ANALYSIS OF CHOICE MODELING DATA WITH VARIOUS CHOICE SETS

Yuki Takatsuka
Commence Division, Lincoln University

Ross Cullen
Commerce Division, Lincoln University

Matthew Wilson
School of Business Administration,
University of Vermont

Steve Wratten
Bio-Protection and Ecology Division,
Lincoln University

LINCOLN UNIVERSITY
Te Whare Wānaka O Aoraki

Introduction

Non-market valuation

1. Contingent Valuation Model (CVM)

2. Discrete Choice Modeling

contains *choice sets (questions)*

Neoclassical economic theory…

WTP estimated delivered by CVM and choice modeling should be the same.

However…..

Several studies have observed differences in the estimated WTP between the two models.

Causations of WTP differences between the two models:

- Psychological perspective of decision making (Irwin et at., 1993; Stevens et al., 2000)
- Uncertainty about decisions (Ready et al., 1995; Champ et al, 1997)
- Substitutes for a cost associated with alternative state (Boxall et al., 1997)
- Provision rule (Boyle et al., 2004)

More….

- Experimental aspect

CVM - a one shot question format

Choice Modeling – multiple question format

Objectives:

-To explore individual's behavior on WTP decision making in the multiple question format in choice modeling.

1. Use nationwide mail surveys

   Two strata: CVM and choice modeling

   Choice modeling contains three sub sets, each with different number of multiple questions

2. Analysis of respondents' sensitivity depending on the number of choice sets

CVM and Choice Modeling

Random Utility Model (RUM):

- Both the CVM and the Choice Model utilize RUM.

$$U = V(v) + \varepsilon \qquad (1)$$

U=utility function
V=indirect utility function
ε=stochastic error

$$v_i = \beta_k X_{ki} + \alpha y = \beta_1 + \beta_2 x_{2i} + \beta_3 x_{3i} + \ldots + \beta_k x_{ki} + \alpha_i y_i \qquad (2)$$

$X_{ki} = \{x_1, x_2, \ldots, x_k\}$
β= coefficient vector
y=income
α=coefficient vector of income

Assuming ε is logistically distributed.

the probability of choosing alternative i is given by:

$$\Pr(i) = \frac{\exp(\rho v_i)}{\Sigma_{j \in C}^{J} \exp(\rho v_i)} \qquad (3)$$

To estimate the welfare impacts for a change from the status quo

$$v_i(X_i, y) + \varepsilon_i = v_j(X_j, y - CV) + \varepsilon_j \qquad (4)$$

v_i, v_j = utility before and after the change
CV = compensating variation

$$\beta_\iota X_{ki} + \alpha_\iota y + \varepsilon_\iota = \beta_j X_{kj} + \alpha_j (y - CV) + \varepsilon_j \qquad (5)$$

Using conditional logit model (β_i=β_j), welfare change is :

$$CV = -\frac{1}{a}\left[\beta\left(X_{ki} - X_{kj}\right) + \left(\varepsilon_\iota - \varepsilon_j\right)\right] \qquad (6)$$

Case Study

Estimation of values of Ecosystem Services

(water quality, air quality, soil quality, scenic views) associated with NZ arable farming

-3012 households were randomly selected from the electoral roll

960 CVM surveys

2052 choice modeling surveys

Choice modeling contained three groups:

CHOICE SET 4 – Four choice questions were contained (972 surveys)

CHOICE SET 6 – Six choice questions were contained (648 surveys)

CHOICE SET 9 – Nine choice questions were contained (432 surveys)

ES Attributes on Arable Land

Attributes	Levels	Definitions
Greenhouse Gas Emissions	Big Reduction	50% reduction from the current emission level
	Small Reduction	20% reduction from the current emission level
	No Change	maintain current emission level
Nitrate Leaching	Big Reduction	50% reduction in nitrate leaching to streams
	Small Reduction	20% reduction in nitrate leaching to streams
	No Change	maintain current nitrate leaching to streams
Soil Quality	Small Change	soil organic matter and structure are retained over 25 years
	No Change	maintain current slow rate of soil degradation
Scenic Views	More Variety	more trees, hedgerows and birds and a greater variety of crops on cropping farms
	No change	maintain the current cropping farm landscape
Cost to Household	10; 30; 60; 100	annual payment to a regional council for the next 5 years (NZ$)

