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Modelling heterogeneity in response behaviour towards a sequence of discrete choice questions: a probabilistic decision process model

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The research problem

- **Standard assumptions when estimating values from responses to multiple choice tasks:**
 1. **each task is answered truthfully and independently of other tasks, and**
 2. **preferences are stable over the course of the tasks**

- **Growing body of evidence finding these assumptions are violated**

The research problem

- **Several candidate decision processes (or heuristics) raised in literature**
 - **Strategic misrepresentation**
 - ▶ preferences stable, but responses untruthful
 - **Value learning**
 - ▶ responses truthful, but preferences unstable

Probabilistic decision process model

- **Estimates the proportion of respondents behaving in accordance with three ‘classes’:**
 1. **The standard assumptions;**
 2. **Value learning; and**
 3. **Strategic misrepresentation.**

Focus of the model

- **Case where similar goods offered at different prices over course of a sequence**
- **Heuristics that affect WTP estimates in full compensatory framework**
 - **excludes *institutional learning*, fatigue, and simplifying heuristics**

Probabilistic decision process model

- Random utility framework $U = \beta x + \varepsilon$
- Logit probability of choosing alternative j :

$$\text{Prob}[\text{choice } j \text{ by individual } i \text{ in choice task } t \mid \text{class } q] = P_{it|q} = \frac{\exp(\mathbf{x}'_{ij} \beta_{jq})}{\sum_{j=1}^J \exp(\mathbf{x}'_{ij} \beta_{jq})}$$

- Estimate by maximising log-likelihood:

$$\ln L = \sum_{i=1}^N \ln P_i = \sum_{i=1}^N \ln \left[\sum_{q=1}^Q H_{iq} \prod_{t=1}^T P_{it|q} \right]$$

- where H is class probability

Defining the classes

- The three classes are defined by three sets of restrictions (different β vectors) on a *master* utility function
- Effectively, three different utility functions designed to capture the behaviour associated with each class

Class 1: The standard assumptions

- Conventional sum-product of k attributes in choice task and associated taste intensities

$$U_{it,SQ,class1} = \beta_1 x_{1,it,SQ} + \dots + \beta_k x_{k,it,SQ}$$

$$U_{it,ALT,class1} = \beta_0 + \beta_1 x_{1,it,ALT} + \dots + \beta_k x_{k,it,ALT}$$

Class 2: Value learning

- Preferences are initially poorly-formed and are discovered in process of completing choice tasks
- Prices influence values (also observed in real markets)
- Variants:
 - Starting-point bias / anchoring
 - Coherent arbitrariness (Ariely *et al* 2003, *Quart. J. Econ.*)
 - ‘Good deal / bad deal’ heuristic

Class 2: Value learning

$$U_{it,SQ,class2} = \beta_1 x_{1,it,SQ} + \dots + \beta_k x_{k,it,SQ}$$

$$U_{it,ALT,class2} = \beta_0 + \beta_1 x_{1,it,ALT} + \dots + \beta_k x_{k,it,ALT} + \beta_{k+1} z_{it,ALT}$$

where

$$z_{itj} = z_{itj}^o - \check{z}_j$$

z_{itj}^o = the average of cost levels observed up to and including the current choice task

\check{z}_j = the average of cost levels in the sample (across all respondents and all choice tasks)

Class 3: Strategic misrepresentation

- **Choice experiments generally not incentive compatible in the field**
- **Predicted response pattern:**
 - **Rejection of alternatives that are preferred to status quo when a similar good was offered at lower price in earlier choice task**
 - **This rejection is weighed up against perceived risk of good not being provided at the lower price**

$$U_{it,SQ,class3} = p_{it,SQ}(\beta_0 + \beta_1 x_{1,it}^a + \dots + \beta_k x_{k,it}^a)$$

$$U_{it,ALT,class3} = p_{it,ALT}(\beta_0 + \beta_1 x_{1,it,ALT} + \dots + \beta_k x_{k,it,ALT})$$

