Analysis of Stated Preference Survey Data for River-crossing Travel Behavior in the Portland/Vancouver Metropolitan Area

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Abstract

The MPO in the Southwest Washington and Oregon initiated a major activity and travel behavior survey from the Spring of 1994 to the Fall 1994, including the Stated Preference survey for river-crossing trip behavior. The purpose of the survey is to gain an in-depth understanding of the activities and travel behavior of households as well as individuals within the households in order to build an activity-based travel behavior model.

Southwest Washington Regional Transportation Council (RTC) as an MPO in the Southwest Washington region is using Metro's Travel Forecasting Model as a part of mutual efforts to keep regional consistency in travel forecasting process. Currently, the travel model seems unable to explain the river-crossing travel pattern and demand between the Vancouver area and the Portland area, where two areas are located in two different states and accessed only by two interstate freeway bridges. As an example, the travel model overestimates the home-based work trips by 40 to 50 percent, while it underestimates the home-based other and non-home-based non-work trips especially from the Vancouver area to Portland CBD by 30 to 200 percent, which forces us to use the significant K-factors in calibration. In this situation, it is necessary to explore residents' travel behavior beyond the framework which the conventional travel model can handle. The State Preference methodology is applied to this analysis to identify factors or attributes to affect the residents of the Vancouver/Portland are in their river-crossing trip decision process. Although the Portland/Vancouver area in the same metropolitan area, there are many differences between the two areas in tax structures, social and cultural aspects.

In developing the Stated Preference Survey, the experimental orthogonal design methodology was used. Attributes considered in this analysis are property tax, state income tax, sales tax, vehicle registration, property value, rent, school quality, travel time, tool, shopping opportunities, specialty stores, restaurant, and special attractions.

The Stated Preference Survey was completed with the 378 respondents in the Vancouver area and the 150 respondents in the Portland area. These sample households were selected from those who completed the Revealed Preference Survey. In this analysis, the discrete data conjoint method is used in developing the multinomial logit model with a fractional factorial experimental design to estimate elasticity of varying levels of attributes.

Vancouver, USA, is located in the southwest of Washington State and is a part of the Portland/Vancouver metropolitan area. Two Interstate bridges cross the Columbia River and connect the Washington and Oregon parts of the metropolitan area. The bridges are currently showing severe congestion during AM and PM peak periods and carry 232,000 average weekday vehicles. Between the two states, there are substantial differences in tax structures, activity opportunities, living amenities, and other factors (Table 1). Housing prices had been lower in Vancouver, but they are now comparable. Property tax used to be much higher in Portland, but

Background of Stated Preference Methods

Stated preference (SP) methods were originally developed in marketing research in the early

Table 1: Current differences between Portland and Vancouver area

Attributes	Portland Area	Vancouver Area
Property Tax	Avg. $20 per $1,000 value	Avg. $15 per $1,000 value
State Income Tax	9%	None
Sales Tax	None	7.6%
Vehicle Registration Fee	$50 per 2 years	3% of the car value per 1 year
Property Value	Comparable	Comparable
Monthly Rental Rate for 2 bed room	Avg. $537	Avg. $507
Shopping & Recreation Opportunities	More	Less

1970s, known as “Conjoint analysis,” “Functional measurement,” and “Trade-off analysis” (Kroes and Sheldon 1988). In transportation research, conjoint analysis has been variously referred to as “direct utility assessment” (Lerman and Louviere, 1978), “functional analysis” (Benjamin and Sen, 1983), and “stated preference analysis” (Ministry of Transport and Public Works, the Netherlands, 1985).

Behavioral foundations of conjoint analysis include Lancaster’s consumer theory (Lancaster, K. 1966), behavioral decision theory in psychology, known as Information Integration Theory (IIT) (Anderson 1970) or Social Judgement Theory (Brunswick 1952; Hammond 1955), and random utility theory (Thurstone 1927; McFadden 1974; Manski 1977). The approach used here relies on newly emerged paradigms (Louviere and Woodworth 1983) based on random utility theory, discrete or qualitative responses and discrete multivariate statistical analysis techniques.

SP Analysis Procedures

1. Identifying Attributes and Response Choices

Differences between two states in tax structures, amenity, shopping and recreation opportunities, and river-crossing travel conditions were considered as attributes affecting respondents’ location choice behavior (Table 2.). Behavioral response choices were defined as location choices for residence, work, shopping, and social-recreation, and as mode choices for work, shopping, and social-recreation purpose. With given conditions described by combinations of attributes for two areas, respondents were to choose one of three locations (Portland, Vancouver, and outside) and one of five modes (drive alone, carpool, regular bus, express bus, and light rail).