CVM Survey Question

Please tick the option that you prefer:

	Option A	Option B
Greenhouse Gas Emission	Big Reduction	No Change
Nitrate Leaching	No Change	No Change
Soil	No Change	No Change
Scenic Views	No Change	No Change
Cost to Household ($ per year for next 5 years)	$60	$0

Option A ☐ Option B ☐

Choice Modeling Question

Please tick the option that you most prefer:

	Option A	Option B	Option C
Greenhouse Gas Emission	Big reduction	No change	No change
Nitrate Leaching	Big reduction	Small reduction	No change
Soil	No change	No change	No change
Scenic Views	More variety	No change	No change
Cost to Household ($ per year for next 5 years)	$100	$10	$0

Option A ☐ Option B ☐ Option C ☐

Choice Modeling Questions

- Multiple Questions
- 144 (=2^2x3^2x4) factorial designs
- D-efficient design, excluding unrealistic case
- 72 designs were selected from the 144 designs, which made up 36 choice sets.
- The same choice sets were ordered in the same technique across the 3 different groups.
- All choice sets were ordered and numbered from 1 to 36.

Order of Choice Sets/Questions

	CHOICE SET 4	CHOICE SET 6	CHOICE SET 9
1	4-1-1	6-1-1	9-1-1
2	4-1-2	6-1-2	9-1-2
3	4-1-3	6-1-3	9-1-3
4	4-1-4	6-1-4	9-1-4
5	4-1-5	6-1-5	9-2-1
6	4-1-6	6-1-6	9-2-2
7	4-1-7	6-2-1	9-2-3
8	4-1-8	6-2-2	9-2-4
9	4-1-9	6-2-3	9-3-1
10	4-2-1	6-2-4	9-3-2
11	4-2-2	6-2-5	9-3-3
12	4-2-3	6-2-6	9-3-4
13	4-2-4	6-3-1	9-4-1
14	4-2-5	6-3-2	9-4-2
15	4-2-6	6-3-3	9-4-3
16	4-2-7	6-3-4	9-4-4
17	4-2-8	6-3-5	9-5-1
18	4-2-9	6-3-6	9-5-2
19	4-3-1	6-4-1	9-5-3
20	4-3-2	6-4-2	9-5-4
21	4-3-3	6-4-3	9-6-1
22	4-3-4	6-4-4	9-6-2
23	4-3-5	6-4-5	9-6-3
24	4-3-6	6-4-6	9-6-4
25	4-3-7	6-5-1	9-7-1
26	4-3-8	6-5-2	9-7-2
27	4-3-9	6-5-3	9-7-3
28	4-4-1	6-5-4	9-7-4
29	4-4-2	6-5-5	9-8-1
30	4-4-3	6-5-6	9-8-2
31	4-4-4	6-6-1	9-8-3
32	4-4-5	6-6-2	9-8-4
33	4-4-6	6-6-3	9-9-1
34	4-4-7	6-6-4	9-9-2
35	4-4-8	6-6-5	9-9-3
36	4-4-9	6-6-6	9-9-4

* (CHOICE SET) - (Version) - (Number of choice set/question)
For example, 4-3-2 is the 2nd question of the version 3 in CHOICE SET 4.

Results

Response rates

	Number of mailed survey	Number of undelivered survey	Number of answered survey	Response rate
CVM	960	32	333	35.9
CHOICE SET 4	972	23	341	35.9
CHOICE SET 6	648	8	231	36.1
CHOICE SET 9	432	19	153	37.1

Descriptive statistics

	CVM		CHOICE SET 4		CHOICE SET 6		CHOICE SET 9	
	Mean	Std.Dev.	Mean	Std.Dev.	Mean	Std.Dev.	Mean	Std.Dev.
AGE	50.47	15.78	54.07	15.96	54.34	16.53	50.15	14.43
GENDER	0.45	0.50	0.45	0.52	0.60	0.49	0.64	0.49
EDU	4.12	1.67	3.99	1.65	3.83	1.56	4.13	1.59
INC	52.20	32.82	56.54	33.08	54.46	32.85	62.74	35.85
URB	0.75	0.48	0.70	0.46	0.69	0.46	0.74	0.44

