thead>
<tr>
<th>project</th>
<th>benefits (PV)</th>
<th>costs (PV)</th>
<th>B – C (NPV)</th>
<th>B/C</th>
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<tbody>
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<td>X</td>
<td>200</td>
<td>100</td>
<td>100</td>
<td>2.0</td>
</tr>
<tr>
<td>Y</td>
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<td>Z</td>
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<td>50</td>
<td>70</td>
<td>2.4</td>
</tr>
</tbody>
</table>

--- **with mutual exclusion:** Max NPV chooses X, but B/C chooses Z

by choosing Z, one sacrifices 30 additional units of NET benefits that could have been had from X.
DECISION RULES
BENEFIT-COST RATIO
mutual exclusion

**example**

<table>
<thead>
<tr>
<th>project</th>
<th>benefits</th>
<th>costs</th>
<th>B – C</th>
<th>B/C</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>200</td>
<td>100</td>
<td>100</td>
<td>2.0</td>
</tr>
<tr>
<td>Y</td>
<td>110</td>
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<td>60</td>
<td>2.2</td>
</tr>
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<td>Z</td>
<td>120</td>
<td>50</td>
<td>70</td>
<td>2.4</td>
</tr>
</tbody>
</table>

--Note that the problem is that projects are of different size, so the bases (denominator; costs) are different.

SO,

--B/C is sensitive to size of project

DECISION RULES
BENEFIT-COST RATIO
budget constraint

**Example:** let budget constraint = 100

--by ranking by B/C and working down the list until the budget is exhausted we get the correct choice of Z + Y:

<table>
<thead>
<tr>
<th>project</th>
<th>cost</th>
<th>benefits</th>
<th>B – C</th>
<th>B/C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z</td>
<td>50</td>
<td>120</td>
<td>70</td>
<td>2.4</td>
</tr>
<tr>
<td>Y</td>
<td>50</td>
<td>110</td>
<td>60</td>
<td>2.2</td>
</tr>
<tr>
<td>X</td>
<td>100</td>
<td>200</td>
<td>100</td>
<td>2.0</td>
</tr>
</tbody>
</table>
DECISION RULES
BENEFIT-COST RATIO
budget constraint = 100

--this is a very limited example of B/C ratio usefulness, and the same result could be achieved by lumping smaller projects and finding the NPV of the “new, combined” project

<table>
<thead>
<tr>
<th>project</th>
<th>cost</th>
<th>benefits</th>
<th>B – C</th>
<th>B/C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z</td>
<td>50</td>
<td>120</td>
<td>70</td>
<td>2.4</td>
</tr>
<tr>
<td>Y</td>
<td>50</td>
<td>110</td>
<td>60</td>
<td>2.2</td>
</tr>
<tr>
<td>X</td>
<td>100</td>
<td>200</td>
<td>100</td>
<td>2.0</td>
</tr>
<tr>
<td>Y + Z</td>
<td>100</td>
<td>230</td>
<td>130</td>
<td>2.3</td>
</tr>
</tbody>
</table>

DECISION RULES
BENEFIT-COST RATIO
budget constraint = 100

With this more realistic example where costs don’t perfectly match the budget, it seems the B/C method fails, as Project X should be chosen.

<table>
<thead>
<tr>
<th>project</th>
<th>cost</th>
<th>benefits</th>
<th>B – C</th>
<th>B/C</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>100</td>
<td>200</td>
<td>100</td>
<td>2.0</td>
</tr>
<tr>
<td>Y</td>
<td>60</td>
<td>126</td>
<td>66</td>
<td>2.1</td>
</tr>
<tr>
<td>Z</td>
<td>30</td>
<td>63</td>
<td>33</td>
<td>2.1</td>
</tr>
<tr>
<td>Y + Z</td>
<td>90</td>
<td>189</td>
<td>99</td>
<td>2.1</td>
</tr>
</tbody>
</table>
DECISION RULES

BENEFIT-COST RATIO

B/C ratio is also sensitive to whether items are recorded as costs or benefits.
- benefits can be considered negative costs, costs can be considered negative benefits

\begin{align*}
B's: & \quad 60 \quad 40 \quad 20 \quad \text{(120)} \\
C's: & \quad 40 \quad 20 \quad \text{(60)} \\
B's: & \quad 60 \quad 40 \quad 20 \quad -20 \quad \text{(100)} \\
C's: & \quad 40 \quad \text{(40)} \\
\end{align*}