Attributes and levels were defined to represent the relevant range of variation to be observed in daily life. These were identified through discussion of issues in a series of focus group meetings, which consisted of ten to fifteen recruited participants. Eligibility for the focus group was specified and used for recruiting sample respondents, such as age (18 years or older), head of household, representative income group, age group, occupations, residency, etc. Findings of the focus group meetings are critical in defining significant attributes and ranges of levels to be varied for the analysis.

2. Choice Experiments

The discrete choice conjoint experiment was designed by Anderson and Louviere based on nine

Table 2: Attributes and levels for Vancouver/Portland Metropolitan area conditions

Attributes	Portland Area	Vancouver Area
Property Tax	$1500, $2000, $2500	$1000, $1500, $2000
State Income Tax	9, 14, 18%	0, 5, 10%
Sales Tax	0, 4, 8%	8, 12, 16%
Vehicle Reg. Fee	$50 / 2 yr., $200 / 2 yr., $300 / 2 yr.	$30 per $1000, $40 per $1000, $50 per $1000
Property Value Increase	no change, 30%, 60%	No change, 30%, 60%
Monthly Rent (for a 2 bedroom)	No change, +$150, +$300	no change, +$150, +$300
School Quality (average class size)	20-25, 30-35, 40-45	20-25, 30-35, 40-45
Travel Time (one way)	no change, +20 min., +40 min.	No change, +20 min., +40 min.
Toll for 2-way	no change $3 for peak $2 for off-peak $6 for peak $4 for off-peak	no change $3 for peak $2 for off-peak $6 for peak $4 for off-peak
Shopping Opportunities	no change, significant increase	No change, significant increase
Specialty Stores	no change, significant increase	No change, significant increase
Restaurant/Evening Entertainment	no change, significant increase	No change, significant increase
Special Attractions	no change, significant increase	No change, significant increase

three-level and four two-level attributes. The total number of profiles is to be set by the number of possible attribute level combinations, so called factorial designs or factorial combinations of attribute levels, which yields a huge number, $3^9 \times 2^4$, in this case. It would be impossible for respondents to evaluate a huge number of profiles. In this analysis, a smallest orthogonal fractional factorial design of 6^1x3^{24} was chosen. The six-level was used for blocking of profiles, which creates six statistically balanced groups of profiles. Nine degrees of freedom for nine 3-level attributes were used for each alternative and the rest were assigned to four 2-level attributes by collapsing three levels to two levels with the proper coding in orthogonal. From the smallest fractional factorial design of 6×3^{24}, there are 54 (=1+5+2x24) degrees of freedom available, which means the least total number of profiles would be 54. Therefore, each block had a set of nine profiles, which each randomly chosen respondent is to evaluate.

3. Survey Form Design and Conduct Survey

The whole survey form package mailed to each respondent included preamble as an introduction to explain the meaning of the survey, a pull-out section of key terminology, survey instructions with examples, and the actual survey questionnaire, so called “SP mockup.” The SP mockup design was important so that respondents could understand clearly and be attracted naturally to the visually well-designed mockups. In this survey, each page of a mockup set (total 54 sheets) carried each profile as a table in landscape format (Table 3.). Each respondent received nine sheets of a mockup set and evaluated different combinations of levels for Portland and Vancouver conditions nine times. Respondents were recruited randomly among those who already completed the activity diary survey. The SP survey was a mail-out and telephone retrieval survey with an

Table 3: SP mockup

Table: 1 Version: 1

Changes In Urban Conditions	Future Portland Situation	Future Vancouver Situation
Property taxes	$2,500 per $100,000 value	$2,000 per $100,000 value
State income tax	14%	10%
Sales taxes	0%	12%
Vehicle registration fee	$50 every 2 years for any car	$30 per $1,000 car value per year
Property value increase	No change	no change
Monthly rental rate (for a 2 bed room unit)	$300 more/month	no change
School quality	average class size 30-35	average class size 30-35
Travel time one way between Portland and Vancouver	Additional 20 minutes	additional 20 minutes
Toll for round trips between Portland and Vancouver	$3 for peak & $2 for off-peak	$3 for peak & $2 for off-peak
Shopping opportunities	Significant increase	significant increase
Specialty stores	Significant increase	significant increase
Restaurants/Evening entertainment	Significant increase	significant increase
Special attractions	Significant increase	significant increase

For each of the following questions, CHECK ONE BOX ONLY.

	Portland Metro Area	Vancouver Metro Area	Outside of Portland & Vancouver
Given the above conditions, Where would you…	⬇	⬇	⬇
11a. choose to live?	1❑	2❑	3❑
11b. choose to work?	1❑	2❑	3❑
11c. primarily choose to shop?	1❑	2❑	3❑
11d. primarily go for recreation?	1❑	2❑	3❑

average retrieval time of less than five minutes. The overall response rate was 52.3 percent. The sample size was 378 for the Vancouver area and 151 for Portland area (Nustats, Inc. 1995).

