Valuation of biodiversity and ecosystem services

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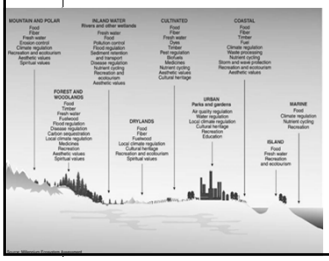
Session overview

- Introduction to revealed preference methods
  - Hedonic price method
    - Case-study 1: Amenity value of English nature
  - Travel cost method
    - Case-study 2: Valuing recreational fishing in the Brazilian Pantanal
- Introduction to stated preference methods
  - Contingent valuation method
    - Case-study 3: Valuing land-use change in the Peruvian Amazon
  - Choice experiments
    - Case-study 4: Valuing preferences for carbon offsets
- Introduction to the happiness approach
    - Case-study 5: Valuing air pollution

From changes in ecosystem services to well-being changes

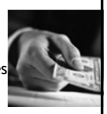
Ecosystem services change → **Natural science** → **Economics**



How much have ecosystem services changed, in physical units?

How much does the level of well-being in society change?

Money measures



Happiness measures

Economic values: benefits and costs

Benefits	Costs
– Anything that ***increases*** human welfare	– Anything that ***decreases*** human welfare

For non-market changes: valuation based on individual **WTP** (or **WTA**)

Total economic value

Category (1)	Category (2)	Example
Use value	**Direct use**	**Recreational use, livelihoods**
	Indirect use	**Ecological functions**
Option value		**Future use**
Non-use value	**Altruistic**	**"Preserve for others"**
	Bequest	**"Preserve for my descendents"**
	Existence	**"Preserve for its own sake"**

Market and non-market goods

- When markets exist
  - Market prices
- When markets exist but are imperfect
  - Adjusted market prices
- When markets do not exist
  - Use non-market valuation techniques
    - Intangibles, non-quantifiable…
    - Valuing non-market goods has become central to many policy debates over environmental quality

Market goods

Non-market goods

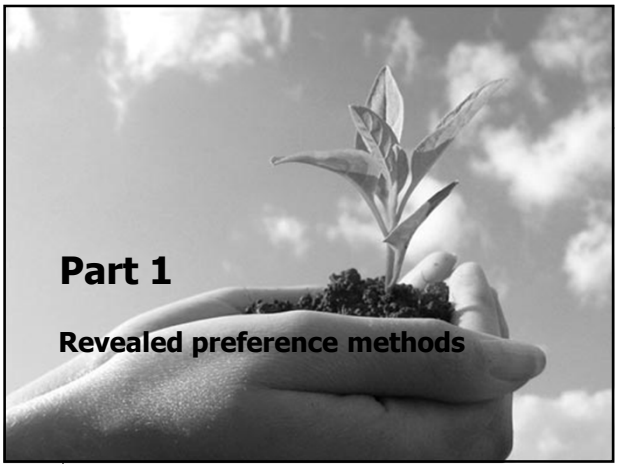
Uses of environmental valuation in policy

- **Cost-benefit analysis:** measure all costs and benefits in monetary terms
- **Pricing/ resource management**: e.g. entrance fee to recreation sites, optimising site characteristics
- **Taxation**: measuring the externality and setting the tax. E.g. landfill tax, aggregates tax (UK)
- **Damage litigation:** compensation for oil spills, land contamination, etc (US)
- **Green national accounting**: calculating true measures of economic growth, with pollution damage and resource depletion
- **Market creation:** E.g. payments for environmental services requires knowledge of the value of service

Non-market valuation techniques

Techniques of Environmental Valuation

Revealed Preference Methods - Actual behaviour - Implied WTP	Stated Preference Methods - Intended actions - Expressed WTP
Travel Cost Method	Contingent Valuation
Hedonic Methods	Choice Modelling
Avertive Expenditures	



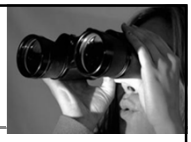
Part 1

Revealed preference methods

Environmental Goods and Market Goods

WELL-BEING

Revealed preferences



- Based on the assumption that we can infer preferences for environmental goods by analysing people's actual behaviour in real (related) markets
- Strength: based on real behaviour/ actual choices

Hedonic price method

- Assumes the price of a market good (e.g. house) is a function of its characteristics
- One characteristic may be environmental quality

Value of environmental good is calculated as price differential between houses that vary in that environmental good, all else constant

Variables

25 Leamount Dr, Sth Yardley

Price: £179,950

Type: Semi

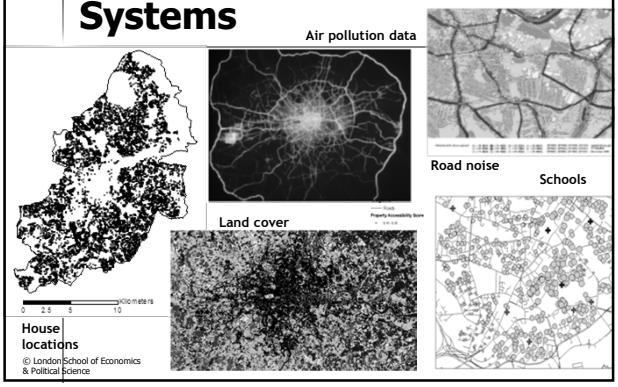
Rooms: 4 bedrooms (1: 13ft/10ft; 2: 14ft/11ft; 3: 12ft/10ft; 4: 8ft/6ft); lounge (14ft/14ft); dining room (10ft/11ft); kitchen (16ft/8ft); bathroom (6ft/6ft); porch

Features: garage & off road parking; fully double glazed; landscaped garden with shed; gas central heating; fully fitted kitchen; burglar alarmed with panic buttons

Local Amenities: Located in a quiet cul de sac in sought after neighbourhood; primary school within 5 min walk, local shops 5 min walk, 10 mins to centre of Birmingham, 10 mins to Airport; Local parks and canal close by

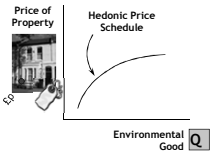
~~Dependent variable~~: Sale price
1. Structural: Number of rooms; presence of garage; size of garden; presence of central heating
2. Locational/accessibility: Distance to: bus stop; town centre; school; shopping centre *(use of GIS)*
3. Neighbourhood: Average age; race distribution; crime rate; quality of surrounding schools
4. Environmental: Noise levels; air pollution levels; lake water quality; quality of views from the property

