Choice modelling and environmental valuation: Where have we been, what’s up ahead?

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Overview

- Introduction – environmental valuation
  - Measuring economic welfare for environmental damage assessments, regulation / policy, environmental investments, etc.
- Trends in valuation research
- Some new (and not so new) challenges / opportunities
  - A few examples…
- Conclusions / New Directions?
Valuation Mapping: Ecosystem Service Values (ESV)

**ENDPOINT (ESV)**
- Health Related
  - Mortality
  - Morbidity
- Recreation
- Market Products
- Carbon
- Aesthetics / Visibility
  - “Passive Use”
- Habitat
- End. Species
  - “Biodiversity”

**ENVIRONMENTAL CHANGE**
- Water quality / quantity
- Air quality
- Land use change

**VALUATION METHOD**
- Recreation demand
- Hedonic property values
- Hedonic wage
- Production functions
- Stated preference
- Contingent Valuation
- Choice Experiment
Publication Trends – Valuation Methods, Geographic Locations

- Trends in major valuation methods
  - Stated Preference (use and passive use values)
    - Contingent Valuation (CV)
    - Choice Experiment (CE)
  - Outdoor Recreation Demand / Travel Cost (revealed preference)
  - Hedonic Price / Property Value Analysis (revealed preference)
Analysis of Trends?

- Stated preference dominates revealed preference analysis;
- RP methods most popular in North America
- Relatively little recreation / tourism
  - At a time when “ecosystem service values” are increasingly required?
- North America – declining CV, increasing “hedonic”
- Other regions – CE increasing rapidly
- Why?
  - Policy differences?
  - Geographic factors? (e.g. outdoor recreation)
  - Movement away from “structural” econometrics?
  - Data?
Environmental Valuation
Stated Preference Methods
- Contingent Valuation
- Choice Experiments

Environmental Valuation
Revealed Preference Methods
- Recreation Demand
- Hedonic Property / Wage

Experimental / Survey Design
- Experimental Design
- CV, CE, B/W approaches
- Novel Data Sources
- Consequentiality / Incentive Compatibility

Econometrics
- Heterogeneity
- Heuristics
- Unobserved Attributes
- Endogenous Attributes / Sorting
- Choice Sets
- Decision Strategy

Behavioral
- Ref. Dep.
- Attention / Effort
- Heuristics
- Risk Processing
- Discounting

Social
- Norms, Scrutiny
- Social Networks
- Social Interactions
- Altruism

Structural vs. Experimental Approaches, Data
New (and not so new) Challenges / Opportunities

- What environmental values are important for policy analysis?
- What issues “make a difference”?
- Potential linkage with “choice modellers”

Challenges / Areas of Research

1. Valuing Health Risk Reductions – SP, RP and Behavioral Aspects
2. Choice Set Analysis / Formation
3. Stated Preference Analysis – Consequentiality
4. Data, program evaluation and valuation.
Challenge 1: Valuing Health Risk Reductions

- Mortality risk reduction represents 80-90% of the benefits of air quality regulation (e.g. U.S. Clean Air Act)
- Widely used in policy analysis
- Significant component of value of water quality programs, food safety, etc.
- Evidence that health risk reduction values are increasing over time? (Costa and Kahn 2003)
- Measurement by hedonic wage models, contingent valuation, choice experiments.
- Opportunity for crossover between health, environment researchers.
FIGURE 1
Example of a Choice Question

If you had to choose, would you prefer Alternative A or Alternative B?

<table>
<thead>
<tr>
<th></th>
<th>Alternative A</th>
<th>Alternative B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Constant annual risk reduction</td>
<td>Constant annual risk reduction</td>
</tr>
<tr>
<td>Reduced risk for fatal</td>
<td>Heart attack</td>
<td>Cancer</td>
</tr>
<tr>
<td>Risk reduction each year:</td>
<td>reduced each year by:</td>
<td>reduced each year by:</td>
</tr>
<tr>
<td>For the next 10 years</td>
<td>1 in 10,000</td>
<td>2 in 10,000</td>
</tr>
<tr>
<td>11 years from now and onward</td>
<td>1 in 10,000</td>
<td>2 in 10,000</td>
</tr>
<tr>
<td>Your current risks</td>
<td>Click here to view Table 1</td>
<td></td>
</tr>
<tr>
<td>Additional costs you pay each year starting now</td>
<td>$100</td>
<td>$300</td>
</tr>
</tbody>
</table>

Which do you prefer?  

A  

B  

Value of Health Risk Reduction Puzzles?