Analysis of the Stated Preference Survey Data

1. Model

Multinomial logit models (MNL) as probabilistic discrete choice models based on random utility theory are used to explore the impact of explanatory attributes on location choices from the fractional factorial orthogonal experiments. The probability to choose an alternative can be estimated by MNL models, where the coefficients of attributes are the marginal probabilities and can be estimated directly and independently of one another. In this location choice analysis, the "no-choice" option was included as a choice of place other than Portland or Vancouver (Louviere 1988). Interaction and cross effects were not significant throughout the location choice analyses.

In this analysis, the main effects were estimated by conditional logit choice models.

Location choices are affected by the perceived influence of four sets of attributes; 1) tax structures (property tax, income tax, sales tax, vehicle registration fees), 2) amenities (property value, monthly rents, school quality), 3) river-crossing travel conditions (travel time and tolls), and 4) others (shopping and recreation opportunities). The perceived influence can be represented by a utility function for each alternative. By repeated measures designs (Louviere 1988), the mean variations of response log odds ratios were examined and led to an additive utility function for the residential location choices.

The observed influence and unobserved influence can be expressed as followings.

$$V_j = \alpha_j + \Sigma \beta_{jk} X_{jk}$$

where

j = location choice of Portland, Vancouver, other and k = k^{th} attribute,
a_j = alternative-specific constant for alternative j
b_{jk} = alternative specific coefficient for j alternative k^{th} attribute
X_{jk} = k^{th} attribute level associated with alternative j.

$$U_j = V_j + \varepsilon_j$$

where

V_j = observed influence, and
e = unobserved influence (random error).

The probability for alternative j to be chosen can be estimated by the random utility maximization rule.

$$\text{Prob } (j) = \exp(U_j) / \Sigma \exp(U_j);$$
$$\text{Prob}(j) = \text{Prob}\{(V_j + \varepsilon_j) \geq (V_l + \varepsilon_l); j \neq l\}$$

2. Residential Location Choice Analysis

The income tax attribute was the most significant impact in location choice. Property tax and sales tax attributes were also strong and significant (Table 4.). The vehicle registration fee attribute was not significant for either area or for both sets of respondents. Respondents were less sensitive to the vehicle registration fee levels than to other tax attribute levels.

The school quality attribute expressed in student/teacher ratio, had a strong impact among amenity attributes. Both Portland and Vancouver respondents were strongly sensitive to levels of the school quality attribute. It was clear that both sets of respondents would not like crowded school conditions. This result may suggest that school quality could be an important factor in the residential land use allocation process. The monthly rent attribute was significant for only Vancouver respondents' evaluation of the Vancouver area. Respondents were not sensitive to different levels of the property value attribute in the two areas, because the two areas have very comparable property value and may be perceived not to have different property values.

Travel related attributes were not significant in residential location choice, though the toll attribute was close to statistical significance for Portland respondents' evaluation of the Vancou-

Table 4: Coefficients for residential location choices

	Portland Respondents			Vancouver Respondents		
Observation	4077 (151 hh)			10206 (378 hh)		
Chi2(28)	383.45			1806.21		
Prob>chi2	0			0		
Pseudo R2	0.1285			0.2416		
Log Likelihood	-1300.1921			-2834.3729		
	Coef.	Z	P>|z|	Coef.	Z	P>|z|
Property tax_p	-0.1015339	-1.497	0.134	-0.2515861	-2.887	0.004
Income tax_p	-0.1979535	-2.916	0.004	-0.5036089	-5.594	0.000
Sales tax_p	-0.1762814	-2.588	0.010	-0.2502334	-2.815	0.005
Veh. Reg. Fee_p	-0.0420212	-0.618	0.536	-0.0622429	-0.695	0.487
Property value_p	-0.0453235	-0.667	0.505	-0.0504305	-0.588	0.556
Monthly rent_p	-0.0738651	-1.090	0.276	-0.0733969	-0.844	0.398
School quality_p	-0.1868449	-2.756	0.006	-0.3135825	-3.557	0.000
River-crossing time_p	-0.0214277	-0.316	0.752	-0.0554377	-0.647	0.518
River-crossing toll_p	-0.0035629	-0.053	0.958	-0.0432492	0.490	0.624
Shopping_p	-0.0306891	-0.255	0.799	-0.0048114	-0.031	0.975
Specialty store_p	-0.0411595	-0.341	0.733	0.1346608	0.840	0.401
Dining/entertain_p	-0.0710871	-0.591	0.555	-0.1377608	-0.913	0.361
Special event_p	-0.0169334	-0.141	0.888	0.1637652	1.084	0.278
Constant_Portland	1.37151	5.073	0.000	-0.2412511	-0.829	0.407
Property tax_v	-0.3177785	-3.189	0.001	-0.1644313	-3.759	0.000
Income tax_v	-0.4415691	-4.366	0.000	-0.2440348	-5.572	0.000
Sales tax_v	-0.1230158	-1.229	0.219	-0.1155582	-2.644	0.008
Veh. Reg. Fee_v	0.0561304	0.565	0.572	-0.0471399	-1.077	0.281
Property value_v	-0.1181811	-1.178	0.239	-0.0706662	-1.616	0.106
Monthly rent_v	-0.1711912	-1.718	0.086	-0.0989602	-2.262	0.024
School quality_v	-0.2376837	-2.366	0.018	-0.1989496	-4.548	0.000
River-crossing time_v	0.0546177	0.551	0.582	-0.0728323	-1.668	0.095
River-crossing toll_v	-0.1772368	-1.782	0.075	-0.0193219	-0.443	0.658
Shopping_v	-0.0132052	-0.075	0.940	0.0027880	0.036	0.971
Specialty store_v	0.0121207	0.069	0.945	-0.0114291	-0.148	0.882
Dining/entertain_v	-0.0129173	-0.074	0.941	-0.0070650	-0.092	0.927
Special event_v	0.1022627	0.582	0.561	-0.0180721	-0.235	0.814
Constant_Vancouver	0.4279702	1.118	0.264	1.6955060	12.700	0.000