Geographical Information Systems



Hedonic price and implicit price functions

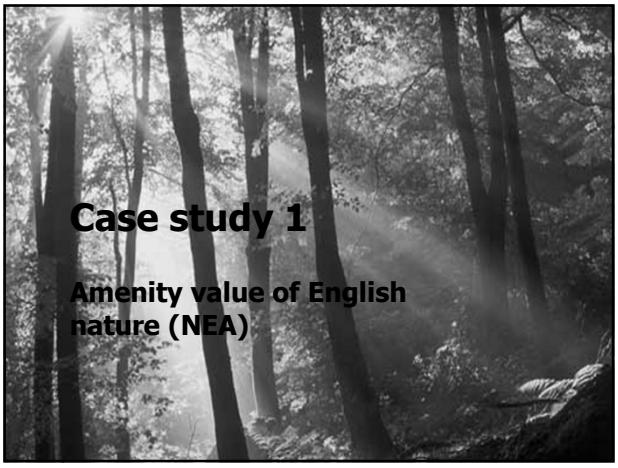
- Value of environmental good is calculated as price differential between identical houses that vary in that environmental good



Hedonic price function example:

HOUSE PRICE = 25.9 + 6.8xSIZE
+ 1.6xHEAT + 23.5xGARAGE
– 5.1xCRIME_RATE
– 7.5xDIST_SCHOOL – 20xPARK(Km)

Implicit price of proximity to park: £20 (WTP for being 1 km closer)



Case study 1

Amenity value of English nature (NEA)

Measuring the amenity value of UK nature

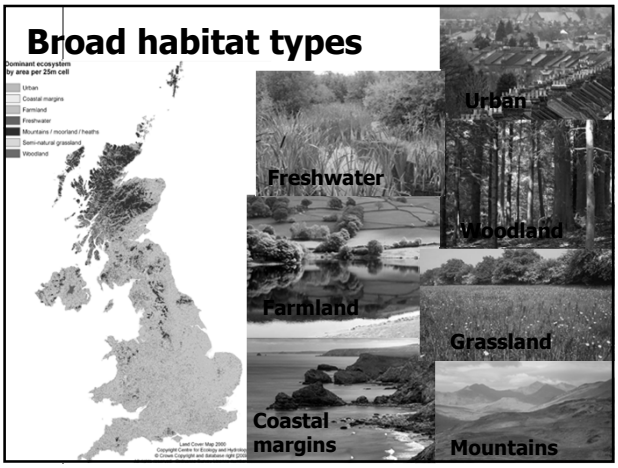
- What is the value associated with living in or within close proximity to desirable natural areas and environmental resources?

Big regression…

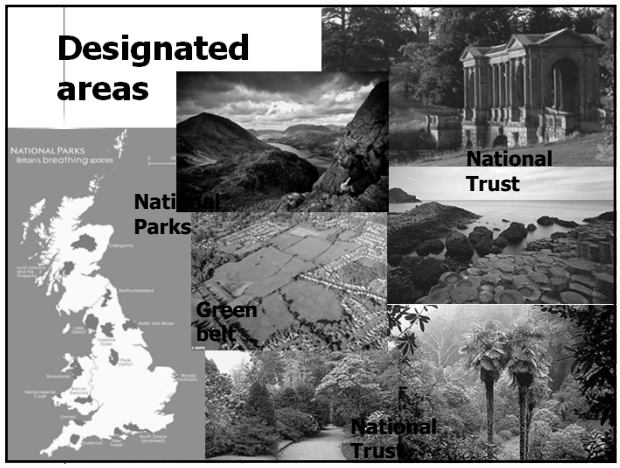
- 1,000,000 UK housing transactions
  - Sale price (1996-2008)
  - Postcode
- Large number of environmental variables
- House characteristics
  - Property type; floor area; central heating type; garage; age; number of bathrooms; number of bedrooms, etc.
- Many other neighbourhood variables
  - Distance to station and to roads; school quality; population size, etc.

Gibbons, Mourato and Resende (2014) The amenity value of English nature: A hedonic price approach. *Environmental and Resource Economics* 57: 175-196.

Broad habitat types



Designated areas



Other environmental resources

- **Domestic gardens**
  - 23m households have access to a garden
- **Public parks**
  - 50% of population in England use a public urban green space at least once a week
- **Rivers**
  - Over 160,000km of rivers and almost 6000 permanent lakes

Hedonic price function for environmental amenities

- Domestic gardens, green space and areas of water within ward attract a similar positive price premium
- Strong positive effect from freshwater habitats, broadleaved and coniferous woodland, and farmland
- Increasing distance to natural amenities is associated with a fall in prices

	Hedonic regression OLS on ln(sale prices)
Ward share of:	
Domestic gardens	***1.01
Green space	***1.04
Water	***0.97
Domestic buildings	***2.16
Other buildings	***2.67
Green Belt	0.02
National Park	0.05
Ward area (km2)	***0.0000009
Distance (100kms) to:	
Coastline	-0.14
Rivers	*-0.91
National Parks	***-0.24
Nature Reserves	-0.07
National Trust properties	***-0.70
Land in 1km x 1km square:	
Marine and coastal margins	0.04
Freshwater, wetlands, floodplains	***0.40
Mountains, moors and heathland	0.09
Semi-natural grassland	-0.01
Enclosed farmland	***0.06
Coniferous woodland	*0.12
Broadleaved woodland	***0.19
Inland bare ground	***-0.38
R-squared	0.865
Sample size	1,013,125

Implicit price of broad habitats and natural areas

1 percentage point increase in share of:	Implicit price (based on house price increase in relation to average 2008 house price)
Freshwater	£768
Broadleaved woodland	£377
Coniferous woodland	£227
Farmland	£113
Domestic gardens	£1,970

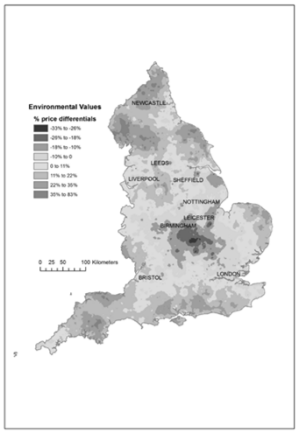
Baseline: Urban

Implicit price of designated areas

Designation	Implicit price (based on house price increase in relation to average 2008 house price)
Being in a National Park	£9,400
Being in the Green Belt	£5,800
1 Km increase in distance:	
Distance to National Trust property	-£1,347