- Why are stated preference estimates *lower* than revealed preference estimates?
- Valuing context specific risk reductions
  - Illness type
  - Medium (water, air, etc.)
- Risk processing
- Scope / Proportionality
- Altruism
- Latency
- Risks to children

Challenge 2: Choice Set Analysis

- Longstanding issue in choice modelling
- Environmental and Resource Economics
  - Revealed Preference
    - Recreation demand (e.g. Haab and Hicks 1997; von Haefen 2008)
    - Property / Housing choice and environmental valuation (e.g. Banzhaf and Smith 2007)
    - Commercial fisheries (spatial choice) (e.g. Hicks and Schneir, 2010)
  - Stated Preference
    - Less exploration, but....
    - Linkages to “cutoff” models?
Choice Set Analysis (CSA)

- Does it matter?
  - Case Study 1: RP analysis of recreational site choice over time

- Approaches to CSA in Environmental Econ
  - Case Study 2: Simulation analysis
  - Case Study 3: CSA / “Cutoffs” in Stated Preference

- CSA and Social Networks
- The Extent of the Market?

- Summary
1. A Case Study: What is the economic welfare impact of CWD?

- Chronic Wasting Disease (CWD): prion disease that affects deer, elk and other cervid wildlife species
  - Neurodegenerative disease
  - No known link between the consumption of CWD affected meat and human health, but
  - Cautions were provided to hunters
- CWD might affect a recreational hunter’s:
  - choice sets
  - site choice
Foundations

- Manski’s two stage decision process:

\[ p_j = \sum_{C_k \subseteq C_m} P(j \mid C_k) Q(C_k) \]


- Probability of \( C_k \) being the "true" choice set

- Estimation challenges

\[ Q(C_k) = \prod_{j \in C_k} A_j \prod_{l \in C_k} (1 - A_l) \]

\[ A_j = \frac{1}{1 + e^{-\gamma Z_{ij}}} \]
Foundations

- Cascetta and Papola 2001; Martinez et al 2009 – “Approximations”
- Availability function:

\[ p_{ij} = \frac{A_j e^{\mu V_{ij}}}{\sum_{k=1}^{J} A_k e^{\mu V_{ik}}} \]

\[ A_{ij} = \frac{1}{1 + e^{-\alpha z}} \]

\[ U_{ij} = V_{ij} + \frac{1}{\mu} \ln A_{ij} + \varepsilon_{ij} \]

Note “penalty” interpretation.

- GenL Model (Swait, 2001)
Analysis (Truong, Adamowicz, Boxall 2012; Zimmer et al 2012)

- 2 years of data on hunter actual site choices (and stated preference data)

Analysis
- Standard approach (all alternatives in the choice set)
- Explicit choice set models
  - Independent Availability Model (Swait)
  - Constrained MNL (Cascetta and Papola, Martinez)
  - Incorporate scale over time as well as data source

Identification?
- Does CWD affect utility, scale, choice set?
- Is it CWD or something else?
Analysis

Results

- Welfare impacts up to 3 times larger when choice set component incorporated
- Presence of CWD increases the chance that a site is not considered; increasing over time
- Often the choice set effect dominates the utility effect.
- Scale lower (variance higher) in second year (uncertainty following increase in disease).
- Qualitative evidence the choice sets changed – but in a heterogeneous fashion.
## Results – Welfare Measures for an Increase in CWD

<table>
<thead>
<tr>
<th>Model</th>
<th>MNL2</th>
<th>CPA2</th>
<th>IAL2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1 – Rural</td>
<td>15 (5.18)</td>
<td>-27.15 (28.49)</td>
<td>12.96 (24.72)</td>
</tr>
<tr>
<td>Year 2 – Rural</td>
<td>-23.07 (6.28)</td>
<td>-61.66 (13.36)</td>
<td>-42.88 (8.71)</td>
</tr>
</tbody>
</table>
2. Simulation Analysis (Li, Adamowicz, Swait 2013)

- How large is the effect of choice set misspecification on estimation of welfare measures?

Recreation context

- True process IAL / Threshold
  - Travel cost threshold + error determined inclusion in choice set. ("cutoff" based CSA)

- Policy change – travel cost increase
  - Affects utility and choice set.

- MNL, RPL, IAL, CMNL (Martinez), GenL (Swait)

- Examine homogeneous and heterogeneous preference versions.
Simulation Analysis (Li, Adamowicz, Swait)

- Preliminary Results / Implications
  - MNL, RPL biased welfare measures.
    - MNL, RPL 1/2 to 1/3 the size of “true” measure.
  - Models capture choice set structure as “heterogeneity” in some contexts.
    - When there is heterogeneity in choice sets (cutoffs)
Simulation Analysis (Li, Adamowicz, Swait)

- Preliminary Results / Implications
  - CMNL generates unbiased measures of choice set parameters, and welfare measures. – in some contexts!

- New uses of CMNL –
  - Reduce estimation time for IAL (-50%)
  - Role of CMNL as “Scaling” or instrument?
3. “Choice Set Analysis” and “Cutoffs”?