Note: ---tax_p: attributes for Portland conditions, ---tax_v: for Vancouver Conditions

ver area. When Portland respondents evaluate Portland or when Vancouver respondents evaluate Vancouver, the river-crossing travel time and tolls may not be relevant in their decision. None of shopping and recreation attributes was significant. Significant increase in specialty store and special events in Portland was appealing factors for Vancouver respondents, while increase in those in Vancouver was appealing factor for Portland residents.

Willingness of Vancouver respondents to choose the Portland area for residence was much lower than that of Portland respondents to choose the Vancouver area. Consequently, the willingness of Portland respondents to move to Vancouver is higher than that of Vancouver residents to move to Portland. Vancouver respondents are more willing to stay in Vancouver as well than Portland respondents.

Currently, Oregon has state income tax for those who reside and work in Oregon as well as for those who work in Oregon and reside elsewhere. Washington has sales tax for those who reside and buy something in Washington, but Oregon residents are exempt. Respondents in two areas have different experience with sales tax and state income tax. Consequently, Vancouver respondents responded to levels of the state income tax and sales tax attributes differently from Portland respondents. For Portland respondents, the impact of sales tax in evaluating Portland or Vancouver was very comparable, while the impact of income tax in evaluating Vancouver was more severe than in evaluating Portland. For Vancouver respondents, the impact of both state income tax and sales tax in evaluating Portland was stronger than in evaluating Vancouver by about two times.

The SP models for residential location choices predict the probabilities of Portland or Vancouver residents to choose their residential locations according to changes in state income tax and sales tax (Table 5). By income tax changes in Washington, Portland respondents are much more likely to choose Portland than other place, as their probabilities to choose Vancouver decrease substantially. Vancouver respondents are more likely to move out to Portland and other places. Those who work in Washington and reside in Oregon are still subject to Oregon income tax and have some incentive to move to Washington. But, some Portlanders seem to be attached to Portland and stay in Portland in spite of the burden of Oregon income tax. If Washington had income tax, Portlanders would stay in Portland.

With sales tax changes in Oregon, Portland respondents are likely to move to Vancouver slightly more than to Other Place. The probabilities of Vancouver respondents to choose Portland decrease, as the probabilities to choose other place slightly increase (Table 6.).

Table 5: Residential location choice probability variations by income tax changes in Washington

	Income Tax Changes	Portland	Vancouver	Other	Total
Portland Respondent Choices	Current Situations	60.9%	23.7%	15.4%	100%
	5% Income Tax in WA	66.5%	16.6%	16.9%	100%
	10% Income Tax in WA	70.7%	11.4%	17.9%	100%
Vancouver Respondent Choice	Current Situations	10.9%	75.3%	13.8%	100%
	5% Income Tax in WA	13.0%	70.5%	16.5%	100%
	10% Income Tax in WA	15.3%	65.2%	19.5%	100%

Table 6: Residential choice probability variations by sales tax changes in Oregon

	Sales Tax Changes	Portland	Vancouver	Other	Total
Portland Respondent Choices	Current Situations	60.9%	23.7%	15.4%	100%
	4% Sales Tax in OR	56.6%	26.3%	17.1%	100%
	8% Sales Tax in OR	52.2%	28.9%	18.9%	100%
Vancouver Respondents Choice	Current Situations	10.9%	75.3%	13.8%	100%
	4% Sales Tax in OR	8.7%	77.2%	14.1%	100%
	8% Sales Tax in OR	6.9%	78.7%	14.4%	100%