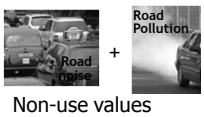
Geographical distribution of environmental value

- Predicted price differentials from property value regressions
  - Mean 2008 house price: £194,000
- Dark green areas represent places with highest value of environmental amenities: >£67,900
  - Lake District, Northumberland, North York Moors, Pennines, Dartmoor and Exmoor
- Lowest levels of environmental value occur in central England, somewhere in the vicinity of Northampton



Limitations

- Data requirements
  - availability, objective vs subjective measures, choice of variables, their measurement, GIS data
- Statistical problems
  - Multicollinearity, functional form
- Need second stage for non-marginal changes in environmental quality
- Correlation between environmental characteristics:



- Non-use values
  - Estimates based on user preferences
- Property market
  - competitive?

Travel cost method

Natural areas (outdoor recreation):

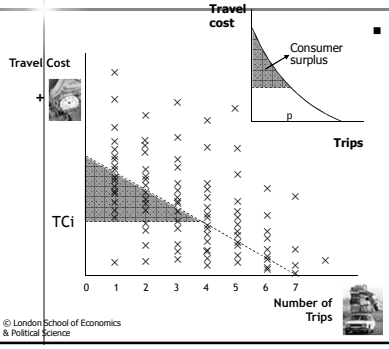
Recreational market complements:

- Demand-based model that estimates use values of recreational sites
  - Assumes that travel cost to a site can be regarded as a proxy for the value of accessing the site
- Usual applications:
  - Closure/opening of a recreational site
  - Change in access costs for a recreational site
  - Change in environmental quality at a recreational site

Travel cost method

- Single site:
  - How many trips are made to site X at a particular cost? (*continuous decision*)
  - Benefits of visiting site X?
  - *Traditional travel cost method*
- Multiple sites:
  - What is the probability of visiting site X, rather than Y or Z? (*discrete decision*)
  - Benefits of visiting site X when Y and Z are also available?
  - Newer *random utility models* of choice between sites

Single-site travel cost method

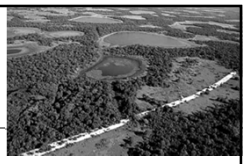


- Willingness to pay to visit the site can be estimated based on demand curve: number of trips made at different travel costs
  - Demand curve slopes down as number of trips decline with distance (cost)
  - Area above cost and below demand curve is consumer surplus:
    - Measure of benefit derived from trip
    - Difference between max WTP and actual price paid

Case study 2

Valuing recreational fishing in the Brazilian Pantanal

Pantanal



- The Pantanal, in Brazil, is a tropical seasonal wetland and one of the world's largest wetlands
- It is a World Heritage Site, exceptionally rich in biodiversity
- Recreational fishing is an important economic activity: 72% of all fish caught are captured by sport fishers
  - 1994-95: around 50,000 recreational anglers
  - Regulated: no nets, maximum catch, no fishing periods

Valuing recreational fishing in Pantanal

- Single site travel cost method
- Estimate values to Brazilian recreational fishing visitors to Pantanal
  - Individual data
- Large travel cost literature on the value of recreational fishing
  - But most in the North America and Europe…

Shrestha, Seidl and Moraes (2002) 'Value of recreational fishing in the Brazilian Pantanal: A travel cost analysis using count data', Ecological Economics 42: 289-299

Data requirements

- Identify user group
  - Recreational anglers in Pantanal
  - Brazilians
- Collect data on number of fishing trips in last 12 months to Pantanal
  - *Survey* data
  - Anglers surveyed in the high season (Aug-Nov 1994) while weighing their catches at key mandatory weighing stations
  - N=286
  - But could be based on secondary data if available
- Calculate travel cost and time cost of round trip
  - Survey data on *perceived* round trip travel costs and travel time
    - Transport, accommodation, access fees, expenses on-site, equipment, etc
  - But typically these variables are constructed by the researchers
    - GIS used to calculate precise door-to-site distances, plus assumptions about travel speed, fuel consumption, road type, etc.
    - OC of time measured as proportion of wage rate
- Demographic variables
  - Sex, age, education, income, etc.

Results: count data model

Variable	Coefficient
Travel cost ($)	-0.00185**
Travel time (hour)	-0.03033**
Education	-0.48611**
Reason for trip: Catch many fish species	0.88727**
Constant	1.52050**
Adjusted R2	0.57

- Dependent variable: number of trips
- Average consumer surplus is $540.54 per trip (negative inverse of cost coefficients) and $86.34 per day (average trip length: 6.26 days)
- Total recreational value to anglers is $35,059,424 per year (multiplying by total trips number).
- Comparing coefficients of travel cost and travel time gives implied value of travel time of $16.39/hour

** significant at 5% level

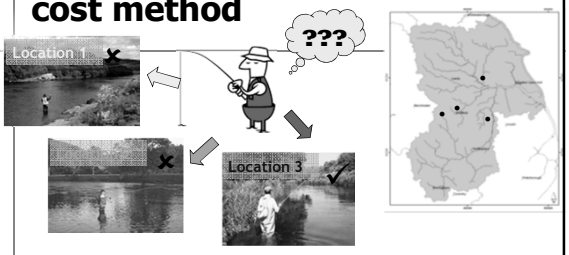
Conclusion

- Evidence of high benefits of recreational fishing in Pantanal ($35 million in 1995)
  - Consumer surplus values for Pantanal anglers ($86/day) are much higher than typical recreational fishing values for USA ($33/day)
  - Consistent with being a globally unique centre for ecosystem services, and an incredibly fertile habitat for aquatic species
  - Suggests the importance of managing recreational fishing to maximise revenues from anglers, by enhancing visitor experience, and protecting the aquatic resources