NPV = 60 \quad B/C = 2.0
NPV = 60 \quad B/C = 2.5

\text{Again, the problem is in the scale, or size of the base (project size)}

DECISION RULES

Internal Rate of Return

Under many circumstances the IRR produces sensible results

\text{definition: the discount rate that would make a project’s net present value equal zero.}

\text{this means that IRR is the discount rate that equates initial outlays to the present value of future net cash flows.}

For IRR = ?, \quad NPV = ? \quad \frac{(B_t - C_t)}{(1 + ?)^t} = 0
DECISION RULES
Internal Rate of Return

**Rule for IRR:**

✏️ A project is worthwhile if the IRR is greater than some benchmark discount rate.

✏️ with MUTUAL EXCLUSIVITY:
   -- choose the project with the higher IRR.

---

**EXAMPLE:**

<table>
<thead>
<tr>
<th></th>
<th>YEAR 0</th>
<th>YEAR 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital cost</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Benefit</td>
<td>0</td>
<td>130</td>
</tr>
<tr>
<td>Operating cost</td>
<td>0</td>
<td>20</td>
</tr>
</tbody>
</table>

\[
\text{NPV} = -100 + \left\{ \frac{(130 - 20)}{1.10} \right\} = 0 \quad \text{so IRR} = 10\%
\]
DECISION RULES
Internal Rate of Return

*Can give wrong results in case of mutual exclusivity*

--example 1: different sized projects:

--costs incurred in Year 1, benefits occur annually starting Year 2:

<table>
<thead>
<tr>
<th>Project</th>
<th>Cost</th>
<th>Benefit</th>
<th>IRR</th>
<th>NPV at 10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>1000</td>
<td>300</td>
<td>30%</td>
<td>3000</td>
</tr>
<tr>
<td>Y</td>
<td>5000</td>
<td>1000</td>
<td>20%</td>
<td>5000</td>
</tr>
</tbody>
</table>

--for independent projects and no constraints all would be accepted

--for mutually exclusive projects, IRR wrongly picks project X because IRR discriminates against larger capital outlays

---

DECISION RULES
Internal Rate of Return

IRR can also lead to erroneous results in cases of:

--projects with different project lives
--projects with different timing of benefits and costs
--projects where the discount rate varies over time

*of particular importance:*
In cases with large delayed costs, *preferred* investments may have lower IRR
DECISION RULES

summary:

--IRR seems to have nothing to offer
--B/C ratio may be of use in special case of one-period constraint, but

☞ maximizing NPV works better.

--maximizing NPV avoids problems encountered by other methods

Categorizing benefits

TOTAL ECONOMIC VALUE

USE VALUES

<table>
<thead>
<tr>
<th>Direct use values</th>
<th>indirect use values</th>
<th>option values</th>
<th>existence/bequest values</th>
</tr>
</thead>
<tbody>
<tr>
<td>-fishing</td>
<td>-flood protection</td>
<td>-insurance value of preserving options for use</td>
<td>-value derived from knowing a species/system is preserved</td>
</tr>
<tr>
<td>-recreation</td>
<td>-storm protection</td>
<td></td>
<td>-value of passing on assets to future generations</td>
</tr>
<tr>
<td>-transport</td>
<td>-nutrient cycling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-navigation</td>
<td>-waste assimilation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-sedimentation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Monetary valuation methods

<table>
<thead>
<tr>
<th>Demand curve approaches</th>
<th>Non-demand curve approaches</th>
</tr>
</thead>
<tbody>
<tr>
<td>\</td>
<td></td>
</tr>
<tr>
<td>expressed preference methods</td>
<td>revealed preference methods</td>
</tr>
<tr>
<td>\</td>
<td></td>
</tr>
<tr>
<td>--contingent valuation</td>
<td>--travel cost model</td>
</tr>
<tr>
<td>--choice modeling</td>
<td>--hedonic pricing</td>
</tr>
</tbody>
</table>

Non-demand curve methods

dose-response relationships

- Production function:

  --for estimating economic value of ecosystem products/services that contribute to the production of marketed goods
Non-demand curve methods
dose-response relationships

• Production function:

\[ \text{fish yield} = f(\text{labor, capital, stock (habitat quality)}) \]
\[ \text{habitat} = f(\text{pollution}) \]