3. Shopping Location Choice Analysis

The sales tax attribute was only significant and a relevant factor to shopping location choice among tax attributes (Table 7.). Currently Oregon residents are not subject to sales tax in Washington, when they buy something in Vancouver. For Portland respondents, the impact of sales tax in evaluating Vancouver was more severe than in evaluating Portland. Portland respondents seemed to really dislike sales tax in Vancouver, more than Vancouver respondents. For Vancou-

Table 7: Shopping location choice

	Portland Respondents			Vancouver Respondents		
Observation	4077 (151 hh)			10206 (378 hh)		
Chi2(10)	829.88			924.69		
Prob>chi2	0.0000			0.0000		
Pseudo R2	0.2780			0.1237		
Log Likelihood	-1077.6704			-3275.1330		
	Coef.	Z	P>|z|	Coef.	Z	P>|z|
Sales tax_p	-0.1734285	-2.380	0.017	-0.2941371	-6.671	0.000
River-crossing time_p	-0.0631361	-0.867	0.386	-0.0420728	-0.958	0.338
River-crossing toll_p	0.0280335	0.387	0.699	-0.0868363	-1.976	0.048
Shopping_p	0.0220346	0.171	0.864	-0.0073318	-0.089	0.929
Specialty store_p	0.0344248	0.266	0.790	-0.0174748	-0.213	0.831
Constant_Portland	1.367873	6.991	0.000	1.504495	12.301	0.000
Sales tax_v	-0.4656589	-3.892	0.000	-0.3981494	-9.238	0.000
River-crossing time_v	0.0098670	0.085	0.932	-0.0308113	-0.723	0.470
River-crossing toll_v	-0.1684838	-1.453	0.146	0.0533157	1.247	0.212
Shopping_v	0.2339661	1.103	0.270	0.2038771	2.540	0.011
Specialty store_v	0.1937558	0.993	0.361	0.0628038	0.781	0.435
Constant_Vancouver	-0.5480905	-1.902	0.057	1.511748	12.811	0.000

Table 8: Shopping location choice probability variations by sales tax changes in Oregon

	Sales Tax Changes	Portland	Vancouver	Other	Total
Portland Respondents Choice	Current Situations	71.3%	10.5%	18.2%	100%
	4% Sales Tax in OR	67.7%	11.8%	20.5%	100%
	8% Sales Tax in OR	63.7%	13.3%	23.0%	100%
Vancouver Respondents Choice	Current Situations	44.8%	45.2%	10.0%	100%
	4% Sales Tax in OR	37.7%	51.0%	11.3%	100%
	8% Sales Tax in OR	31.1%	56.5%	12.4%	100%

ver respondents, the impact of sales tax in evaluating Portland or Vancouver was strong. Vancouver respondents seemed to dislike sales tax in Oregon more than Portland respondents.

Two attributes related to river-crossing travel, river-crossing travel time and tolls, were not statistically significant overall except "river-crossing tolls" in case of Vancouver respondents' evaluation of Portland. When Portland respondents consider Portland or when Vancouver respondents consider Vancouver for shopping places, the river-crossing travel time and tolls may not be relevant factors in their decision.

Significant increase in shopping opportunities in Vancouver was an appealing and important factor for Vancouver respondents. For Portland respondents, significant increase in shopping and specialty store opportunities in Vancouver was statistically significant and strong. Respondents in both areas value highly the increase in shopping and specialty stores in Vancouver. Overall, Portland respondents showed strong willingness to stay in Portland for shopping, while Vancouver respondents were likely to go to Portland as much as to stay in Vancouver for shopping.

The SP models for shopping location choice predict Vancouver residents' probability to choose Portland for shopping according to changes in Oregon sales tax (Table 8.). The four-percent sales tax in Oregon decreases the Vancouver residents' probability to choose Portland by sixteen percent (from 44.8% to 37.7%), while the eight-percent sales tax in Oregon decrease it by thirty one percent (from 44.8% to 31.1%). Portland respondents are likely to go somewhere else for shopping rather than to Vancouver when Oregon had a sales tax. Vancouver respondents are likely to stay in Vancouver for shopping, but still likely to shop in Portland with more than thirty percent chance, when Oregon has sales tax as much as Washington currently has. Although Oregon had sales tax, Vancouver residents would perceive much richer retail arrays in Portland than in Vancouver and still would shop in Portland.