where

x_{it}^a = the levels of attributes in the highest-cost alternative accepted in previous choice tasks ($x_{1,it}^a$ is the maximum cost level accepted in previous choice tasks)

$$p_{it,SQ} = x_{1,it}^a / x_{1,it}^o$$

$x_{1,it}^o$ = the maximum cost level observed up to and including the current choice task

$$p_{it,ALT} = \max[p_{it,SQ}, x_{1,it,ALT} / x_{1,it}^o]$$

Class structure

Variable	Alternative	Class 1 (Standard)	Class 2 (Learning)	Class 3 (Strategic)
$P_{it,SQ}$	SQ	0	0	β_0
$\mathbf{x}_{it}^a P_{it,SQ}$	SQ	0	0	$\boldsymbol{\beta}$
$P_{it,ALT}$	Alt	β_0	β_0	β_0
$\mathbf{x}_{it} P_{it,ALT}$	Alt	$\boldsymbol{\beta}$	$\boldsymbol{\beta}$	$\boldsymbol{\beta}$
$1 - P_{it,ALT}$	Alt	β_0	β_0	0
$\mathbf{x}_{it}(1 - P_{it,ALT})$	Alt	$\boldsymbol{\beta}$	$\boldsymbol{\beta}$	0
$z_{it,ALT}$	Alt	0	β_{k+1}	0

a $\boldsymbol{\beta}$ refers to a coefficient vector, $\beta_1, \beta_2, \dots, \beta_k$, associated with x_1, \dots, x_k .

within class

across classes

Data

- **Stated choice survey of WTP for undergrounding power lines in Canberra**
- **Two choice formats. Sequences of four:**
 - **Binary choices (status quo and one undergrounding option)**
 - **Multinomial choices (status quo and two undergrounding options)**
- **Power supply reliability attributes vary across undergrounding options, and cost ranges from \$1,000 to \$16,000**
- **Backward navigation prevented, no advance knowledge of attribute levels**



Option set 4 of 4

Reminder

Your two most important benefits of underground wires are:

- Improved appearance and unobstructed views
- Better safety, particularly during storms and bushfires

Your most important disadvantage of underground wires is:

- Inconvenience during undergrounding works

Please choose your preferred option below.

	Your current service	Option 1	Option 2
Type of infrastructure	Overhead on poles	Underground	Underground
Power cuts without warning:			
Number power cuts each 5 years	4 power cuts	1 power cut	3 power cuts
Average duration of power cut	1 hr 0 min	0 hr 40 min	1 hr 20 min
Power cuts with written notice (occurring in normal business hours):			
Number power cuts each 5 years	3 power cuts	3 power cuts	1 power cut
Average duration of power cut	3 hr 0 min	2 hr 0 min	4 hr 0 min
Your one-off undergrounding contribution*	\$0	\$8000	\$8200
I would choose:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

* The contribution can be paid either (a) upfront with a 3% discount; or (b) in instalments for up to 5 years at a 6.5% p.a. interest rate.