Binomial logit: CVM

	Coeff.		Std.Err.	t-ratio
COST	-0.009	**	0.004	-2.550
CONSTANT	0.969	**	0.213	4.550
Number of observation	305			
Chi-squared	6.559			
Log-likelihood	-197.782			
R-squared adj.	0.021			
Akaike I.C.	1.310			
** Significant at the 0.05 level				

Effects codes: Choice modeling

Attributes	Variables	
Green House Gas Emissions	GGS	1 if small reduction ; 0 if big reduction ; -1 if no change
	GGB	1 if big reduction; 0 if small reduction; -1 if no change
Nitrate Leaching	NLS	1 if small reduction ; 0 if big reduction ; -1 if no change
	NLB	1 if big reduction; 0 if small reduction; -1 if no change
Soil Quality	SOIL	1 if small change; -1 if no change
Scenic Views	SV	1 if more variety; -1 if no change
Cost to Household	COST	NZ$10; $30; $60; $100

Conditional logit: Choice modeling

	CHOICE SET 4			CHOICE SET 6			CHOICE SET 9		
	Coeff.	Std.Err.	t-ratio	Coeff.	Std.Err.	t-ratio	Coeff.	Std.Err.	t-ratio
COST	-0.012 **	0.002	-4.852	-0.013 **	0.002	-5.379	-0.011 **	0.002	-4.903
GGS	0.092	0.059	1.573	0.069	0.059	1.153	0.224 **	0.058	3.867
GGL	0.513 **	0.073	7.016	0.440 **	0.070	6.291	0.263 **	0.067	3.906
NLS	0.158 **	0.067	2.362	0.167 **	0.067	2.470	0.196 **	0.065	2.992
NLL	0.484 **	0.066	7.302	0.399 **	0.066	6.011	0.346 **	0.064	5.412
SOILC	0.222 **	0.052	4.278	0.216 **	0.052	4.158	0.212 **	0.050	4.277
SVV	0.117 **	0.043	2.703	0.077 *	0.043	1.779	0.053	0.043	1.230
A_01	0.376	0.273	1.379	0.446 *	0.260	1.712	0.212	0.261	0.813
A_02	0.354 **	0.174	2.037	0.435 **	0.165	2.630	0.112	0.164	0.683
Number of observation	1292			1264			1328		
Chi-squared	137.271			113.950			107.105		
Log-likelihood	-1261.726			-1200.645			-1318.958		
R-squared Adj.	0.051			0.042			0.036		

