

**Environmental Economics for
Development Policy IX**

The World Bank

Choice Modelling Methods

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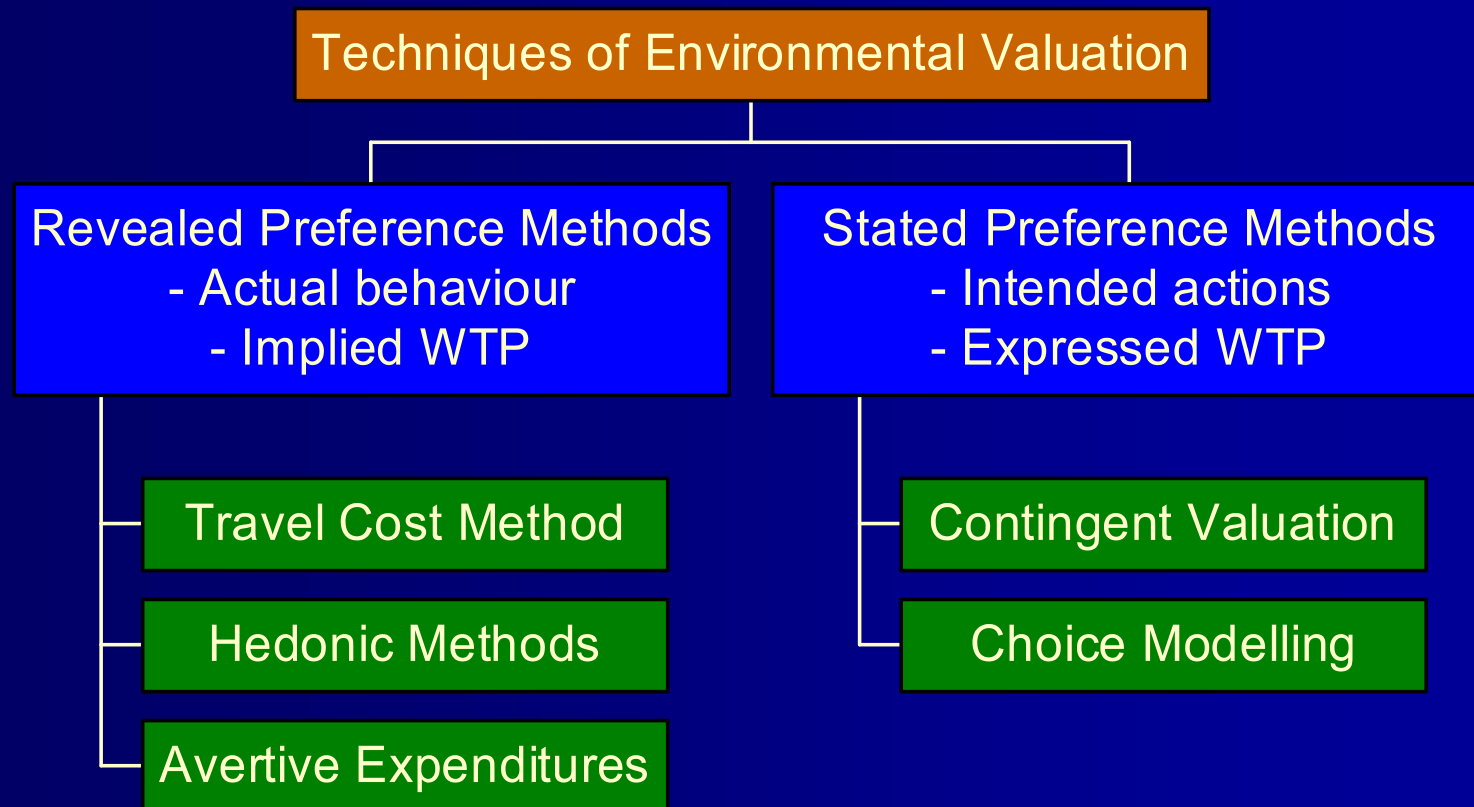
Lecture overview