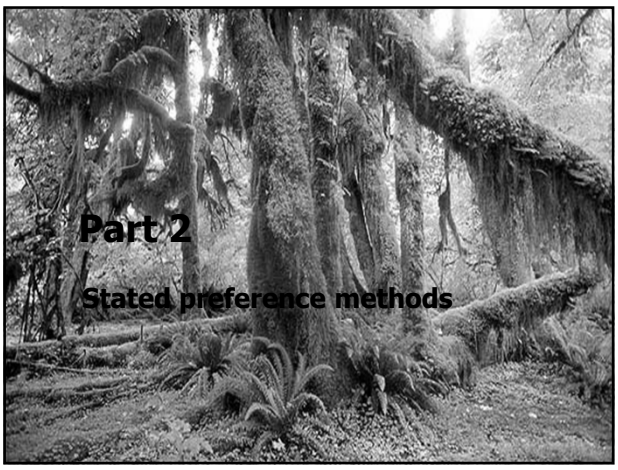
Limitations

- Multi-purpose trips
  - How to attribute travel costs to a particular site?
- Substitute sites
  - The more substitutes, the less valuable a site is
- Site quality
  - Policy to change site quality? No variation observed at one site, with cross-sectional data
- Value of time
  - How to calculate the opportunity cost of time?
  - Shadow price of time calculated as proportion of wage rate: ½? ¼?
- Non-use values
  - Method estimates recreational use values only

Multiple-site travel cost method



- Considers a person's discrete choice of one recreation site from a set of many possible sites (random utility model):
  - Choice depends on site characteristics: trip cost, amenities, accommodation, etc.
  - Choice of site reveals trade-offs between site characteristics
- Focus is on a *discrete decision*



Part 2

Stated preference methods

Stated preferences

- Based on the assumption that people's intended behaviour in hypothetical/ simulated markets (e.g. survey) reflect preferences for non-market assets
- Valuation based on intended future behaviour

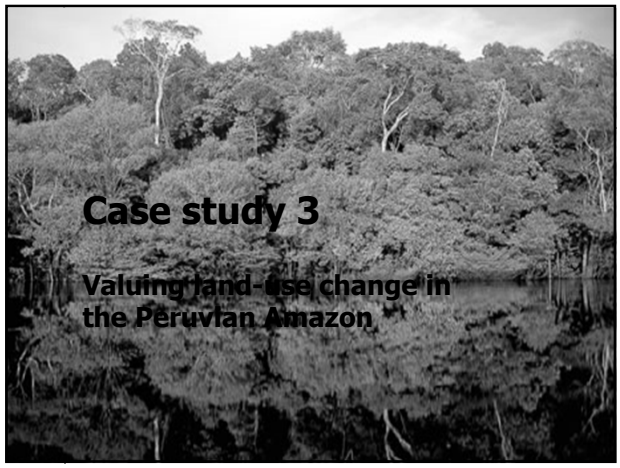
Contingent valuation (CV) method

- Survey method:
  - Constructs a scenario (or a sequence of scenarios) where the asset in question can be traded
- Explicitly asks individuals to place values upon the asset
  - Directly measures people's preferences
  - Correct welfare measures: WTP / WTA
  - WTP / WTA determinants
- Strongly rooted in economic theory (& cognitive psychology)
- Can measure non-use values

A key challenge…

- "The principal challenge facing the designer of a CV study is to make the scenario sufficiently understandable, plausible and meaningful to respondents so that they can and will give valid and reliable values despite their lack of experience with one or more of the scenario dimensions".

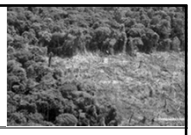
(Mitchell and Carson, 1989, page 120)



Case study 3

Valuing land-use change in the Peruvian Amazon

Objectives



- Investigate possibility of establishing trade in carbon offsets between:
  - utility companies
  - slash-and-burn farmers in the Peruvian Amazon who adopt land-use changes

- Are resource-poor farmers too preoccupied with survival to value the environment?

Outline of a CV questionnaire

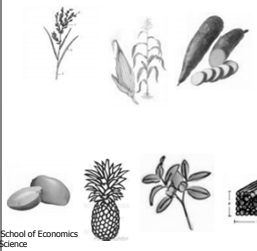
- **Uses / visits**
  - Profile of use / visit
  - Satisfaction / opinion
- **Attitudes**
  - General views and attitudes
  - Specific views and attitudes
- **Scenario description**
  - Current situation
  - Proposed situation (provision mechanism, time-frame, financing)
- **Value elicitation**
  - Payment type, vehicle and frequency
  - Elicitation mechanism
- **Follow-up questions**
  - Motivation behind WTP answer
  - Credibility / meaningfulness
- **Demographics**
  - Sex, age, income, family size, education

Contingent valuation method

- Simulated market:
  - Utility companies willing to compensate farmers to adopt land use changes
- Two land-use changes:
  - Slash-and-burn to forest preservation
  - Slash-and-burn to agroforestry
- WTA compensation:
  - Fixed annual payment per hectare
  - Competitive market
  - *Open-ended*

Market products under both systems: visual aids

- Traditional
  - Rice, maize, yuca
- Agroforestry
  - Rice, maize, yuca
  - Pineapple, oranges, bananas, mango, palmitos, guaba
  - Timber
  - Carbon, fuelwood
  - Construction materials



Open-ended elicitation

What is the minimum amount that you would be willing to accept, every year, to preserve one hectare of your remaining forest?

.....

Dichotomous choice elicitation

- Would you be prepared to accept $100, every year, to preserve one hectare of your remaining forest?

Yes /No

Payment card: $/year

Looking at the values listed in this card, what is the minimum amount you would be prepared to accept, every year to preserve one hectare of your remaining forest?

500	✓
450	✓
400	✓
350	✓
300	✓
250	✓
225	✓
200	
175	
150	✖
125	✖
100	✖
50	✖

Amounts people are sure they would accept

Amounts people are uncertain about

Amounts people are sure they would NOT accept

Elicitation method: visual aid (1)

	Traditional system	Agroforestry
Investment	.....	.....
Labour	.....	.....
Market products	.....	.....
WTA (no environment)	.....	

Elicitation method: visual aid (2)

	Traditional system	Agroforestry
Investment	.....	.....
Labour	.....	.....
Market products	.....	.....
Environment	.....	.....
WTA (no environment)	.....	
WTA (with environment)	.....	