Key estimation results

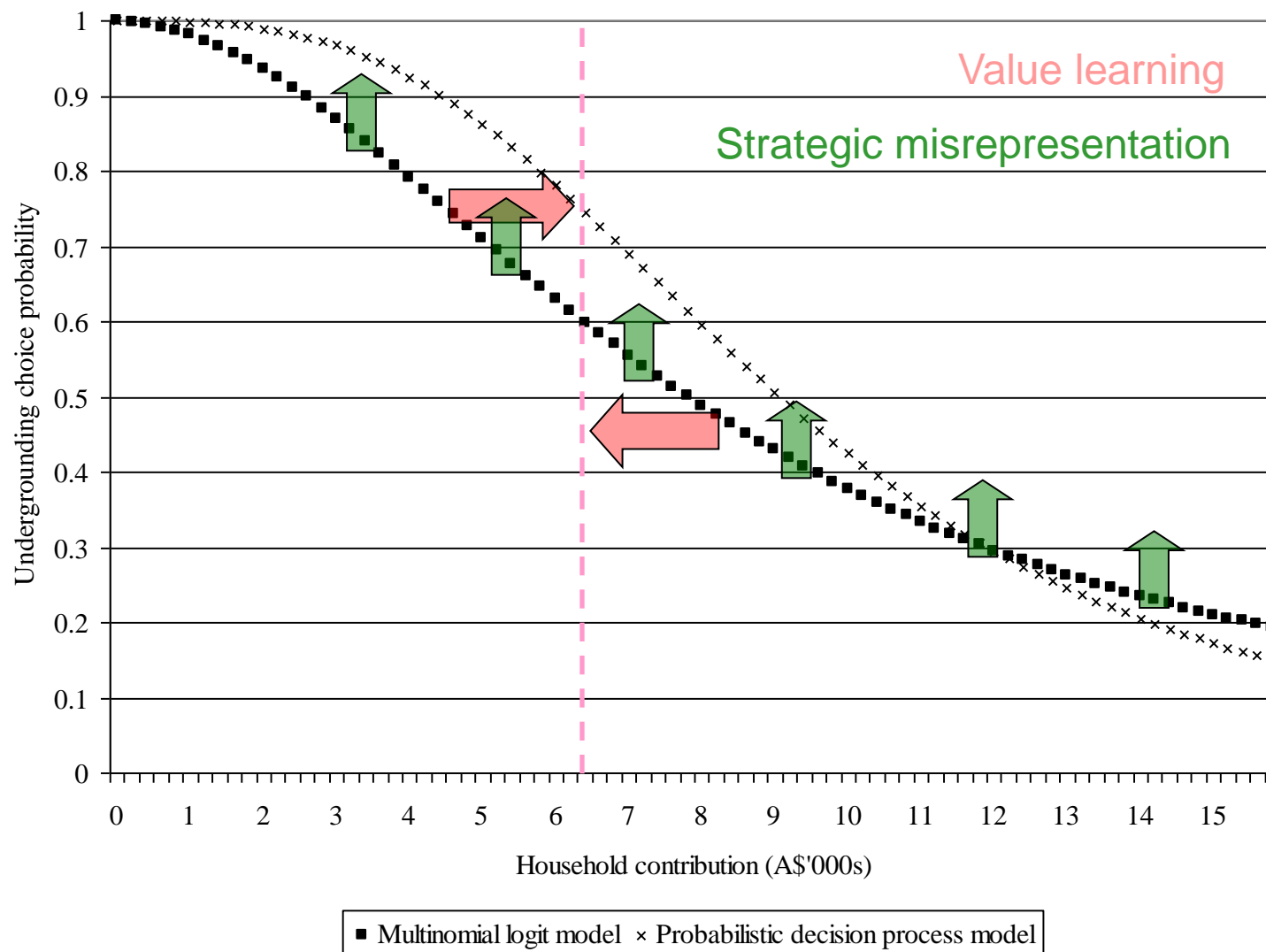
Estimated class probabilities (%)

	Binary	Multinomial
Standard assumptions	27	13
Value learning	41	42
Strategic misrepresentation	32	45

Model fit

	PDP binary	PDP multinomial	MNL binary	MNL multinomial
Log-likelihood	-342	-740	-362	-760
AIC	722	1518	756	1552

Implications for welfare estimates



Conclusion

- **Research problem confirmed**
- **Results may explain the variation in findings across studies and the ambiguity of evidence within studies that have attempted to identify a single heuristic**
- **Excluding data based on question order may not be appropriate**
- **Further research**
 - **Extend beyond the ‘obvious’ case of similar goods with different costs**
 - **Extend to accommodate taste and scale heterogeneity, and simplifying heuristics**



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Thank you

Questions?