Discrete choice experimental design for alternative specific choice models: an application exploring preferences for drinking water

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Overview

1. Experimental design & indirect utility functions
2. Alternative specific L^MA designs
3. Best Worst DCE
4. SBWMNL
5. Empirical study: preferences for drinking water
6. Summing up

DCEs

- Three components:
  1. Use of experiments to generate choice data
  2. Use generated data to estimate IUF in a RUT framework
  3. Use IUF to derive welfare measures & other policy analysis

Experimental Design & IUFs

- ED: Combination of attributes & levels to create hypothetical scenarios & placement of scenarios into choice sets
- ED has key implications for composition and properties of indirect utility functions estimated from DCEs

Standard practice

- Generic forced choice ED – e.g. health care provider A or health care provider B
  - Generic attribute effects
- Generic alternatives plus a status quo or an opt out alternative – e.g. health care provider A, health care provider B or current provider
  - Generic attribute effects
  - Capture preferences for hyp v current provider via ASCs

Alternative specific IUFs

- Not all choice problems of interest are between generic alternatives
- Choice between labelled alternatives
- Attributes available in some but not all alternatives
- Some attributes could have alternative specific levels
- Sensitivity to attributes could differ by alternative

Example: Choice of Health Care Provider

- Alternatives could be labelled: Nurse Practitioner & GP
- E.g. described by wait time, price, etc.
- Willingness to wait may be longer for particular type of health care provider than others
- ED to allow estimation of separate effects for ‘waiting time’ linked to each of the two types of alternatives

Enter L^MA designs

- Developed by Louviere & Woodworth 1983/Louviere et al 1988
- Used in conjunction with labelled experiments where the labels of the alternatives carry meaning
- Allow for the identification & estimation of alternative specific attribute effects
- L^MA adds an additional dimension, M = alternatives per choice set

Health Care Provider E.g.

- Suppose wait time attribute had 4 levels & suppose there is one additional attribute, price, also with 4 levels
- L=4, A=2 & M=2, giving 4^2*2 or equivalently 4^4= 256

L^MA Properties

- Simultaneously creates both the alternatives & allocation of alternatives to choice sets
- Identification properties of L^MA designs are well understood (Louviere et al 2000)
- Optimality results for the efficiency not yet published

What are best-worst DCEs?

- One of 3 types of BWS (Louviere and Finn 1992, Louviere et al 2008)
- Same as standard DCE except: rather than ask single choice per choice set, ask repeated discrete best & worst choice questions to obtain an implied rank ordering
- For a choice set with J alternatives, there are J-1 subsets considered by respondents who can be asked to make up to J-1 choices
- E.g. for a choice set with 5 alternatives {A, B, C, D, E}: 4 choices
- Suppose, best=A, worst=E, 2^{nd} best=B , 2^{nd} worst=D → A>B>C>D>E

Best worst DCEs

- Two useful properties:
  - Full preference order → more data → ↑ statistical efficiency

  - Coupled with optimal ED, allows estimation of models for single individuals (Louviere et al 2008), Lancsar & Louviere (2009)

Rank order logit

- ROL assumes arrive at the rank order by choosing best from successively smaller choice set – best from ABCDE, best from BCDE, …
- Not how the data are generated in a best worst DCE
- Objective – model the sequential process used to generate the best worst preference order

Sequential Best Worst MNL

- Models probability of BW preference order as product of J-1 choices made per choice set (Lancsar 2009; Lancsar & Louviere 2009)
- E.g. if A>B>C>D>E

$$\Pr(best - worst\ ording\ \ A, B, C, D, E)$$
$$= \frac{e^{V_A}}{\sum_{j=A,B,C,D,E} e^{V_j}} * \frac{e^{-V_E}}{\sum_{j=B,C,D,E} e^{-V_j}} * \frac{e^{V_B}}{\sum_{j=B,C,D} e^{V_j}} * \frac{e^{-V_D}}{\sum_{j=C,D} e^{-V_j}}$$

- Accounts for the sequential way the data were collected
- Choice of best and worst follow MNL models
- V(W) = - V(B)
- Highly tractable
- Estimate models for single individuals & pooled models

Empirical Study:

Eliciting Preferences & Values for Different Types of Drinking Water

Water study background

- Safe drinking water is fundamental to good public health
- Health risks associated with untreated & treated drinking water
- Adding fluoride to tap water has been shown to produce improved oral health
- Substitution from tap water to tap + home filter &/or bottled water