Results


- 214 farmers personally interviewed in 10 localities (11% of all farm units)
- Resource-poor farmers:
  - 93% have precarious wooden/bamboo houses with no sanitation facilities
  - 62% have no means of transport (e.g. animals, bicycles)
- Average farm size: 29 ha
  - 76% have some primary forest left
  - 23% have some agroforestry

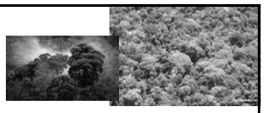
Attitudes and uses: forest

Direct use values	Timber	36%
	NTFP	27%
	Shade	8%
	Wind shelter	10%
Indirect use values	Water quality	26%
	Air purification	51%
	Soil improvement	19%
	Climate stability	14%
Option value	Biodiversity	42%
Non-use value	Bequest value	21%

Estimated mean WTA ($/ha)

	WTA for economic losses	'WTP' for environmental services
Forest preservation	218	67
Agroforestry	138	41

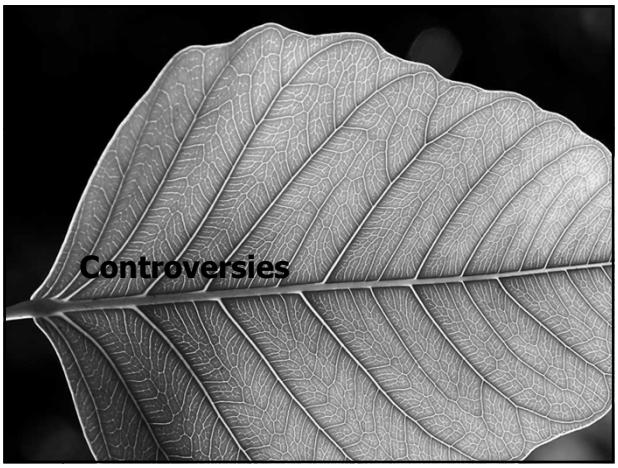
Conclusions



- WTA mechanism yields realistic values:
  - mean WTA for adoption of agroforestry ($138) is very close to the average difference in returns between slash-and-burn and agroforestry in the first two years, from experimental data ($144)
- Farmers appear to place a high value on environmental services (30% of WTA)
- Possibility of mutually profitable international trade in carbon sequestration services appears to exist

Postscript

- In the last 10 years, multi-million dollar markets in carbon, wetlands, water pollution and biodiversity have been created
- Hundreds of markets for environmental services have been inventoried
  - Many involve systems of 'payments for ecosystem services' that involve transfer of financial resources from beneficiaries of the environmental services (e.g. international community) to those who provide these services (e.g. developing country landowners)



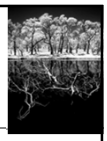
The CV debate

- The raise in popularity of stated preference methods has been accompanied by a very active debate and critical assessment of the merits and limitations of the techniques and their underlying conceptual framework
- Kerry Smith (2000): "*Contingent valuation has prompted the most serious investigation of individual preferences ever undertaken in economics*"
- **Stated preference methods are subject to more stringent quality checks and validity testing than any other methodology…**

Problem areas

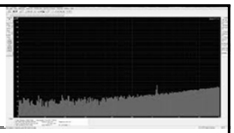
- **Hypothetical bias**
  - Ask a hypothetical question, get a hypothetical answer?
- **Insensitivity to scope**
  - WTP insensitive to the scope of the environmental change
- **Ability to pay**
  - Does inability to pay cause a bias?
- **Ethical concerns**
  - Is it ethical to value environmental change?

Hypothetical bias



- One of the staunchest criticisms of CV: 'Ask a hypothetical question, get a hypothetical answer'
  - **No real economic commitment**
  - Has originated active debate and research
- Definition:
  - Any deviation of stated WTP from 'true' WTP, due to the hypothetical nature of the change to be valued
  - Nature of bias: Individuals are widely believed to overstate the amount they are WTP for improvements in a public good
- WTP is an intention to pay. There is plenty of evidence dating back to at least the 1930s that stated intentions can differ significantly from observed actions.
- The presence of hypothetical bias has been well-documented in both laboratory and field studies:
  - Meta-analyses of the experimental literature (List and Gallet 2001; Murphy *et al.* 2005) report that mean hypothetical values are about two to three times greater than actual values (from highly skewed distribution, median closer to 1.5).

Instrument calibration



- Increasing realism of scenario
- Avoid donations (not incentive compatible
- Giving respondents time-to-think
- Convince respondents that survey instrument is consequential
- Ask respondents about the likelihood that their answers are accurate: certainty measures
- Budget and substitute reminders as a corrective entreaty
- Cheap talk entreaty
  - simply make people aware of the hypothetical bias problem and to account for it when making their decisions
- All found to reduce hypothetical bias

Insensitivity to scope

- **Insensitivity to scope**
  - Occurs when the value of a good does not have a multiplicative relationship to its size

Mental accounts

- Thaler, 1999: We think of money as sitting in different "mental accounts"
  - salary, savings, expenses, good causes, etc
- We are reluctant to move money between such accounts
- 'Good cause dump hypothesis': Individual allocates the whole 'good cause' budget to good(s) on offer in contingent market

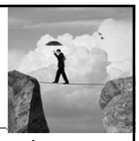
Warm glow

- WTP captures moral satisfaction from the act of giving, not preferences for the good on offer in contingent market
  - Kahneman calls it the purchase of moral satisfaction

Framing effects

- Bad survey design due to inadequate framing
- A key tenet of psychology is that the context and the framing of a situation matter
  - Two equivalent decision problems that are framed differently may elicit different responses
- It may not be sufficiently clear that different quantities of the good are being valued
- Solutions:
- Top-down approach
  - Describing the larger and smaller commodities, and then asking respondents to focus their attention on the smaller commodity
- Using visual aids: maps, photographs, images to describe the scenario
- Providing opportunity to respondents to revise the bids

Small risk changes



- Desvousges et al. (1993) found insensitivity to scope in WTP for preventing deaths of migratory birds from oil spills using three independent samples.
- Three versions of the survey :
  - 2,000, 20,000 or 200,000 bird deaths prevented
  - And their respective percentage: much less than 1%, less than 1% and above 2%...
- Many health valuation studies also involve small risk changes
- Respondents may not be sensitive to variation in risk magnitude due to their lack of understanding of probabilities and poor appreciation for numerical differences in magnitude
  - People are known to be insensitive to things such as small risk changes
  - The mg U for preventing additional bird deaths may be too small to detect
- Solutions:
  - Visual representations of risk
  - Presentation of analogies in the stimulus
  - Focus on increments in risk rather than levels

Willingness and ability to pay

Wants / Budget	Willing to pay	NOT willing to pay
Able to pay	Willing and able **WTP>0**	Able but NOT willing **WTP=0**
Not able to pay	Willing but NOT able **WTP=0**	NOT able and NOT willing **WTP=0**

WTP in developing countries (1)

- 20 years of research show that WTP is typically low in developing countries
  - In absolute terms and as a percentage of income
  - Relative to the cost of service provision
- Whittington (2010) reviews evidence from:
  - Improved water infrastructure, sanitation and sewage, household water treatment, ecosystem services and watershed protection, solid waste management and collection, marine turtle conservation, vaccines against cholera and typhoid infection, preservation of cultural heritage assets.

