

## Lecture 7

ECON 4910, Environmental Economics  
Spring 2010

Monetary valuation of environmental  
changes

The ethics and politics of  
cost-benefit analysis

Readings:

**Perman et al., Ch. 12**

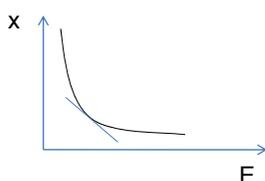
Perman et al., Ch. 3.1-3.4.

### Monetary valuation and CBA

- Max net benefits/Pareto optimum:
  - $\sum_i (u'_{iE} / u'_{ix}) z' = f'_k$       or:       $\sum_i (u'_{iE} / u'_{ix}) = f'_k / z'$
  - Total marginal benefits of improved E = marginal cost
- How to measure WTP?
- Cost-benefit analysis
  - Total marginal *project* benefits: exceed *project* costs?
  - Are we moving in the right direction?
- Assumptions so far:
  - Full information about WTP
  - Costless lumpsum-transfers feasible
- If not fulfilled: CBA is normatively controversial
  - How? Why?

## Marginal willingness to pay

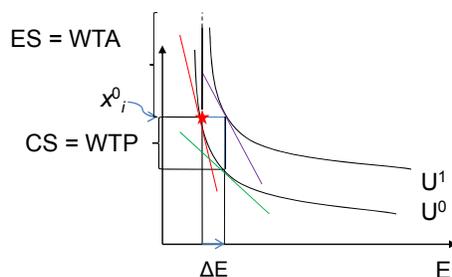
- If  $E$  increases by one unit, how much  $x$  can be taken away from  $i$  while keeping her initial utility level?
- Homo Oeconomicus:  $U_i = u_i(x_i, E)$
- $MWTP = (u'_{iE} / u'_{ix})$
- WTP for small change  $dE$ :  $(u'_{iE} / u'_{ix})dE$
- Willingness to accept (WTA; required compensation): If  $E$  decreases by one unit, how much  $x$  must be given to  $i$  to keep her initial utility level?



Marginal changes:  $WTP = WTA = MRS$   
 ("Marginal":  $(u'_{iE} / u'_{ix})$  considered fixed)

## Non-marginal increase in $E$

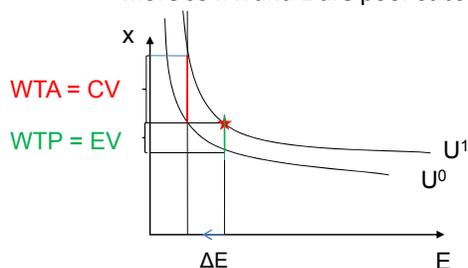
- $(u'_{iE} / u'_{ix}) = MRS$  cannot be considered constant
  - Varies along the indifference curve (level of  $E$  (and  $x$ ))
  - Varies across indifference curves (level of  $U$ )
  - Cannot just use  $MRS \cdot \Delta E$ , since  $MRS$  not constant



- Discrete benefit measures:
- **Compensating surplus:** The income change required to keep  $i$  at the initial utility level ( $U^0$ ).
- **Equivalent surplus:** The income change required to keep  $i$  at the "after  $\Delta E$ " utility level ( $U^1$ ).

### Non-marginal decrease in E

- $\Delta E < 0$ : Environmental deterioration
- WTP: Your willingness to pay to *avoid* this
- WTA: The compensation you need to *accept* this
- Typically:  $WTA > WTP$ 
  - more so if x and E are poor substitutes



- CS or ES: which utility level is relevant?
  - Implicit: Property rights
  - "Income" effect on values

### CS and ES versus WTA and WTP

- **If  $\Delta E > 0$ :**
  - CS = WTP (to get  $\Delta E$ )
  - ES = WTA (*not* getting  $\Delta E$ )
- **If  $\Delta E < 0$ :**
  - CS = WTA ("suffering"  $\Delta E$ )
  - ES = WTP (to avoid  $\Delta E$ )

## Example: Valuation of bird reserve

- $\Delta E > 0$ : Create a new bird reserve
  - CS:
  - ES:
  - Status quo: No "right" to the reserve ->  $U^0$  natural reference point -> WTP
- $\Delta E < 0$ : Destroy existing bird reserve
  - CS:
  - ES:
  - Status quo: "Right" to reserve exists ->  $U^1$  natural reference point -> WTA