Health Risks

- Untreated tap water can be hazardous to human health due to micro-organisms, e.g. Cryptosporidium & Giardia

  $\Rightarrow$ clean & filter water using various methods to prevent microbial illness

- Chlorine = most widely used disinfectant in Aust

- Chlorination produces disinfection by products: Trihalomethanes (THM)

- Possible (?) association between long term (35yr) exposure to THMs & risk of bladder cancer

- Can remove disinfection by products with further treatment, e.g. carbon filtration etc

Risk-risk tradeoff

- Multi-dimensional risk tradeoff
  - Immediate risk of microbial illness from untreated water
  - Possible (?) small risk of bladder cancer from treating water with chlorine over time
  - Adverse oral health from not drinking tap water
- Morbidity & mortality risk within a type of disease

Previous work

- Bateman et al looked at taste & aesthetics
- Water supply disruptions – e.g. Hensher et al (2006)
- Mitchell & Carson (2006) investigated THMs using CVM
- Adamowicz et al (2011) investigated tradeoffs between microbial illness & bladder cancer in the treatment of tap water

This study

- Builds on earlier work
- Broader inclusion of health risks
- Explores preferences over types of water: tap, filter, bottled
- Labelled alternative specific choice experiment
- Uses BW data collection & analysis

Choice Context

- Drinking water at home in Sydney, Australia
- Choice between:
  1. Status quo tap water
  2. Hypothetical tap water (using new treatment methods)
  3. Hypothetical tap water + home filter
  4. Hypothetical bottled water
- Asked best, worst & best of remaining two alternatives per choice set
- Panel data collection, n=504

Attributes & levels

- Pilot & focus groups
- 6 attributes: 5 with 4 levels & 1 with 2 levels:
  - Risk of microbial illness
  - Risk of death from microbial illness
  - Risk of bladder cancer
  - Risk of death from bladder cancer
  - Price (alternative specific)
  - Added fluoride
- Price levels alternative specific
- Other possible drivers of choice – taste & aesthetics held constant across choice alternatives

Allow utility to differ by alternative:

$$V_{tap} = V_{tap}(\beta x_{tap}, \gamma z_i)$$

$$V_{tap + filter} = V_{tap+filter}(\beta x_{tap+ filter}, \gamma z_i)$$

$$V_{bottled} = V_{bottled}(\beta x_{bottled}, \gamma z_i)$$

$$V_{SQ} = 0, \text{ for identification}$$

Experimental Design

- Labelled alternative specific utility $\Rightarrow$ used L^MA design:
  - 4^3x5 x 2^3x1 = 4^15 x 2^3
  - Created fractional factorial L^MA by hand from an orthogonal array of 17 16-level attributes (16^17) in 256 scenarios
  - Blocked into 16 version s.t orthogonal, level balance

- All ME + three 2-way interactions (one per alternative: cancer x cancer death) identified

Econometric modeling

- Conditional logit (robust std errors)
  - Alternative specific v generic
  - Explored non linear functional form
- SBWMNL (robust std errors)
- Comparison
- Preliminary and ongoing analysis…

Type of water drunk most at home

Tap	40.7%
Filtered tap	31.7
Boiled tap	9.1
Bottled – delivered	4.4
Bottled – supermarket	12.7
Rain	1.4

Clogit: Preferences for drinking water

- Preference for tap alternatives over bottled water
- ASCs: SQ > tap > filter > bottled water (reflects RP data)
- Preferences for risk attributes generic across alternatives
- Price sensitivity & response to fluoride varies by alternative