? pollution ? habitat ? stock ? harvest

✏️ If you can quantify these relationships, you can quantify the benefit of a program that reduces pollution

Non-demand curve methods
replacement-cost/preventative measures

• Often overlap:

expenditures may be considered as preventing further damage, or restoring original conditions
Non-demand curve methods
replacement-cost/preventative measures

• Preventative (averting) measures:
  --WTP to prevent degradation

Example:
Beach with mandatory water quality standard
  --cost of achieving standard taken as proxy for benefits
  (assumes benefits are worth the costs)

Non-demand curve methods
Replacement cost method

• Cost of replacing or restoring a damaged asset
  --cost of restoration taken as a minimum estimate of damage from loss
Non-demand curve methods
Replacement cost method

Examples:
--Valuing storm protection services of coastal wetlands by measuring the cost of building retaining walls
--Valuing fish habitat/nursery services by measuring cost of fish breeding/stocking programs

Non-demand curve methods
preventative measures method

Method
1) specify the relevant service
2) estimate the potential damage
3) calculate value of potential damage, or amount people spend to avoid such damage
### Non-demand curve methods

**replacement cost method**

**Method**

1. specify the relevant service
2. identify least costly alternative means of providing the service
3. calculate the cost of the substitute or replacement service

### Limitations:

- Presumes expenditures are worth incurring
  --assumes well-informed people
- Expenditures constrained by ability to pay
  (downward bias in poorer communities)
Non-demand curve methods
replacement cost/preventative measures

Limitations (cont’d):

- Replacement cost assumes full restoration is possible
  --if not, underestimates the asset

- Assumes no secondary benefits
  --example: reforestation costs as proxy for soil stabilization benefits
  --forests yield other benefits

--result: overestimation of benefits
Demand curve methods

- Revealed preference methods
  -- Hedonic pricing
  -- Travel cost models

  -- valuation of non-market impacts by observing actual market behavior
  -- behavior in one market reveals an implicit price of a related non-market good

Demand curve methods
revealed preferences

- Strength:
  -- based on actual behavior

- Problems:
  -- complexity of methods
  -- data requirements
Revealed preferences

• **Hedonic price method** (HPM)
  --certain environmental services affect certain market prices
  --try to imply prices of these services by determining how they affect market prices

• Applications: typically housing, labor markets

---

demand curve methods
hedonic price method

**basic process:**

--Observe systematic differences in values of property between locations,

--Isolate the effect of ambient environmental quality on those values

**Examples:**
--exposure to pollution
--proximity to amenities
Revealed preferences
hedonic prices

Methodology:
1) Estimate a price function:

\[ \text{Property price} = \text{function of:} \]
-- physical characteristics (house size, no. of rooms, etc)
-- location characteristics (proximity to work, amenities)
-- environmental quality variables (ex.: pollution level)

Hedonic price methodology

2) For each household ‘i’, estimate WTP for incremental decrease in pollution:

\[ \text{-- } \text{WTP}_i = \text{? (est'd property price}_i \text{)} \]
\[ \text{? pollution level} \]

Total change in value = sum of \( \text{?WTP}_i \)
Hedonic price methodology

Problems

- **Significant** data requirements
- Complex statistical analysis
- Requires individuals properly understand relation between pollution and welfare
- Not usually applicable when housing markets constrained
  -- rent controls, housing shortages, government ownership
- ? pollution in other prices also, so hedonic method underestimates value of ? pollution

Revealed preferences methods

Travel cost models

Travel cost models (TCM)

- Purpose: estimate a demand curve for non-marketed good
- Used primarily for recreation sites without prices
  -- cost of travel used as surrogate price
- Most data collected with surveys
Revealed preferences methods
Travel cost models

Simple form:

\# visits = function of:
--travel cost
--socio-economic data (income, age, etc)
--available alternative sites

Travel costs may include:

- Vehicle expenses
- Food, lodging
- time
Issues/problems:

- **time costs:**
  - general belief: ignoring value of travel time will underestimate total travel costs, and so also recreational value
  - But how to value time?