- To introduce the **choice modelling** approach to environmental valuation
- To discuss the **advantages and disadvantages** of attribute-based methods
- To illustrate how choice modelling techniques can be applied to a wide range of **policy issues**

Part 1

Choice modelling methods

Non-market valuation techniques



Stated preferences

- Based on the assumption that people's intended behaviour in **hypothetical markets** (e.g. survey) reflect preferences for non-market assets
- Valuation based on **intended future behaviour**
 - Contingent valuation method
 - **Choice modelling techniques**








Choice modelling

- Assumes that the value of a good is a function of its characteristics
- Individuals are asked to **choose, rank or rate** various **hypothetical alternatives**
 - Each alternative is a function of various **attributes** (including price)
 - Each attribute varies at different **levels**
 - Choice involves **trade-offs**
 - WTP is inferred indirectly
- Popular in marketing, transport, psychology, health and now environment







Choice experiments (1)

option example

		Plan A	Plan B	Neither
	LANDSCAPE visual impact caused by location and/or size	HIGH	NONE	No increase in renewable energy Alternative climate change programs used North Sea gas fired power stations instead
	WILDLIFE health of habitat	SLIGHT HARM	SLIGHT HARM	
	AIR POLLUTION	NONE	NONE	
	EMPLOYMENT new jobs in local community	8-12 JOBS	1-3 JOBS	
	PRICE OF ELECTRICITY additional rates per year	£16 per year	£7 per year	
YOUR CHOICE: (please tick one only)		A <input type="checkbox"/>	B <input type="checkbox"/>	I would not want either A or B <input type="checkbox"/>

Choice experiments (2)

Table 3.4: Example of a choice card used in the survey

Policy Option		Current Policy	Policy Option A	Policy Option B
	Change in area of Heather Moorland and Bog	A loss of 2% (-2%)	A gain of 5% (+5%)	A loss of 2% (-2%)
	Change in area of Rough Grassland	A loss of 10% (-10%)	A gain of 10% (+10%)	A loss of 10% (-10%)
	Change in area of Mixed and Broadleaf Woodlands	A gain of 3% (+3%)	A gain of 20% (+20%)	A gain of 10% (+10%)
	Condition of field boundaries	For every 1km, 100 m is restored	For every 1km, 200 m is restored	For every 1km, 50 m is restored
	Change in farm building and traditional farm practices	Rapid decline	Much better conservation	No change
	Increase in tax payments by your household each year	£0	£70	£10

Contingent ranking (1)

	Bread A	Bread B	Bread C
Ill-Health	100 cases	60 cases	40 cases
Birds decline	9 species	2 species	5 species
Price	60p	85p	£1.15
Rank	3	1	2

Contingent ranking (2)

RANK THE ALTERNATIVES FOR A SUMMER VISIT BELOW ACCORDING TO YOUR PREFERENCES, ASSIGNING 1 TO THE MOST PREFERRED, 2 TO THE SECOND MOST PREFERRED, 3 TO THE THIRD MOST PREFERRED AND 4 TO THE LEAST PREFERRED.


CHARACTERISTICS OF ROUTE	ROUTE A	ROUTE B	ROUTE C	STAY AT HOME
Length of climb	200 metres	250 metres	250 metres	
Approach time	3 hours	2 hours	2 hours	
Quality of climb	2 stars	1 stars	0 stars	
Crowding at route	Crowded	Not crowded	Crowded	
Scenic quality of route	Scenic	Not at all scenic	Not scenic	
Distance of route from home	160 miles	70 miles	30 miles	

RANKING:


Rated pairs

ESC


Current:



Basic protection from the wind and rain for those under the shelter




Bench seat – not always available




No toilets

Fare: £0.70 per journey


Alternative:



Good all-round protection from wind and rain for those under the shelter



Tip-up seats – always available




Toilets – cleaned **continually**

Fare: £0.90 per journey
(an increase of 20p)

Which of these do you prefer?