Conclusions

The analysis examined the impact of explanatory attributes including two travel-related attributes on respondents' location choices. Two attributes related to river-crossing travel, such as "river-crossing travel time" and "river-crossing tolls," were found to be statistically insignificant in this analysis. In this unique geographical situation, both residents have only limited access by two interstate bridges in their river-crossing decisions. Also, these two attributes seem relevant to respondents' river-crossing location choices. Consequently, other location specific explanatory attributes showed much stronger impact in respondents' location choice decisions. Another trans-

portation-related attribute grouped as one of tax attributes, “vehicle registration fee,” was also generally not significant in this analysis. Both sets of respondents were the least sensitive to levels of the vehicle registration fee among tax attributes in their residential location choice decisions. They seem more tolerant of vehicle registration fee changes among tax changes.

The SP methods used here was an application of newly emerged paradigms based on random utility theory, discrete or qualitative responses and discrete multivariate statistical analysis techniques. Stated Preference analysis can be applied to many types of transportation research and can offer a better understanding of travel behavior. SP analysis is not only a useful tool to measure utilities and marginal probabilities of explanatory variables directly, but also a powerful tool for prediction of travel choice behavior. SP analysis results can support and improve the current travel modeling process.

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Appendix I. Experimental Design Matrix for Location Choice (Six Blocks of Nine Sets Each, Alternative Specific Models, and All Cross Effects Estimable)
by Dr. Donald A. Anderson, StatDesign