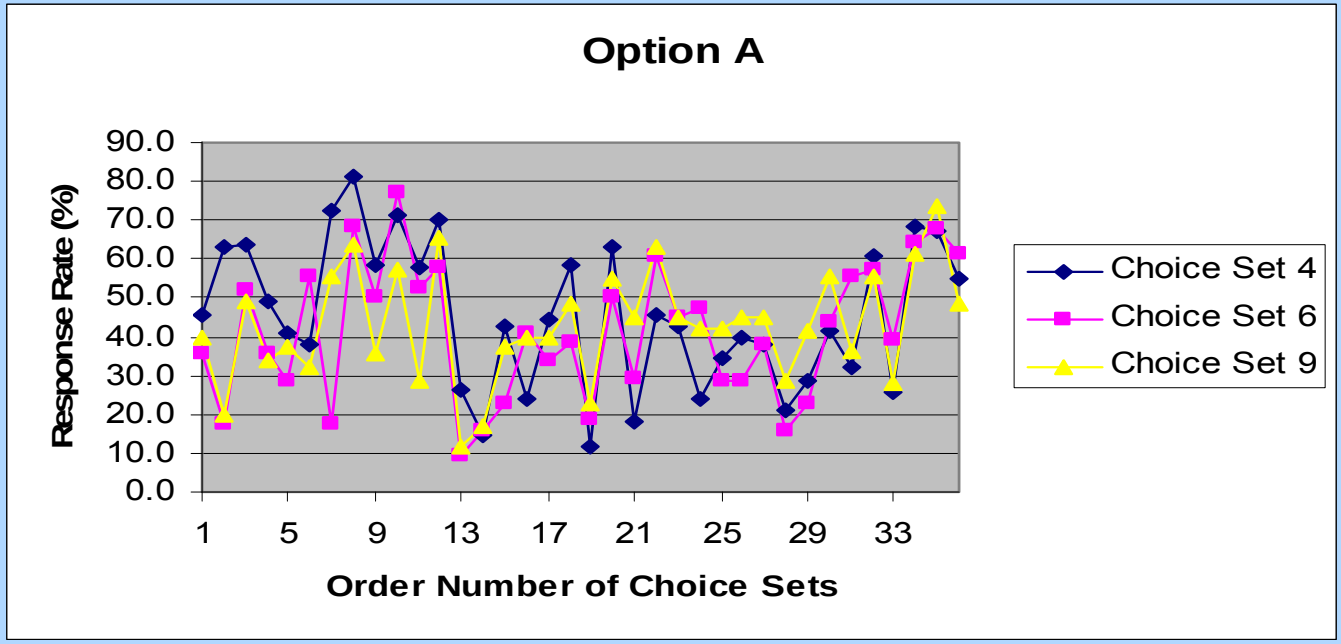
* Significant at the 0.10 level

** Significant at the 0.05 level

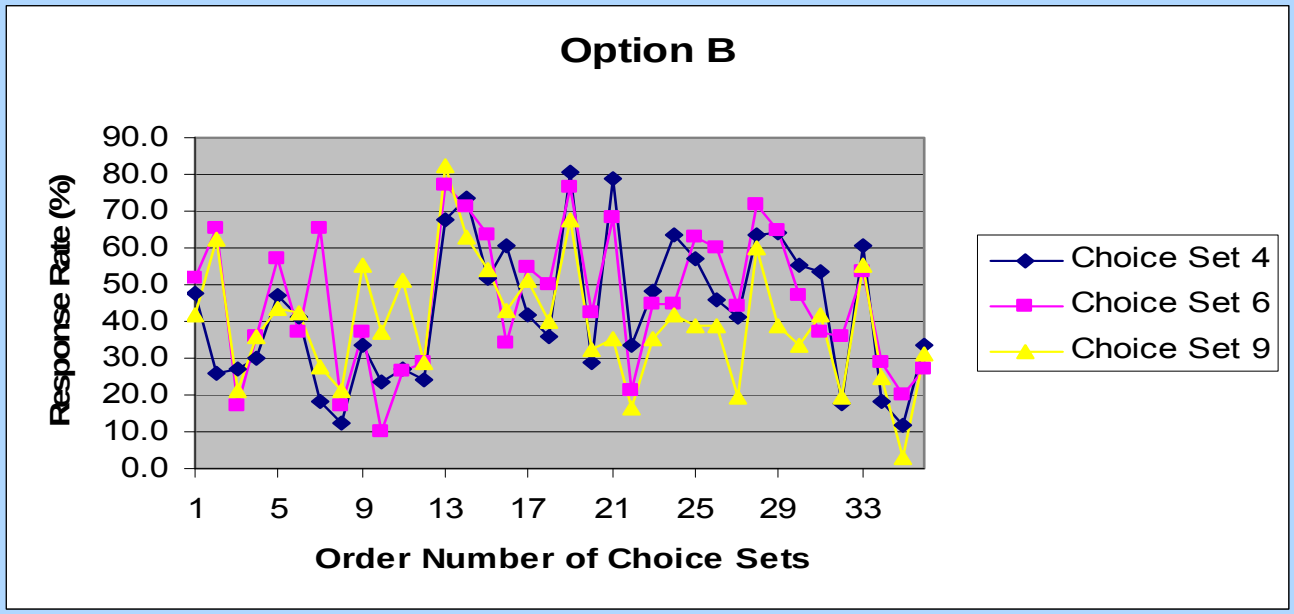
WTP

		GGS	GGL	NLS	NLB	SQ	SV	ALL IMV
CVM			105.27					
CHOICE	SET 4	59.92	**96.05**	68.69	96.69	38.13	**20.11**	**250.98**
	SET 6	45.69	**75.09**	58.02	76.45	34.23	**12.18**	**197.96**
	SET 9	65.45	**68.11**	66.92	85.59	38.53	**9.58**	**196.81**