Extreme Strong Slight Cannot choose Slight Strong Extreme



Confirm

Choice modelling: outputs

- Marginal rates of substitution between attributes, including “implicit prices”
- Values for an array of potential options (attribute levels combinations) relative to the “current situation” option
- Proportion of the community supporting alternative options

Case study

Valuing the impacts of pesticide application in the UK



Pesticides study



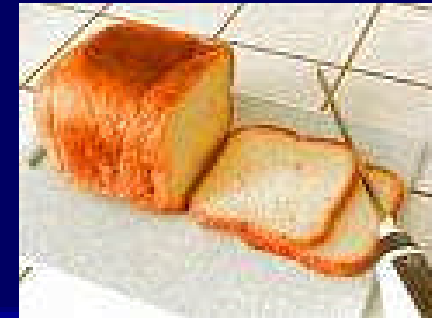
- Aim: Measure the multiple benefits of pesticide reduction in the UK
- Sponsor: US EPA
- Method: Contingent ranking
- 500 face-to-face interviews (1995) of UK households

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Pesticides study



	Bread A	Bread B	Bread C
Ill-Health	100 cases	60 cases	40 cases
Birds decline	9 species	2 species	5 species
Price	60p	85p	£1.15

Pesticides study: value of 'parts'

Attributes	WTP per loaf of bread
Avoided cases of ill health	1p
Avoided bird species in decline	7p



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Pesticides study: value of 'whole'



Bird species in decline	Cases of ill health					
	100	80	60	40	20	0
9	£0.60	£0.74	£0.87	£1.01	£1.14	£1.28
7	£0.70	£0.84	£0.98	£1.11	£1.25	£1.38
5	£0.81	£0.95	£1.08	£1.22	£1.35	£1.50
2	£0.97	£1.10	£1.24	£1.37	£1.51	£1.65
0	£1.07	£1.21	£1.34	£1.48	£1.61	£1.75

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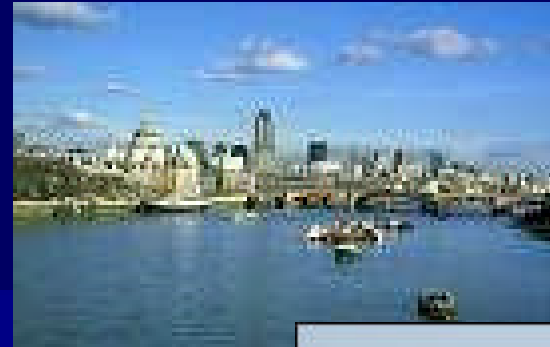
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Part 2

Choice experiments

Case study

Sewage overflows in Tidal Thames (UK)



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Sewage overflows in the River Thames

- Thames Tideway:
 - Tidal Thames: >150 miles
- London's Victorian sewer system is 'combined':
 - Carries both human waste and rain water
 - Capacity often exceeded and raw sewage discharged into the Thames
- How to estimate the non-market benefits of solving this problem?



The general problem



- 60 overflows per year
 - Combined sewer overflow (CSOs)
- Impacts on:
 - Visual appearance of the river
 - Health risks for swimmers, rowers and so on
 - Fish populations

“Thames Fish in Poison Disaster” **(*Evening Standard*, 05/08/04)**

- August 3rd 2004
 - ‘Freak’ weather led to storm-water overflow
 - 600,000 tonnes of raw sewage ended up in Thames
 - Fish deaths and other impacts widely reported in the media



Engineering answers ...

Cost questions

- Investigation of solutions to overflows part of "Tideway Strategy"
- No. of engineering options identified
 - Storage/Transfer tunnels
 - Treatment plant/systems
 - Upgrades of existing treatment works
- Construction period lasts from 6 to 9 years
- Costs of options: from £0.5bn to >£4bn
 - Most options £1bn-£2bn
- If "go ahead", Thames Water customers would pay
 - Several million households
 - Add another £10 to £20 per year to water bills

London's "Super-Sewer"

- BBC London Poll (August 5th 2004)
 - "Should London's Super-sewer (33 km long tunnel) be built even if it meant an increase in water bills?"
 - >80% of callers say: "yes"
- Decision to go-ahead (or not) more complex...