WTP in developing countries (2)

- Typical findings:
  - Demand for improved services rarely found to be sufficient to recover the costs of service provision
  - Issue not a priority
- Unsurprisingly, poor households in developing countries often have much more pressing needs than the hypothetical goods and services offered by SP researchers…
  - People living at a subsistence level must spend almost all their money on calories to survive…
- Policy solution:
  - Capital subsidies needed
  - International assistance needed
  - Wait until incomes are higher and WTP has risen

Money is a dirty word?

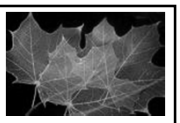
- Some critics …

…"believe most sincerely that monetising the environment is merely a further step in global degradation of the human spirit, let alone the natural world"

(O'Riordan, 1995)

- The environment is priceless
- But what is the alternative???
- In a world of scarce resources trade-offs have to be made
  - What about human health? Education? Poverty alleviation? Culture?
- Can provide powerful argument for conservation
- Irreversibilities / uncertainty
  - 'don't do anything disgusting' → safe minimum standard?

Final remarks

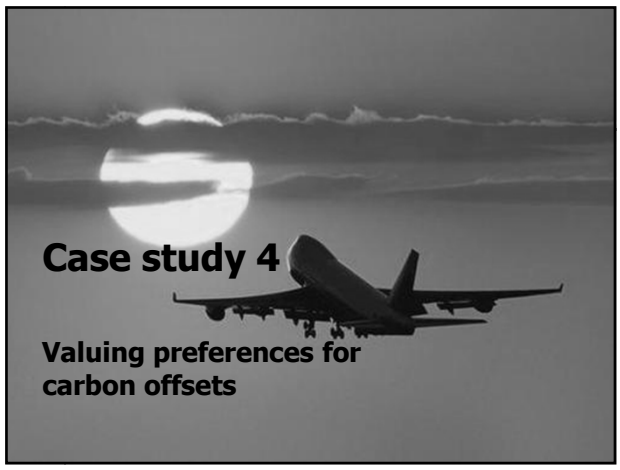


- A healthy dose of scepticism is important in the application, use, and interpretation of any empirical methodology such as CV.
  - 'Survey results should not be given an economic meaning unless the good to be valued is clearly explained, its delivery to the public is plausible and a realistic expectation of payment is created' (Carson et al. 2001)
  - That is, the results are only as good as the survey instrument itself.
- Careful survey design can overcome several apparent CV anomalies: but developing valid/ reliable surveys is not simple and can be expensive
- Ultimately, CV is a very useful addition to environmental economists 'toolkit', especially where non-use values are important.

Choice experiments (for multidimensional changes)

- Assumes that the value of a good is a function of its characteristics
- Individuals are asked to choose their preferred alternatives amongst various constructed scenarios
  - Each scenario is a function of various attributes (including price)
  - Each attribute varies at different levels
  - Choices involve trade-offs
  - WTP or WTA is inferred indirectly

Attributes	Management Option 1	Management Option 2	Status Quo
Closure	10	50	0
% closed of current fishing grounds			
Net	6	1	3
mesh size in "			
Payment (Tsh)	10,000	5,000	0



Objectives

- Estimate WTP for voluntary carbon offsets and for:
  - Potential sustainable development **co-benefits** of offset projects
    - *Biodiversity*
    - *Human development*
    - *Low carbon technology/market development*
  - **Certification**
- Web-based choice experiments
- N=350, UK residents aged 18-34

Design of the choice questions

- Select scenario
- Select attributes
  - Lit reviews, focus groups, etc.
- Assign levels
  - Realistic, span preference range
- Choose experimental design
  - Complete factorial, fractional factorial
- Construct choice sets
  - Include a baseline or opt-out
  - Number of choice sets per person and number of scenarios per choice set

Scenario

- Please imagine that you are flying from New York to London and are offered the opportunity to offset your contribution to the CO2 produced by this flight.
- You will be presented with a series of six choice cards. Each card presents three options.
  - The first two options in each case represent different offsetting projects, with different features and prices. The last option in each case represents the 'do nothing' scenario: no payment and no carbon offset."

Example choice card

Please indicate your preferred option: A, B or no offsetting.

	Offset project A	Offset project B	No offsetting
Carbon offset	Yes	Yes	No
Additional benefit	Technology & market development	None	N/A
Certification	None	UK Government certified	
Price	£16	£20	0
Your choice	○	○	○

Example choice card

Please indicate your preferred option: A, B or no offsetting.

	Offset project A	Offset project B	No offsetting
Carbon offset	Yes	Yes	No
Additional benefit	Human development	Conservation & biodiversity	N/A
Certification	None	UK Government certified	
Price	£8	£8	0
Your choice	○	○	○

Attributes & levels

Attribute	Levels
Project co-benefits	Human development
	Conservation & biodiversity
	Technology & market development
	None
Certification	UK Government certified
	None
Price (GBP)	£4, £8, £12, £16, £20

Model

The choice data can be analysed with a Conditional Logit Model, where the probability of choosing an option, depends on the utility of that option relative to other options

$$\text{Probability (choice } i) = \frac{\exp(\lambda V_i)}{\Sigma_j \exp(\lambda V_j)}, \text{j} = 0, 1 \ldots \text{J}$$

$$V_i = C + \Sigma \beta_K \cdot X_K$$

Utility is a function of the choice attributes X and alternative specific constants (and other socio-econ and attitudinal variables in more complex models)

$WTP_{attribute} = -\beta_{attribute}/\beta_{price}$

How much money would one be willing to trade for one extra unit of the attribute?