## Monetary valuation in practice

- **Motives:**
  - *Use value*: WTP to go fishing, hiking etc
  - *Existence value*: WTP to know that the environmental good exists, even if one never plans to use it
  - *Option value*: WTP for the option to use the good later (or having the option than others can use it later)
- **Methods for measurement of WTP**
  - Direct methods: Surveys, voting
  - Indirect methods: Use of market prices/revealed preferences

### Indirect methods

- Even if no markets for environmental goods: Market goods may be closely tied to the *use* of environmental goods
- Some goods are *complementary* to E:
  - Fishing rod/clean water
  - Bus tickets to a national park
- Some goods are *substitutes* to E:
  - Bottled drinking water/ clean tap water
  - Noise isolating window glass / quiet outdoors environment
- By making appropriate assumptions about the relationship between the market good and the environmental good, use value of environmental good can be estimated.
- Most used indirect methods: travel cost method, property prices

### Travel cost method

- Estimating WTP for environmental goods one must travel to: National parks, skiing amenities etc.
- Travelling costs: «Price» to visit the amenity – lower limit of WTP to visit
  - Pecuniary travel costs: Train/bus tickets, gas, car expenses
  - Entrance fees, fishing permits etc.
  - Time costs: Alternative use of time (e.g. working, earning money)

### «Hedonic prices»

- Some goods are heterogeneous; different units have different characteristics
  - Houses: different # of rooms, location, exposure to noise
  - Jobs: different exposure to hazardous substances
- «Hedonic pricing»: Estimating demand for environmental quality, exploiting such market good heterogeneity
  - estimating the partial effect on house prices of noise or pollution exposure
  - or the wage increased demanded by workers to accept marginally higher health risk

### Laboratory experiments

- Choices in the lab: Real choices, real payments
  - E.g.: Give subjects a sum of money and auction a product between subjects. Does WTP vary with info on whether product is genetically modified?

## Contingent valuation: Interview surveys

- «How much would you be willing to pay to improve air quality in Oslo by x pst.?»
- Problems:
  - Strategic reporting? (freeriding, support)
  - Misperceptions (what does «improve air quality by x pst.» mean?)
  - Inexperience: Anchoring effects, framing effects
  - Costly
- Advantages:
  - Only way to measure existence values
  - Great flexibility: can ask almost anything

## Cost-benefit analysis

- Project evaluation:
  - Are the benefits of a project larger than its costs?
  - Net benefits of project  $a >$  net benefits of project  $b$ ?
- Standard cost-benefit analysis:
  - Is  $\sum_j WTP_i - \sum_j C_i > 0$ ?
  - where  $C_i$  = the cost  $i$  must cover
  - Equivalently: Is  $\sum_j (WTP_i - C_i) = \sum_j NWTP_i > 0$ ?
  - If yes: Project defined as 'socially efficient'
- Assume:
  - Marginal project (marg. values fixed)
  - Static analysis
  - No uncertainty
- Does  $\sum_j NWTP_i > 0$  imply that the project is welfare improving?
  - Is  $\sum_j NWTP_i$  a measure of welfare improvement?

## Aggregation of WTP

- WTP (WTA) as a measure of individual benefits: relatively uncontroversial
  - Assume identical costs of projects a and b:
 
$$WTP_i(a) > WTP_i(b) \quad \longleftrightarrow \quad a > b \text{ (for } i\text{)}$$
- If compensation is paid, no losers:
 
$$\sum_j WTP_j(a) > \sum_j WTP_j(b) \quad \longleftrightarrow \quad a > b \text{ (for society)}$$
- If compensation is NOT paid:
 
$$\sum_j WTP_j(a) > \sum_j WTP_j(b) \quad \not\longleftrightarrow \quad a > b \text{ (for society)}$$
- Aggregate WTP (WTA) as a measure of social benefits: controversial
  - implies specific normative (& other) assumptions
- Reason: money is not equally important to all

## The social welfare function

- $W = w(U_1, \dots, U_n) \quad w'_i > 0$
- Welfarism: Only (human) utility matters (not, e.g., rights, religious concerns)
- What is a good society?
  - How should conflicting interests be balanced
  - Inherently normative: no neutral or economically "correct" SWF exists
  - The regulator's view; an ethical observer; the analysts' ...?
- Unweighted utilitarianism:
 
$$W = U_1 + \dots + U_n$$
 i.e.
 
$$w'_i = 1 \text{ for all } i$$

### Welfare changes

- Project: Env. improvement  $dE$ , cost for person  $i$   $C_i (= -dx_i)$
- Will the project produce a welfare improvement?
 