Aim of study

- **Combined sewage overflows** in the Thames Tideway cause raw sewage and sewage litter to enter the river, degrading water quality and causing disamenity
- **Objective of study:** to measure people's preferences for the benefits of engineering solutions to reduce sewage litter and improve water quality in the river
 - Combined **choice experiment / contingent valuation** study

Choice experiments

- Respondents asked to **choose their preferred alternative** between potential river improvement scenarios
- Scenarios are described using attributes which take on different levels across scenarios
- One of the attributes is cost to households
- Choices involve trade-offs








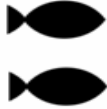




Design of the choice questions

- 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

River attributes and levels

Attribute	Description	Levels
Sewage litter	As % of total litter (human excrement, condoms, etc)	10%, 3%, 1%, 0%
Water sports/ health risk	Number of days per year when water sports are not advisable due to increased health risk (minor illness)	120, 60, 10, 4, 0
Fish population	Potential fish kills per year	8, 4, 2, less than 1, 0
Annual cost	Increase in annual water bills	0, £5, £15, £23, £36, £47, £77, £115

Example: attributes and levels

Ecol. Condition Impact on	What will happen if we do nothing	What will happen if we do something	
	Worsening	Slight Improvement	Big Improvement
Large Mammals	 Large Mammals unlikely to be present	 Medium sized mammals such as water vole possible	 Small populations of large mammals such as otter possible
Plants	 Algae – Pond Scum main vegetation type	 Algae – Pond Scum main plant type but a few aquatic plants present	 A mixture of aquatic plants and algae
Fish	 Few fish species with small populations	 Few fish species with large populations	 Many fish species large populations.
Other factors	 Smell of rotting vegetation noticeable	 Occasional smell of rotting vegetation	 No smell noticeable

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Experimental design

- **Full factorial design**: $4*5*5=100$ scenarios
 - Sewage litter: 4 levels
 - Water sports/human health: 5 levels
 - Fish kills: 5 levels
 - Cost: 8 levels: assigned randomly
- **Fractional factorial design** = 25 scenarios
- **Final choice sets**: 8 choice cards per person
 - Each card: baseline + 2 improvement scenarios
 - Each choice set includes a test for dominance and consistency

05/12/2006 Benefits noticeable after 10-20 / 3-6 years time

Example of a choice card

	Current situation	Option A	Option B
Sewage litter	Some items visible (10% of total litter)	Items almost never visible (1% of total litter)	Not present (0% of total litter)
Other litter	Present	Present	Present
Water sports/ health risk	120 days/ year of increased health risk	4 days/ year of increased health risk	0 days/ year of increased health risk
Fish population	8 potential fish kills per year	0 potential fish kills per year	<1 potential fish kills per year
Annual cost	0	£15	£77
Preferred option			✓

Contingent valuation

- Valuation of the **best possible improvement** (no sewage overflows)
- Elicitation method: **dichotomous choice**
 - Are you willing to pay £X for the described improvement?
 - £X varies across respondents
 - Incentive compatible, easy to answer
 - Less informative

Example of CV question

	Current situation	Improved situation
Sewage litter	Some items visible (10% of total litter)	Not present (0% of total litter)
Other litter	Present	Present
Water sports/ health risk	120 days/ year of increased health risk	0 days/ year of increased health risk
Fish population	8 potential fish kills per year	0 potential fish kills per year

Would you be willing to pay £5 per year on top of your water bill for an engineering solution that would achieve these improvements (noticeable after 10 to 20 years time)?