Value of the 'parts'

- Substantial WTP for offset co-benefits over and above WTP for offsets themselves:
  - Offset: £12
  - Biodiversity co-benefit: £15
  - Development co-benefit: £13
  - Technology co-benefit: £11
  - Certification: £11

Value of the 'whole'

	Option 1	Option 2	Option 3
Offset	£12	£12	£12
Biodiversity	-	£15	£15
Certification	-	-	£11
Total	**£12**	**£27**	**£38**

Conclusion

- Public uptake of voluntary offsets may be encouraged by investing in projects with a range of co-benefits ('boutique offsets'):
  - Biodiversity, human development, or sustainable technology/market development
- Many policy uses
- E.g. World Bank set up funds for carbon financing, that invest in projects with sustainable development co-benefits:
  - Prototype Carbon Fund
  - Community Development Carbon Fund
  - Bio Carbon Fund

Strengths

- Unique ability to deal with situations:
  - Where changes are multidimensional
  - Trade-offs between dimensions of particular interest
- Ability to elicit value of whole and of parts:
  - marginal value of attributes ('implicit prices')
  - values for an array of potential options (attribute levels combinations) relative to status quo
  - proportion of the community supporting alternative options
- Diffuse cost focus: WTP is inferred indirectly

Weaknesses

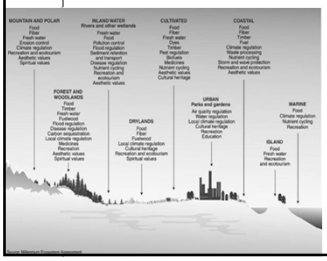
- Cognitive burden
- Technical complexity
  - experimental design
  - econometric analysis
- …and those common to all stated preference methods
  - hypothetical scenarios
  - insensitivity to scope
  - aggregation errors, etc

Part 3

The happiness approach

From changes in ecosystem services to well-being changes

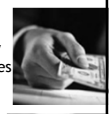
Ecosystem services change → **Natural science** → **Economics**



How much have ecosystem services changed, in physical units?

How much does the level of well-being in society change?

Money measures



Happiness measures

What is happiness economics?

- The **quantitative study of happiness** typically combining economics with other fields such as psychology
- Main aim has been understanding the interconnection between economic outcomes and the resulting (self-reported) happiness of economic actors

Where would you place yourself on this 0–10 scale?

All things considered, how satisfied are you with your life as a whole nowadays?

0 = extremely dissatisfied
10 = extremely satisfied

A complex concept…

- Happiness is a subjective evaluation of life
- There is no accepted, universally used definition of happiness, it is a complex construct

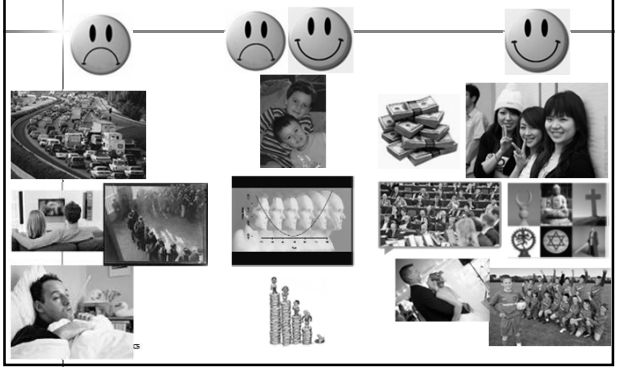
Different accounts of happiness/ subjective well-being

- **Current/remembered emotional report**
  - 'How happy are you right now?'
    - Positive and negative affect (mood, emotions and feelings)
  - 'How happy were you yesterday?'
- **Cognitive life evaluation**
  - 'How happy/ satisfied are you with your life as a whole?'
- **Eudemonic**
  - Does your life has meaning and purpose?
  - Overall, to what extent do you feel that the things you do in your life are worthwhile?

Aim is to estimate a big happiness regression…

Dependent: Life satisfaction	(1)		(2)		(3)		(4)		(5)	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Regeneration	0.594**	0.277	0.687**	0.281	0.652**	0.284	0.661**	0.287	0.511*	0.282
Ln(Household income)	1.031***	0.316	0.794**	0.317	0.729**	0.314	0.800**	0.316	0.667**	0.318
Gender	0.177	0.353	0.128	0.255	0.271	0.350	0.134	0.348	0.075	0.369
Age	-0.129	0.081	-0.162**	0.082	-0.116	0.081	-0.100	0.081	-0.059	0.081
Age^2	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Married	0.683*	0.369	0.638*	0.384	0.571	0.377	0.553	0.392	0.452	0.382
Cohabiting	0.889	0.546	-0.623	0.564	-0.764	0.562	-0.795	0.584	-0.594	0.555
Divorced	0.703	0.515	0.049	0.505	-0.118	0.498	0.008	0.509	-0.615	0.520
Separated	-2.688***	0.969	-1.565	1.148	-1.193	1.139	-1.136	1.165	-0.449	1.228
Widowed	-0.664	1.116	-0.597	1.150	-0.569	1.106	-0.622	1.111	-0.987	1.082
Employed part-time	0.147	0.420	-0.034	0.424	0.059	0.417	0.154	0.419	0.032	0.406
Self-employed	2.451***	0.754	2.209***	0.765	2.289***	0.719	2.168***	0.730	1.519**	0.747
Unemployed – looking for work	-0.007	0.668	-1.667**	0.664	-1.415**	0.673	-1.748***	0.645	-1.439**	0.642
Unemployed – not looking for work	-0.154	0.484	-0.113	0.496	-0.246	0.487	-0.275	0.490	-0.240	0.510
Student	1.343*	0.688	0.953	0.690	0.991	0.676	1.078	0.676	1.116*	0.649
Retired	1.139	0.714	0.539	0.690	0.579	0.689	0.207	0.742	1.088**	0.833
Ln(reference income)	-0.047	1.408	-1.273	1.417	-1.755	1.390	-1.321	1.383	-0.660	1.358
Speaking to family			0.117	0.187	0.165	0.195	0.199	0.199	0.078	0.191
Speaking to friends			0.471**	0.194	0.467**	0.196	0.359*	0.211	0.658***	0.209
Speaking to neighbors			0.118	0.148	0.059	0.146	0.077	0.145	-0.159	0.146
Crime					-0.239*	0.132	-0.229*	0.133	-0.440***	0.140
Noise from neighbors					-0.219*	0.115	-0.162	0.117	-0.171	0.112
Shortage of space in house							-0.118	0.308	-0.065	0.302
Lack of light in house							-0.811**	0.351	-0.779**	0.342
Lack of adequate heating in house							-0.736	0.459	-0.611	0.439
Leisure time									-0.081**	0.037
Health controls…										
Constant	-0.908	13.328	11.879	13.230	16.904	12.976	12.071	12.042	7.398	12.718
N	186		187		185		183		180	
Adjusted R^2	0.23		0.26		0.28		0.32		0.39	
Average household income	£18,917		£18,952		£18,889		£18,776		£19,014	
Income compensation	£14,200		£14,100		£17,100		£14,100		£13,900	