$$W = w(U_1(x_1, E), \dots, U_n(x_n, E))$$

$$dW = \sum_i [w'_i (-U'_{ix} C_i + U'_{iE} dE)]$$

$$= \sum_i [w'_i U'_{ix} (-C_i + (U'_{iE} / U'_{ix}) dE)]$$

$$= \sum_i [w'_i U'_{ix} (WTP_i - C_i)]$$

$$= \sum_i [w'_i U'_{ix} (NWTP_i)]$$
- Change in social welfare: A *weighted* sum of everyone's **net** willingness to pay.
- $\sum_i NWTP_i$ : welfare measure if  $w'_i U'_{ix}$  equal for all  $i$
- **Optimal income distribution**
- *Welfare weights*:  $w'_i U'_{ix}$
- Utilitarian SWF:  $w'_i = 1$  → welfare weights:  $U'_{ix}$
- Can we reasonably assume equal welfare weights for all?

### On welfare weights

$$dW = \sum_i w'_i U'_{ix} (NWTP_i)$$

- $w'_i$ : *Purely normative* (how much emphasis should society put on person  $i$ 's utility?)
  - Economic theory provides little guidance; must be discussed on a normative (ethical/political) basis.
- $U'_{ix}$  (marginal utility of income): Descriptive, but not observable/verifiable
  - Requires cardinal & interpersonally comparable utility (standard utility concept: ordinal)
  - No generally accepted methodology exists to measure and compare  $U'_{ix}$  between individuals.
- **The assumption that  $w'_i U'_{ix}$  is equal for all is not empirically verifiable.**

### ”Optimal income distribution”

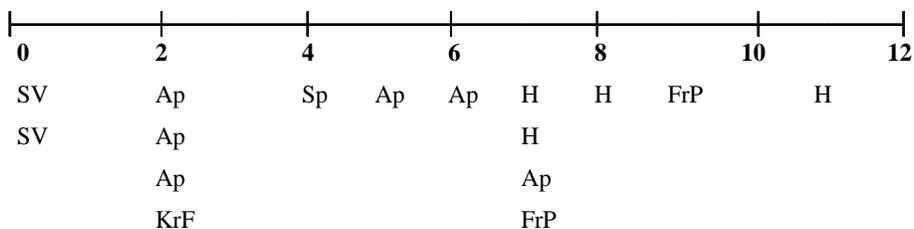
- $w'_i U'_{ix} = 1$  implies
- *either*: Unweighted utilitarianism, *and* everybody has the same marginal utility of income:  
 $w'_i = U'_{ix} = 1$
- *or*: Both  $w'_i$  and  $U'_{ix}$  may differ:  
 $w'_i = 1/U'_{ix}$ 
  - that is: we normatively choose to place *most* emphasis on the interests of those who have the *least* use of marginal income.
  - if identical preferences,  $U'_{ix}$  decreasing in  $x$ , different incomes: CBA systematically favors the rich and disfavors the poor!
- If compensations are not paid, and income distribution is not optimal, CBA will not rank projects according to  $dW$ .

### CBA and decision-making

- **Purpose 1:** Make final ranking of projects
  - Must choose normative premises (choose SWF)
  - *All* relevant concerns must be valued in monetary terms (to be counted)
- **Purpose 2:** Provide factual input to a (democratic) debate between decision-makers with different normative views (SWFs)
  - Requires that information improves decision-makers’ (intuitive) understanding of effects
  - Requires distinction factual/normative judgements
  - Valuation: needed only if it improves the intuitive understanding
  - Rule of thumb: the harder to value something in money, the harder it is to understand, intuitively, what that money value means

## Political parties and CBA

An index for attitudes towards use of CBA as policy tool. Higher number means more positive attitude (Source: Nyborg 1998, Nyborg and Spangen 1996)



## Normative aspects of CBA

- CBA measures social welfare effects if
  - compensations are paid: no losers
  - or: money is equally socially important for everyone
- Main message:
  - when conflicts of interest (losers and winners): there is no such thing as a "neutral" social benefit measure
  - CBA measures costs and benefits in money; but *money* is not *utility*
  - If politicians consider CBA non-neutral: that may be fully rational and reasonable!
- If final decisions are made by politicians, not CBA:
  - Most important: convey a good understanding of effects
  - Monetary valuation not necessarily needed for that

Thank you

and good luck!