Survey implementation

- **Sample:** face-to-face interviews with sample of 1,214 Thames Water customers throughout London and the South East
- **Questionnaire:**
 - Attitudes and uses of the River Thames
 - Health impacts respondents (or their families) may have suffered through contact with Thames water
 - Valuation scenario: choice experiments and contingent valuation
 - Follow-up questions and demographics

River experience

Percentage

Ever see Thames (journey)

74

–At least once a month

20

Ever visit Thames for
recreation

63

–At least once a month

27

Main use of the river

	<u>Percentage</u>
To get from A to B	28
Walking for leisure	27
Riverside café /pub /restaurant	13
Relaxing/ enjoying scenery	11
Place to take children	5

Quality ratings

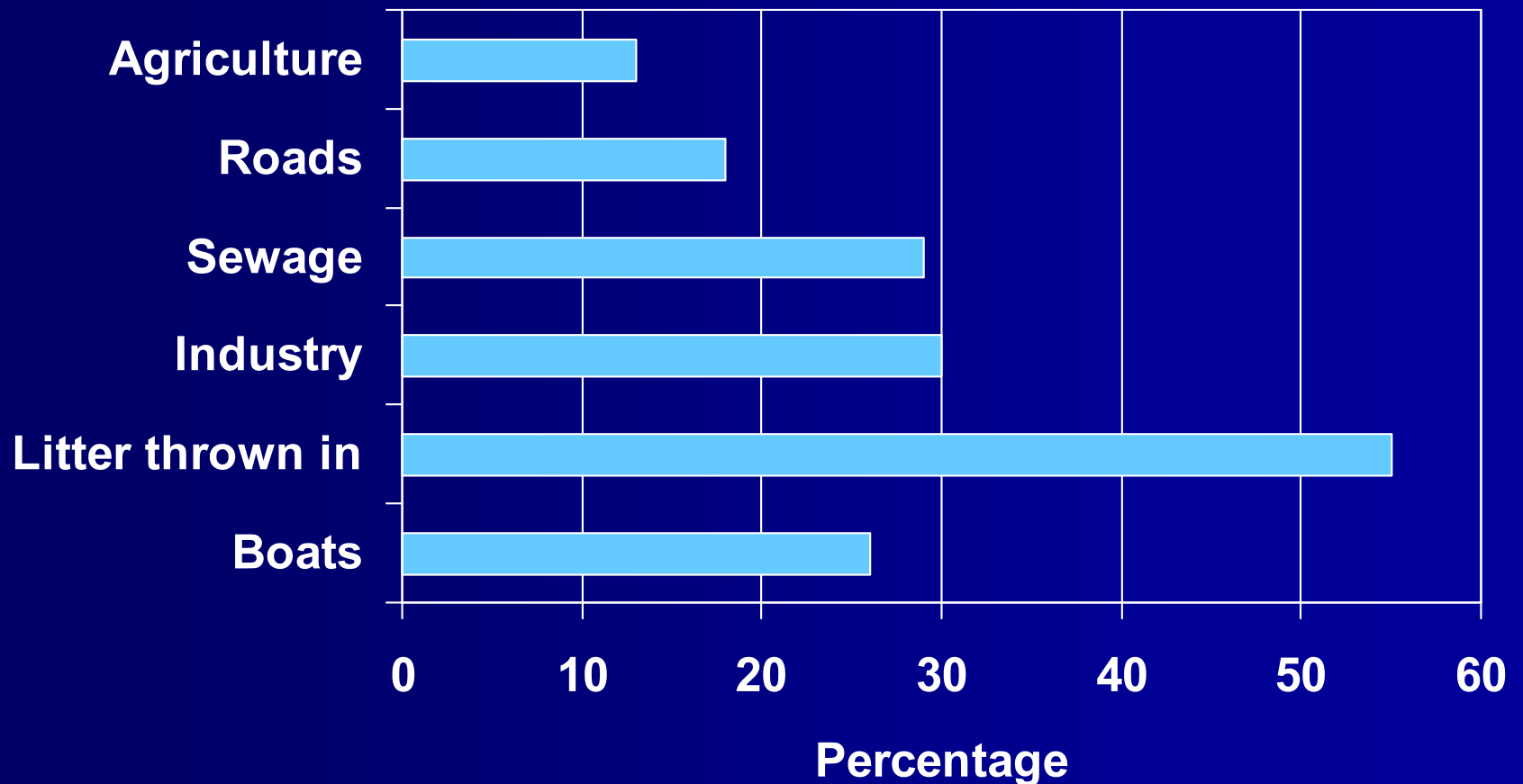
(+2: very good, 0: average, -2: very poor)