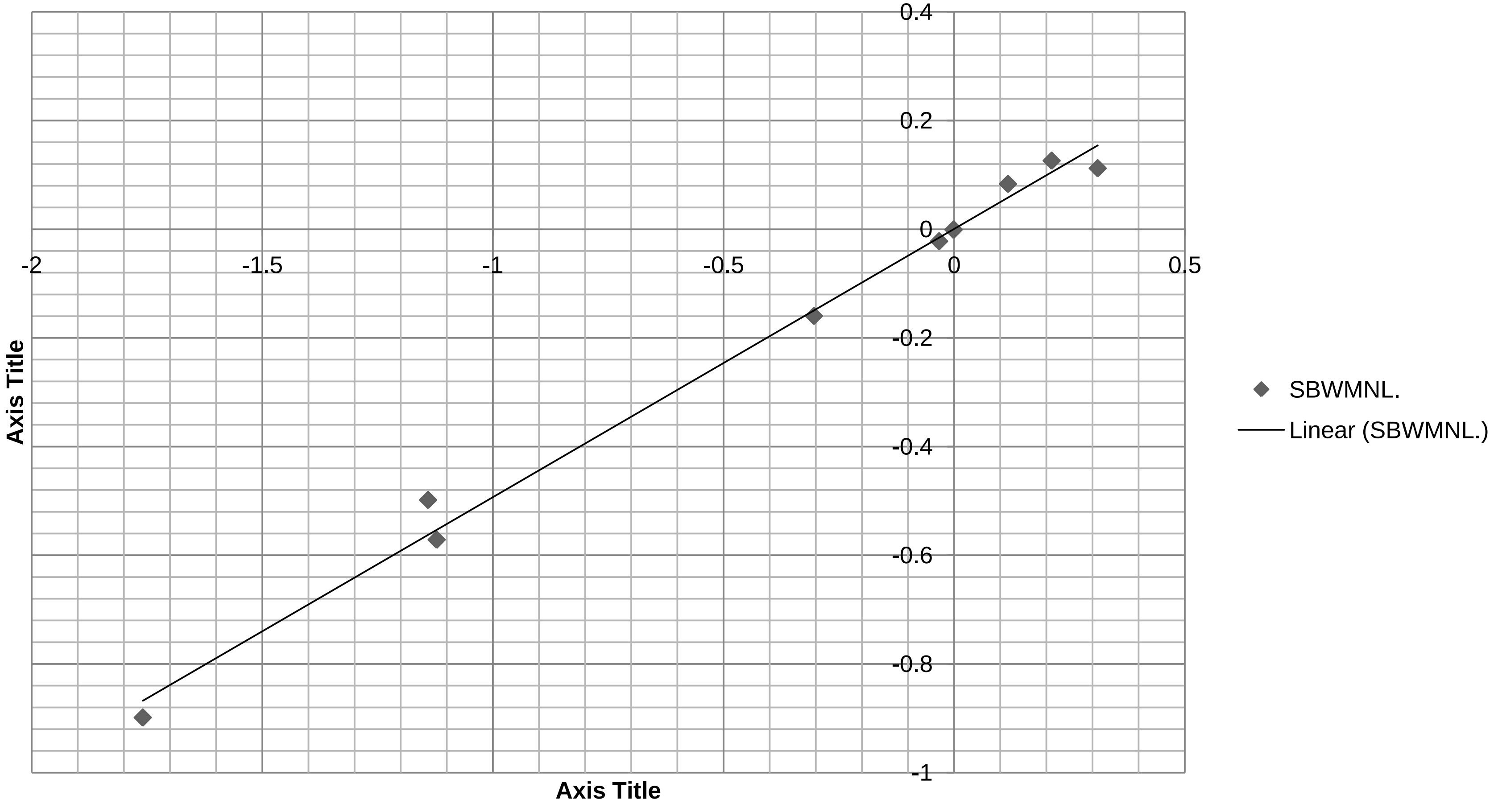
Preferences for drinking water

- Probability of choosing each of the drinking water alternatives increased with lower morbidity/mortality risk, price & added fluoride
  - Risk effects all negative & significant
  - Price effects all negative & significant
  - Prefer added fluoride on tap & filter, don’t care about fluoride in bottled water
- Cancer x cancer death interaction not significant
- MRS
  - Risk of mortality more important than morbidity
  - Risk of cancer more important than microbes

SBWMNL Results

- Same interpretation as clogit except:
- Fluoride on bottled water now significant & positive
- Cancer x cancer death interaction now significant & negative in accord with a priori expectations
- Smaller std errors
- Generally smaller coefficients (scale)

Proportionality of SBWMNL & Clogit results



Gains from BW data

- SBWMNL: Lower standard errors compared to first choice analysis reflecting gains in efficiency from more preference data
- More significant effects

Summing up

- Used L^MA
- Preliminary results
- Found some alternative specific effects
- Preferences for drinking water
  - Preference for tap over other forms of water
  - Response to risk generic across alternatives
  - Prefer lower risk but differential preferences over risk type
  - Price sensitivity varies by type of water
  - Want added fluoride
- Demonstrated use of best worst choice experiment & SBWMNL analytical method – efficiency gains
- Work in progress...

Thank you!

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- Questions?