- Similarity between “cutoffs” and choice set models (penalty for values of attributes in certain ranges).
- Non-compensatory preference models (Swait 2001; Martinez et al. 2009)
- Application to stated preference / passive use valuation
  - Referendum questions – vote for a program to protect caribou herds, at a cost.
Woodland Caribou in Alberta


ASRD and ACA 2010
Exogenous cutoff model (Swait, 2001)

The basic model can be estimated using MNL with

\[ U_{ij} = \sum_k \beta_k X_{ijk} + \sum_k w_k \chi_{ijk} + \sum_k v_k \kappa_{ijk} + \epsilon_{ij} \]

\[ \chi_{ijk} = \max(0, \theta_{ik}^L - X_{ijk}) \quad \kappa_{ijk} = \max(0, X_{ijk} - \theta_{ik}^U) \]

Lower and/or upper cutoff violations

Cutoff violations enter the model as exogenous variables, often elicited directly.

But are cutoffs exogenous?

- Model of “endogenous soft cutoff formation” and choice
## Endogenous Cutoffs (results)

Table 6: Comparison of self-reported and predicted endogenous cutoffs

<table>
<thead>
<tr>
<th>Mean of</th>
<th>Stated cutoffs</th>
<th>CEL3</th>
<th>CEL4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herd cutoff (min # of herds)</td>
<td>9.10</td>
<td>4.55</td>
<td>4.80</td>
</tr>
<tr>
<td>Bid cutoff ($)</td>
<td>140</td>
<td>124</td>
<td>170</td>
</tr>
</tbody>
</table>
4. Is selection of a choice set related to “decision strategy”

- Adamowicz and Swait (2013) examine utility maximizing decision strategy selection
  - Routine, Full Evaluation, Variety Seeking
- Implicitly this is a choice set heuristic (if in “routine” mode: choice set =1)
  - Linkage between strategy choice and choice set formation – avoid complexity by limiting choice set (routine)
- Are there linkages between other decision strategy models and choice set formation? (Hess et al 2012; McNair et al 2012)
5. Social Networks and Environmental Valuation: Neilson and Wichmann (2013)

- Public good value (utility) a function of social network
  - Formal social network structure
- But, perhaps the social network affects choice set formation (and utility?).
- Probability of inclusion in the choice set – a function of network connections and strength of connections.
- Similar models examine the effect of social interactions on voting participation (DellaVigna, List and Malmendier, 2013)
6. Choice Sets – Upside Down

The “Extent of the Market” Challenge

- What is the spatial extent of the influence of a change in a public good?
- Is there “distance decay”?
- Significant impact on benefit cost analysis.
Choice Set Analysis – Summary

Towards a theory of choice set formation?
- Flexibility (Kreps 1979); Avoiding Regret (Sarver 2008); Complexity / Simplification; Decision Strategy Switching (Adamowicz and Swait 2013); Selectivity (Ying, Salisbury and Feinberg, 2013)
- Linkages between choice sets and networks / social interactions? (Neilson and Wichmann, 2013)
- Affects both RP and SP (linkage between CS and non-compensatory models).
- Significant impacts on welfare arise – so it’s worth worrying about!
- Workshop on Thursday! (2pm)
Challenge 3: Stated Preference Methods, Consequentiality and Norms

- Passive use values, especially for “pure” public goods (e.g. endangered species) can have a significant policy impact
  - And continue to be controversial (J.Econ.Persp., 2012)

- Significant advances in understanding issues around consequentiality

- Is CE research using these insights?
- Is there a role for behavioral / social influences?
Consequentiality

- Examine “real” and hypothetical choice experiments for a public good in a binary task
- Incentive Compatibility Requirements
  - Consequentiality, and
  - Independence across choices.
- Provision rule may not matter
- Truthful preference revelation when respondents perceive the valuation question as being consequential (influencing policy)

However, convincing participants that their choices are consequential appears to be critical to ensuring valid results.” (page 148)

- Consequentiality “matters”
- Need more research like this
Challenge 4: Program Evaluation, Valuation and Data Collection

- Increasing demand for “ecosystem service values”
  - Outdoor recreation / tourism is a common activity affected by changes in ecosystem services.
  - Increasing need for RP research
- Yet – few systematic data collection efforts (Moeltner and von Haefen 2011)
- RP Data required to study endogenous attributes (sorting) and dynamics
- Possible linkage between program evaluation (quasi-experimental analysis) and environmental valuation (Ferraro et al, 2012; Pendleton, 2010)
  - Evaluate economic returns from programs (e.g. ecosystem restoration, policy changes).
  - Embed “valuation” into evaluation (Ferraro et al 2012)
Conclusions

- Environmental valuation analysis appears to be in increased demand
  - Policy and regulatory analysis
  - Assessing returns on investments in environmental programs

- Significant challenges / opportunities remain
  - Improved modeling of behavior and choice (RP and SP)
  - Incorporation of research in social networks / interactions, behavioral research
  - Improvements in data collection and linkages to program evaluation.

- New opportunities are arising to address current tensions in methods, approach and data collection.


References