Usual findings…



How does the environment affect happiness?

- Air pollution

- Perceived noise

- Floods/ draughts

- Mild climate

- Scenic amenity

- Biodiversity

Non-market valuation with the happiness approach

- The Happiness approach can be used in principle to estimate the value of non-market goods by looking at how they impact on people's reported well-being
- As long as income is included as a determinant, the marginal rate of substitution between income and the non-market good provide an estimate of economic value

Happiness/life satisfaction approach to valuation

- Assumes LS is an acceptable proxy for utility that can be measured directly:

$$LS_{it} = \alpha + \beta_1 M_{it} + \beta_2 Q_{it} + \beta_3 X_{it} + \varepsilon_{it}$$

  - Where LS: life satisfaction; M: income; Q: non-market good; X: individual characteristics and other factors
- The relative size of any two coefficients provides information about how one variable would have to change (e.g. income) to maintain constant well-being (e.g. LS) in the face of an alteration in the other variable (e.g. non-market good).

$$WTP_{LS} = \frac{\beta_2 (Q_{it}^1 - Q_{it}^0)}{\beta_1}$$

Case study 5

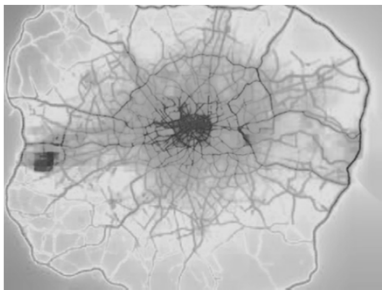
Happiness and air quality

Objectives

- Investigate whether air quality affects life satisfaction in London
  - Using individual-level data
  - Very high spatial resolution
- Web-based survey
- N=413, London residents

Individual postcode data

Air pollution data



- Annual average: ozone, particulates and NO2
- London: 50m x 50m squares

Explaining life satisfaction

Estimated parameters for LS models: ordered probit and OLS

	Model 1	*Model 2*	*OLS*
Variable	*Coefficients*		
AGE	−0.016 †	−0.014 †	−0.023 †
FEMALE	0.112	0.065	0.065
DEGREE	−0.190	−0.240	−0.240
POORHEALTH	−1.134 ***	−1.175 ***	−1.602 ***
MARRIED	0.372 *	0.383 *	0.463 *
[illegible]	0.290	0.275	0.428
LOGINCOME	0.209 *	0.228 *	0.363 *
HOMEOWNER	0.196	0.155	0.225
SOCIALTENANT	−0.400	−0.388	−0.646
CROWDED	−0.377 *	−0.330 †	−0.541 *
RELIGIOUS	0.165	0.118	0.163
TRUST	0.304 *	0.279 †	0.412 *
CHILDREN	−0.017	−0.062	0.020
SINGLEPARENT	−0.373	−0.293	−0.235
TV	0.029	0.017	0.047
RELATIVES	0.238 †	0.291 *	0.423 *
NEIGHBOURS	0.482 ***	0.454 **	0.645 **
GROUPS	0.351 **	0.350 **	0.424 *
SOHOKM	−0.042 *	−0.071 ***	−0.097 **
AIRBAD	−0.266 *		
NOISEBAD	0.188		
NO2c2007		−0.032 *	−0.042 *
NO2TREND		0.182	0.132
MAINROAD50M		0.124	0.209
BOMBDAY	0.181	0.167	0.209
SUNNY	−0.101	−0.078	−0.116
REVSCALE	0.102	0.082	0.092
Constant			5.901 **

Issues: translation into monetary measures…

- If we run the OLS model with log NO2 concentrations, we can value marginal changes in NO2 concentrations by calculating an elasticity as the ratio of the coefficients on log income (0.365) and log NO2 (-1.933).

A 1% increase in NO_2 levels is equivalent in happiness terms to a

5.3%

drop in income!

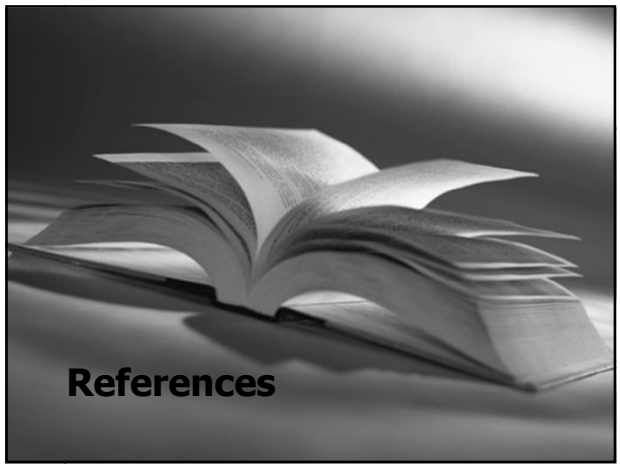
Problems of environmental valuation using happiness

- Implausibly high valuations… Very likely due to underestimated income effects
- Must assume interpersonal comparability
- Difficult to measure non-use values
- Unable to value future impacts
- Difficult to value minor changes

Difficulty in estimating marginal utility of income

- In happiness regressions the coefficient on income is typically significant but small
- This leads to implausibly high estimated values for non-market goods

- Use instrumental variables for income
  - Increase the size of income coefficient
- Include relative income
  - Controlling for relative income increases income coefficient
- Controlling for income determinants
  - Commuting time, hours of work



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