- Opportunity cost of time usually taken as working wage
  - $1/3$ to $1/2$ of wage rate is usually used
Issues/problems

• Housing purchase decisions:
  --those who most value an attribute will likely live closer to it
  --but then travel cost is lower, benefits underestimated

Example: Dunes in Netherlands: indirect uses not captured
Demand curve methods
Expressed (stated) preferences methods

- Not based on actual behavior
- Survey based; hypothetical context
- Capable of capturing both use and non-use values

Two main categories:
- Contingent valuation method (CVM)
  --widely used for environmental impacts
- Choice modeling (CM)
  --gaining acceptance for multi-attribute environmental goods
Contingent Valuation Method

- **primary purpose of a CV survey:**
  - obtain a WTP bid for incremental change in provision of some good or service
- **Basic form:**
  - Interview people: ask:
    - “What is your WTP to use/preserve some environmental asset?”
  - Calculate average WTP, multiply by total users

four basic parts to a typical CV survey

- Attitudinal section
- Behavioral section
- Demographic data collection
- Valuation section
Contingent valuation method

• **Attitudinal section**
  - Examines respondent knowledge and opinions about the survey topic
  - Responses may be used as explanatory variables in a WTP function
  - May serve a “warming-up” purpose

Contingent valuation method

**Behavioral section**
--Gather information regarding interactions with environmental asset
Example:
  People who dive/snorkel frequently will likely place greater value on establishing MPAs

• Responses may be used as explanatory variables in a WTP function
• May serve a “warming-up” purpose
Demographic data collection

- Certain socio-economic data is collected that can be used as explanatory variables in a WTP function
  - income, age, gender, education etc

--statistically significant relations serve as validation of procedure

Valuation section

- Includes:
  --presentation of hypothetical scenario:
    --description of current situation and expected change brought about by some action or policy
  --description of
    - how policy will achieve change,
    - how it will be paid for,
    - who will make the change
Contingent valuation method

Valuation section cont’d

- Includes:
  -- elicitation of respondent’s WTP bid
    - this should be accompanied with a reminder of respondent’s income constraint
  - several formats are available, each with advantages/disadvantages

Payment vehicle:
  -- type of vehicle can affect WTP response

- Taxes, licenses, fees, prices, donations
  -- Non-voluntary vehicles (e.g. taxes) can cause protest bids and non-responses
  -- Voluntary vehicles (donations) encourage over-bidding
Contingent valuation method
survey design concerns

**WTP bid-elicitation formats**
--each format has different biases that may affect reliability of WTP responses

- Open-ended
- Bidding games
- Payment cards
- Dichotomous choice (referendum)
  -- single bounded
  -- double bounded

Survey design concerns
bid-elicitation formats

**Open-ended formats**
“How much would you be willing to pay for…?”

**PROS**
- Provides measure of maximum WTP
- Straightforward statistical analysis and interpretation
- Responses tend to be conservative relative to other formats
- No anchoring/starting point bias
Survey design concerns
bid-elicitation formats

**Open-ended formats**

- **CONS**
  - general criticism: unfamiliarity with format

Results:
- large number of
  - non-responses
- zero responses
- strong outliers

**Bidding games**

--offer increasing bids until one is rejected, followed by final open-ended question

- **problems:**
  - starting point bias
  - yea saying
Survey design concerns
bid-elicitation formats

**Payment card method**
--Provide a card with wide-ranging list of bids

• Reduces outliers, but still some anchoring bias

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Survey design concerns
bid-elicitation formats

**Dichotomous choice method**

• **Single bound**: “Would you pay X amount for …? Answer yes or no.
  --vary bids among respondents

**PROS**
--believed to better replicate real market situation
--reduces outliers and non-responses
Survey design concerns
bid-elicitation formats

Dichotomous choice method

• Problems
  --need large samples (expensive)
  --complex statistical analysis/interpretation
  --results seem significantly larger than other methods

Contingent valuation method
summary of problems

• Hypothetical context
  --scenario must be complete but brief
  --respondent’s budget constraint must be considered
• Strategic behavior
  --different formats give incentive to over- or under-bid
• Response biases
• Expensive
• Complex statistical methods
Expressed preference methods
Choice Modeling

- Choice Modeling (CM) may be used when policies have multi-dimensional changes
- Survey based

Hypothetical scenario:
- A good is described with a variety of attributes
- A menu of attribute combinations and levels is presented:

Example:

- good attributes
  - live cover
- coral reef diversity
  - water clarity
  - cost of visit
Choice Modeling
Hypothetical scenario example