b11 0 0 1 2 2 1 1 0 1 1 0 1 1 b11 0 1 2 1 1 0 1 1 0 0 1 1 0
b12 2 2 0 0 1 0 0 0 2 1 0 1 1 b12 2 2 0 2 2 1 0 0 0 0 1 0 1
b13 1 0 2 1 2 1 0 1 2 1 1 1 0 b13 1 0 2 1 1 1 0 0 2 1 1 0 1
b14 0 1 1 2 0 2 0 2 2 0 1 1 1 b14 0 1 1 0 0 1 0 0 1 1 0 0 0
b15 2 0 0 0 2 1 2 2 0 0 1 0 1 b15 2 2 2 1 1 2 2 2 1 1 0 1 1
b16 2 1 0 0 0 2 1 1 1 1 1 1 1 b16 2 2 1 0 0 0 1 1 2 1 1 1 1
b17 0 2 1 2 1 0 2 1 0 1 1 0 1 b17 0 1 0 2 2 2 2 2 2 1 1 1 0
b18 1 1 2 1 0 2 2 0 0 1 0 0 0 b18 1 0 1 0 0 2 2 2 0 0 1 1 1
b19 1 2 2 1 1 0 1 2 1 0 1 1 0 b19 1 0 0 2 2 0 1 1 1 1 0 1 1
b21 1 2 1 0 0 1 1 2 0 1 0 1 1 b21 2 0 1 1 2 2 0 1 2 1 1 0 0
b22 0 1 0 1 2 0 0 2 1 1 0 0 1 b22 1 1 2 2 0 0 2 0 2 1 1 1 1
b23 2 1 2 2 2 0 1 1 0 1 1 1 0 b23 0 2 2 2 0 2 0 1 0 0 0 0 1
b24 1 0 1 0 1 2 0 1 1 1 1 0 1 b24 2 0 0 0 1 0 2 0 0 0 0 1 0
b25 0 0 0 1 1 2 1 0 0 0 1 1 1 b25 1 1 0 0 1 2 0 1 1 1 1 0 1
b26 2 2 2 2 0 1 0 0 1 0 1 0 0 b26 0 2 1 1 2 0 2 0 1 1 1 1 1
b27 2 0 2 2 1 2 2 2 2 1 0 1 0 b27 0 2 0 0 1 1 1 2 2 1 1 1 1
b28 1 1 1 0 2 0 2 0 2 0 1 1 1 b28 2 0 2 2 0 1 1 2 1 1 1 1 0
b29 0 2 0 1 0 1 2 1 2 1 1 1 1 b29 1 1 1 1 2 1 1 2 0 0 0 1 1
b31 2 1 1 1 1 1 1 1 2 0 0 0 0 b31 2 1 2 0 2 2 1 0 0 1 1 1 1
b32 2 2 1 1 2 2 0 0 0 1 1 1 0 b32 2 1 1 2 1 0 0 2 1 1 0 1 1
b33 0 2 2 0 2 2 2 1 1 0 0 1 1 b33 0 0 1 2 1 1 2 1 0 1 1 0 1
b34 1 0 0 2 0 0 0 1 0 0 0 1 1 b34 1 2 0 1 0 0 0 2 0 1 1 1 0
b35 1 1 0 2 1 1 2 0 1 1 1 1 1 b35 1 2 2 0 2 1 2 1 1 1 0 0 0
b36 2 0 1 1 0 0 2 2 1 1 1 1 0 b36 2 1 0 1 0 1 2 1 2 0 1 0 1
b37 1 2 0 2 2 2 1 2 2 1 1 0 1 b37 1 2 1 2 1 2 1 0 2 0 1 1 0
b38 0 1 2 0 1 1 0 2 0 1 1 1 1 b38 0 0 2 0 2 0 0 2 2 0 1 1 1
b39 0 0 2 0 0 0 1 0 2 1 1 0 1 b39 0 0 0 1 0 2 1 0 1 1 0 1 1
b41 2 1 1 2 1 0 1 1 2 0 1 1 1 b41 1 0 1 1 1 0 2 2 2 1 0 0 1
b42 2 2 1 2 2 1 0 0 0 1 1 0 1 b42 1 0 0 0 0 1 1 1 0 1 1 1 1
b43 1 0 0 0 0 2 0 1 0 0 1 0 0 b43 0 1 2 2 2 1 1 1 2 1 0 1 1
b44 0 0 2 1 0 2 1 0 2 1 1 1 1 b44 2 2 2 2 2 0 2 2 0 1 1 0 0
b45 0 1 2 1 1 0 0 2 0 1 0 0 1 b45 2 2 1 1 1 1 1 1 1 0 1 1 0
b46 1 1 0 0 1 0 2 0 1 1 1 1 0 b46 0 1 1 1 1 2 0 0 0 1 1 1 1
b47 2 0 1 2 0 2 2 2 1 1 0 1 1 b47 1 0 2 2 2 2 0 0 1 0 1 1 1
b48 1 2 0 0 2 1 1 2 2 1 0 1 0 b48 0 1 0 0 0 0 2 2 1 0 1 0 1
b49 0 2 2 1 2 1 2 1 1 0 1 1 1 b49 2 2 0 0 0 2 0 0 2 1 0 1 0
b51 2 2 0 1 1 2 0 0 2 1 1 1 1 b51 0 0 2 1 0 2 2 1 2 0 0 1 0
b52 1 2 2 2 1 2 1 2 1 0 1 0 1 b52 2 1 2 1 0 1 0 2 0 1 1 1 1
b53 2 1 0 1 0 1 1 1 1 1 0 0 1 b53 0 0 0 2 1 1 0 2 1 1 1 1 0
b54 1 1 2 2 0 1 2 0 0 1 1 1 1 b54 2 1 0 2 1 0 1 0 2 0 0 0 1
b55 1 0 2 2 2 0 0 1 2 1 0 1 1 b55 2 1 1 0 2 2 2 1 1 1 1 1 1
b56 0 1 1 0 0 1 0 2 2 0 1 1 0 b56 1 2 0 2 1 2 2 1 0 1 1 1 1
b57 2 0 0 1 2 0 2 2 0 0 1 1 1 b57 0 0 1 0 2 0 1 0 0 1 1 0 0
b58 0 2 1 0 1 2 2 1 0 1 0 1 0 b58 1 2 2 1 0 0 1 0 1 1 1 0 1
b59 0 0 1 0 2 0 1 0 1 1 1 0 0 b59 1 2 1 0 2 1 0 2 2 0 0 1 1
b61 0 1 0 2 2 2 0 2 1 1 1 1 0 b61 2 0 0 1 2 2 1 2 0 1 0 0 1
b62 1 1 1 1 2 2 2 0 2 0 0 0 1 b62 0 2 0 1 2 0 0 1 2 1 1 1 1
b63 2 1 2 0 2 2 1 1 0 1 1 1 1 b63 1 1 0 1 2 1 2 0 1 0 1 1 0
b64 2 0 2 0 1 1 2 2 2 1 1 0 1 b64 1 1 1 2 0 0 0 1 0 1 0 1 0
b65 1 0 1 1 1 1 0 1 1 1 1 1 1 b65 0 2 1 2 0 2 1 2 1 0 1 0 1
b66 2 2 2 0 0 0 0 0 1 0 0 1 1 b66 1 1 2 0 1 2 1 2 2 1 1 0 0
b67 0 0 0 2 1 1 1 0 0 0 0 1 0 b67 2 0 1 2 0 1 2 0 2 1 1 1 1
b68 1 2 1 1 0 0 1 2 0 1 1 1 1 b68 0 2 2 0 1 1 2 0 0 1 0 1 1
b69 0 2 0 2 0 0 2 1 2 1 1 0 0 b69 2 0 2 0 1 0 0 1 1 0 1 1 1

* Note: b11, b12 …., b69: fist-version(block) table 1 to sixth version(block) table 9

Appendix II. Creating Choice Data Set

1. Survey Data Format

sample #, Person ID, version #, 5 questions for 9 sets (45 columns choice response data)