Response Rate Analysis



Response Rate Analysis



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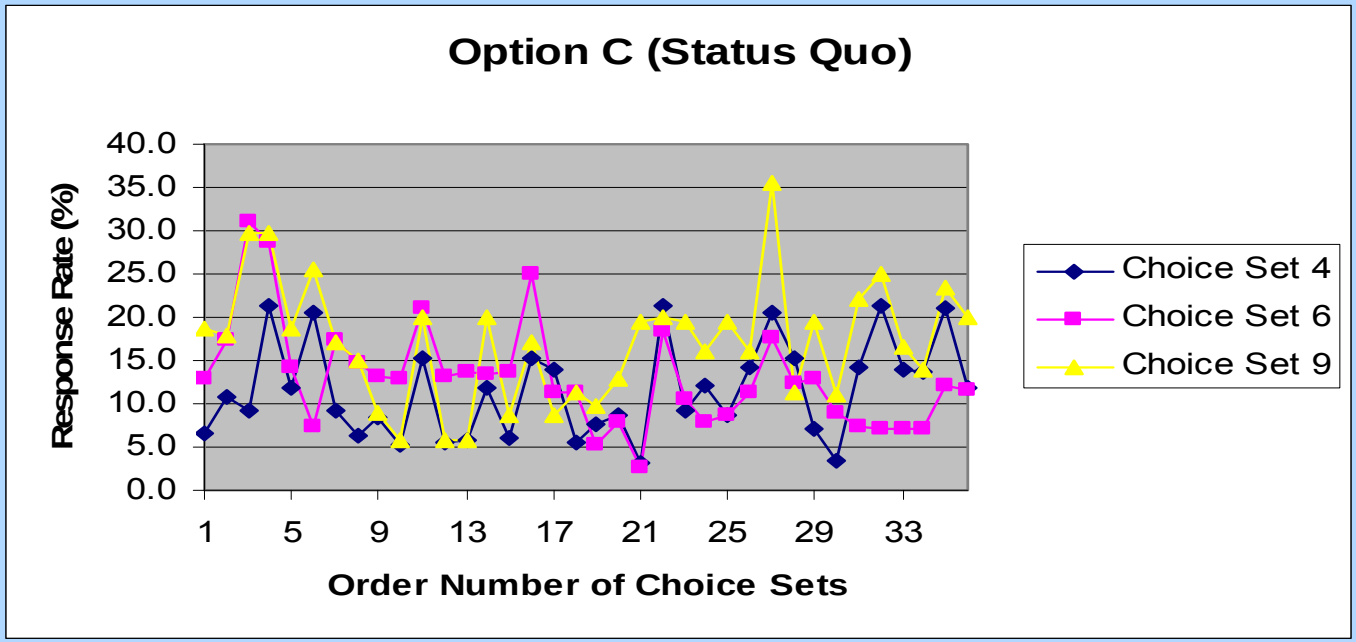

OLS

[*RATE*] = f [*SET, ORDER, COST*]

RATE – Response rates of choosing an option
ORDER – Order of choice set (question)
COST – Assigned cost for an option

OLS: Response rates (Dependent Variable)

	Option A			Option B			Option C (Status Quo)		
	Coeff.	Std.Err.	t-ratio	Coeff.	Std.Err.	t-ratio	Coeff.	Std.Err.	t-ratio
ONE	41.151	10.586	3.887	64.684	11.064	5.846	-5.835	3.751	-1.556
SET	-1.168	1.369	-0.854	-1.155	1.430	-0.807	2.323 **	0.485	4.791
ORDER	2.316 **	0.834	2.778	-2.781 **	0.871	-3.192	0.465	0.295	1.574
COST	0.029	0.074	0.394	-0.128	0.078	-1.651	0.099 **	0.026	3.758
Observation number	108			108			108		
Adj R-squared	0.046			0.088			0.222		
Log-likelihood	-4583.669			-458.435			-341.611		
Akaike info.	8.475			8.564			6.400		
Durbin-Watson	1.715			1.732			1.519		

* Siginificant at the 0.10 level

** Siginificant at the 0.05 level

Conclusion

1. CVM > Choice modeling

   -Dichotomous choice format in CVM might control the process of respondent's decisions in a similar way to the one in choice modeling

2. WTP are smaller for large choice sets in choice modeling

3. Respondents tend to choose an option with no monetary cost when they face more questions in a survey questionnaire.