Menu:

<table>
<thead>
<tr>
<th>attribute</th>
<th>status quo</th>
<th>policy 1</th>
<th>policy 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live cover</td>
<td>low</td>
<td>medium</td>
<td>high</td>
</tr>
<tr>
<td>Diversity</td>
<td>medium</td>
<td>high</td>
<td>medium</td>
</tr>
<tr>
<td>Water clarity</td>
<td>low</td>
<td>medium</td>
<td>high</td>
</tr>
<tr>
<td>Cost</td>
<td>zero</td>
<td>medium</td>
<td>high</td>
</tr>
</tbody>
</table>

Choice Modeling

• Three common approaches:
  --choice experiments
    --simply pick favored alternative

  --contingent ranking
    --rank alternatives

  --contingent scoring
    --attach numerical scores to ranking
Choice Modeling
choice experiment example

Assume following welfare relationship:

\[
\text{Welfare} = a_1(\text{live cover}) + a_2(\text{clarity}) + a_3(\text{diversity}) + a_4(\text{cost}) + \epsilon
\]

Statistical analysis of responses (choices from menu) gives:

\[
a_1 = 0.070 \quad a_2 = 0.014 \quad a_3 = 0.058 \quad a_4 = -0.038
\]

- Divide physical attribute coefficients \((a_1, a_2, a_3)\) by cost coefficient \(a_4\) yields implicit prices:
  - WTP(\text{live cover}) = -1.84
  - WTP(\text{clarity}) = -0.37
  - WTP(\text{diversity}) = -1.53

Benefits Transfer

Obtain a valuation from an original study and apply it to a new site

- Tradeoff occurs:
  -- saves time, money
  but
  -- questionable validity: may be highly inaccurate
Benefits Transfer

Accuracy depends upon ability to match original study site with new site
--requires
--good baseline data and projected changes for new site
--review of relevant studies to find best match

• Transferred values may need adjustment

• Three basic approaches:
  --unadjusted
  --simple adjustment
  --function transfer

☞ Recent studies regarding relative accuracy of each method are mixed
Benefits Transfer

• Unadjusted method

  \[ \text{WTP}_{\text{original site}} = \text{WTP}_{\text{new site}} \]

  --mean WTP x relevant new population = aggregate benefits

Benefits Transfer

**Accuracy of transfer depends upon comparability of sites:**

--socio-economic factors
--physical site factors
--comparability of policy changes
--market conditions at sites:
  --available substitutes/complements
--temporal changes

--Significant site differences indicate need for adjustments
Benefits Transfer

Benefits Transfer with simple adjustment

• Example:

\[ WTP_{\text{New Site}} = WTP_{\text{original site}} \times (\text{Income}_{\text{new}} / \text{Income}_{\text{old}})^e \]

with \( e \) = income elasticity of WTP: \( \%? \text{WTP} \)

\( \%? \text{Y} \)

Benefits Transfer

Benefits Transfer with function transfer

• Original study should provide some WTP function:

\[ \text{WTP} = \text{function of:} \]

- income
- other socio-economic data

WTP for an increase in biodiversity =
constant + \( a_1 \) (income) + \( a_2 \) (age) + \( a_3 \) (education)

\( \varepsilon \) transfer involves use of same coefficients for variables
\( \varepsilon \) An immediate problem: access to data needed for function
Benefits Transfer with function transfer

Meta-analysis
--based on a large sample of original studies
--explanatory variables common across sites
--not specifically from any particular site

Example:
\[ WTP_{site \, i} = c + a_1 \text{(per capital income)} \]
\[ + a_2 \text{ (site characteristics)} \]
\[ + a_3 \text{ (policy characteristics)} \]
\[ + a_4 \text{ (study format)} \]

Benefits Transfer

Benefits Transfer: Does it work?

• Validity of transfer depends in part on similarity of sites, policies, and context

• Are international transfers valid?
  --this would be useful for developing countries

• Are temporal transfers useful?
  --do original studies quickly lose their usefulness?
Benefits Transfer

Temporal transfers

• Pearce (2006) cites studies showing:
  -- over two year period, WTP is stable
  -- over five year period, WTP increases significantly

∧ implications are poor for Meta-analysis

Benefits Transfer

International transfers

-- how to test validity?
  -- perform an original study and a Benefit Transfer
  and compare

-- mixed results at best