2. Convert each row of response data into 9 rows with the same sample # and person ID and version # with table #

sample #, Person ID, 21, 5 columns response data for 5 questions
sample #, Person ID, 22, 5 columns response data for 5 questions
sample #, Person ID, 23, 5 columns response data for 5 questions
sample #, Person ID, 24, 5 columns response data for 5 questions
sample #, Person ID, 25, 5 columns response data for 5 questions
sample #, Person ID, 26, 5 columns response data for 5 questions
sample #, Person ID, 27, 5 columns response data for 5 questions
sample #, Person ID, 28, 5 columns response data for 5 questions
sample #, Person ID, 29, 5 columns response data for 5 questions

3. Create Triplets of Design Matrix for Three Location Choices

21	21.1	Portland Attributes (13 columns)	13 zero value columns (Portland Choice)
21	21.2	13 zero value columns	Vancouver Attributes (13 columns) (Vancouver)
21	21.3	13 zero value columns	13 zero value columns (Other area)
22	22.1	Portland Attributes (13 columns)	13 zero value columns (Portland Choice)
22	22.2	13 zero value columns	Vancouver Attributes (13 columns) (Vancouver)
22	22.3	13 zero value columns	13 zero value columns (Other area)
23	23.1	Portland Attributes (13 columns)	13 zero value columns (Portland Choice)
23	23.2	13 zero value columns	Vancouver Attributes (13 columns) (Vancouver)
23	23.3	13 zero value columns	13 zero value columns (Other area)
24	24.1	Portland Attributes (13 columns)	13 zero value columns (Portland Choice)
24	24.2	13 zero value columns	Vancouver Attributes (13 columns) (Vancouver)
24	24.3	13 zero value columns	13 zero value columns (Other area)
25	25.1	Portland Attributes (13 columns)	13 zero value columns (Portland Choice)
25	25.2	13 zero value columns	Vancouver Attributes (13 columns) (Vancouver)
25	25.3	13 zero value columns	13 zero value columns (Other area)
26	26.1	Portland Attributes (13 columns)	13 zero value columns (Portland Choice)
26	26.2	13 zero value columns	Vancouver Attributes (13 columns) (Vancouver)
26	26.3	13 zero value columns	13 zero value columns (Other area)
27	27.1	Portland Attributes (13 columns)	13 zero value columns (Portland Choice)
27	27.2	13 zero value columns	Vancouver Attributes (13 columns) (Vancouver)
27	27.3	13 zero value columns	13 zero value columns (Other area)
28	28.1	Portland Attributes (13 columns)	13 zero value columns (Portland Choice)
28	28.2	13 zero value columns	Vancouver Attributes (13 columns) (Vancouver)
28	28.3	13 zero value columns	13 zero value columns (Other area)
29	29.1	Portland Attributes (13 columns)	13 zero value columns (Portland Choice)
29	29.2	13 zero value columns	Vancouver Attributes (13 columns) (Vancouver)
29	29.3	13 zero value columns	13 zero value columns (Other area)

4. Merge Triplets of Design Matrix with Response Data

5. Re-code Choice Responses

Vers #	vers. code	Ptld attributes	Vanc attributes	choice	choice code
31	31.1	13 columns	zero 13 columns	1	1
31	31.2	zero 13 col.	13 columns	1	0
31	31.3	zero 13 col.	zero 13 col.	1	0
32	32.1	13 columns	zero 13 columns	2	0
32	32.2	zero 13 col.	13 columns	2	1
32	32.3	zero 13 col.	zero 13 col.	2	0
33	33.1	13 columns	zero 13 columns	1	1
33	33.2	zero 13 col.	13 columns	1	0
33	33.3	zero 13 col.	zero 13 col.	1	0
34	34.1	13 columns	zero 13 columns	3	0
34	34.2	zero 13 col.	13 columns	3	0
34	34.3	zero 13 col.	zero 13 col.	3	1
35	35.1	13 columns	zero 13 columns	2	0
35	35.2	zero 13 col.	13 columns	2	1
35	35.3	zero 13 col.	zero 13 col.	2	0
36	36.1	13 columns	zero 13 columns	1	1
36	36.2	zero 13 col.	13 columns	1	0
36	36.3	zero 13 col.	zero 13 col.	1	0
37	37.1	13 columns	zero 13 columns	2	0
37	37.2	zero 13 col.	13 columns	2	1
37	37.3	zero 13 col.	zero 13 col.	2	0
38	38.1	13 columns	zero 13 columns	1	1
38	38.2	zero 13 col.	13 columns	1	0
38	38.3	zero 13 col.	zero 13 col.	1	0
39	39.1	13 columns	zero 13 columns	2	0
39	39.2	zero 13 col.	13 columns	2	1
39	39.3	zero 13 col.	zero 13 col.	2	0

6. Conditional Logit Analysis & Results