	<u>Average</u>
Cleanliness of river	0.4
River banks landscaping	0.6
Water quality	0.1
Wildlife	0.3
Safety	0.6
Recreational facilities	0.4

Often litter sightings

	<u>Percentage</u>
Cans, bags, bottles	44
Shopping trolleys	8
Condoms	4
Needles	2
Sanitary towels	1
Human excrement	2
Dead fish	2

Perceived pollution sources (% polluting a lot)



CE results

(WTP per household / year)

	10-20 years	3-6 years
Sewage litter (% of total)	£1.6	£2.1
Days of increased health risk	£0.4	£0.4
Potential fish kills	£1.2	£1.9
TOTAL (best scenario)	£72.6	£80.7

CV results

(WTP per household / year)

All sample	£58.9
10-20 years scenario	£52.2
3-6 years scenario	£68.7
Exposure to river at least once/ month	£71.4
Exposure to river less than once/ month	£44.6

Conclusions

- For the 5.6 million households in the Thames Water area, the benefits generated by the best scenario equate to about **£400 million** per year
- **Time over which benefits occur** matter to some extent
- No statistically significant **distance decay function** but a **frequency decay function** was observed

Part 3

Discussion

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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**

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Choice experiments: Smokers preferences for longevity (Canada)

Category	Filter A	Filter B	No Filter
Life extension	You will have 26 months added to your life at age 77.	You will have 45 months added to your life at age 77.	You will have no additional time added to your life at age 77.
Quality of life during extension	<ul style="list-style-type: none"> You are rarely able to leave your home. You walk with the assistance of a walker. You need help dressing and bathing. 	<ul style="list-style-type: none"> You are unable to leave your bed. You cannot eat, dress, bathe, or use the toilet without help. 	<ul style="list-style-type: none"> You are able to leave your home with assistance. You have trouble getting in and out of chairs.
Price of filters	\$10.00 per pack of 20 filters in addition to the \$3.00 per pack of 20 cigarettes.	\$2.00 per pack of 20 filters in addition to the \$3.00 per pack of 20 cigarettes.	No cost in addition to the \$3.00 per pack of 20 cigarettes.
Which filter do you prefer?	<input type="radio"/> Filter A	<input type="radio"/> Filter B	<input type="radio"/> No filter

Choice experiments: Smokers preferences for longevity (Canada)

Mean Future Value for Life Extensions (\$1000s)
3% Discount Rate
(90% confidence intervals in parentheses)

Restriction	Life Extension	
	1 year	3 years
Unable to leave the bed without assistance	-199 (-406/-131)	-436 (-893/-288)
Must use a walker	-119 (-224/-75)	-219 (-452/-135)
Able to leave the home with assistance	-53 (-87/-22)	-26 (-64/45)
Able to drive and leave the home independently	118 (60/426)	543 (309/1875)

Weaknesses

- **Cognitive burden:**
 - Rules of thumb (heuristics)
 - Learning / fatigue effects
- **Technical complexity:**
 - Experimental design
 - Statistical analysis
- ...and those common to all SP methods

Cognitive difficulty



	Bread A	Bread B	Bread C
Ill-Health	100 cases	60 cases	40 cases
Birds decline	9 species	5 species	2 species
Price	60p	85p	£1.15
Rank	3	1	2

Rationality tests

- **Dominance:**
 - A dominates B \Rightarrow Rank (A) > Rank (B)
- **Rank consistency:**
 - 1st set: Rank (A) > Rank (B)
 - 2nd set: Rank (A) > Rank (B)
- **Transitivity:**
 - 1st set: Rank (A) > Rank (B)
 - 2nd set: Rank (B) > Rank (C)
 - 3rd set: Rank (A) > Rank (C)

Rationality failures

