Valuing the Recreation Impacts of Beach Retreat

Introduction

In this section we illustrate how one can jointly estimate site selection decisions and dichotomous choice willingness-to-pay in a RUM framework. A limitation of on-site data collection is that variation of behavior is across current alternatives. Typically, the choke price is not known. In this example we augment site selection data with a contingent valuation scenario that presents a higher cost of access and asks respondents if they would still take the trip. We are able to introduce the "no trip" option that has been found to be important in choice experiments with our contingent valuation question.

Econometric Model

Random utility theory is the basis for models involving joint estimation of revealed preference (RP) and stated preference (SP) discrete choices

$$\begin{aligned} U_{ij} &= v_{ij} + \varepsilon_{ij} \\ &= \beta' x_{ij} + \varepsilon_{ij} \end{aligned}$$

where U_{ij} is the utility individual i receives from alternative j, $i = 1, \ldots, I$, $j = 1, \ldots, J$, $v_{ij} = \beta' x_{ij}$ is the systematic portion of utility, β is a vector of parameters and x_{ij} is a vector of variables specific to the choice, and ε is the random error. The probability of individual i choosing alternative j is

$$\pi_{ij} = \Pr\left(v_{ij} + \varepsilon_{ij} > v_{ik} + \varepsilon_{ik}; \forall k \in J\right)$$

When the random errors are independent and identically distributed (IID) Gumbel errors, the multinomial logit (MNL) model results

$$\pi_{ij} = \frac{\exp(\mu\beta' x_{ij})}{\sum_{j=1}^{J} \exp(\mu\beta' x_{ij})}$$

where π_{ij} is the probability that individual i chooses site j and μ is the scale factor.

Since both revealed and stated preference data follows the theoretical choice framework above, the MNL model can be used to combine and jointly estimate RP-SP data. Suppose the MNL is used to estimate the probability of the RP choice of alternative j, π_{Rij},

$$\pi_{Rij} = \frac{\exp(\mu_R \beta_R' x_{ij})}{\sum_{j=1}^{J} \exp(\mu_R \beta_R' x_{ij})}$$

where β_R is the vector of RP parameters and μ_R is the RP scale parameter which is inversely related to the variance of the error term (Swait and Louiviere, 1993). With identical elements in the x_{ij} vector, a similar model results when the MNL is used to estimate the SP choice probabilities

$$\pi_{Sij} = \frac{\exp(\mu_S \beta_S' x_{ij})}{\sum_{j=1}^{J} \exp(\mu_S \beta_S' x_{ij})}$$

When RP or SP data are estimated separately the scale parameter is arbitrarily set equal to one. When RP and SP data are stacked and estimated jointly, it is common for the error terms that result from the different data to have unequal variance leading to unequal scale parameters. When $\mu_R = 1$ it is typical for the SP data to have a higher variance due to the unfamiliarity of the choice task, $0 < \mu_S < 1$. The difference in the scale parameter will cause the MNL coefficients to differ. In this case the RP coefficient estimates will be larger than the SP coefficient estimates, $\beta_R > \beta_S$, indicating that the characteristics of the SP choices have an unduly large effect on each choice, relative to the RP data.

We estimate the relative scale factor using the joint estimation procedure described in Hensher, Rose and Greene (2005) and implemented with NLOGIT 4.0 (Greene, 2007). The procedure involves construction of an artificial nested logit model with twice as many choice alternatives as actually observed. In other words, each respondent's RP (SP) observation is also allowed to choose from the SP (RP) alternatives. The variance of the RP nest is constrained equal to one while the variance of the SP alternatives is allowed to diverge from one. The nested logit model scales the SP coefficients so that the RP and SP data can be combined and jointly estimated.

Each variance of the error term is an inverse function of the individual scale factor

$$\sigma^2 = \frac{\pi^2}{6\mu^2}$$

When the scale parameter for the RP data is set equal to one, $1 = 1/\mu_R$, the nested logit model will estimate the relative scale factor for the SP data as the inclusive value for the SP data

$$\theta_S = \frac{\sigma_S^2}{\sigma_R^2} = \frac{1/\mu_S^2}{1/\mu_R^2}$$

Random utility models can be used to estimate a variety of willingness-to-pay values. Haab and McConnell (2002) show that the willingness to pay for the elimination of an alternative from the choice set is

$$WTP(j) = \frac{\ln(1 - prob(j))}{\beta_C}$$

where $prob(j)$ is the unconditional probability of choosing alternative j and β_C is the coefficient on the cost variable which measures the marginal utility of income. The marginal willingness-to-pay for a change in a characteristic of an alternative is

$$WTP(\Delta q) = \frac{\Delta q \beta_q}{\beta_C}$$

where Δq is the change in the alternative characteristic and β_q is the coefficient on the characteristic variable.

Data

We use data from an on-site beach recreation survey conducted during 2003 at Bogue Banks, Topsail Island and Brunswick County, North Carolina (Herstine et al. 2004). The sixty-seven miles of oceanfront beach encompasses 10 beaches: (1) Atlantic Beach, Salter Path/Indian Beach, Pine Knoll Shores and Emerald Isle on Bogue Banks, (2) North Topsail Beach, Surf City and Topsail Beach in Topsail Island and (3) Caswell Beach, Oak Island and Holden Beach in Brunswick County. We use data from 387 beach goers who were taking day-trips during the interview (Table 1). The average household income is almost $52 thousand. Forty-five percent of respondents are male. The average amount of time spent on the beach is 4 hours and the average party size is almost 4 people.

The survey contains a contingent valuation method (CVM) question and enough information necessary to conduct a site selection RUM analysis. Both approaches are designed to estimate the economic benefits of a day trip at a particular site. The CVM question asks beach goers if they would be willing to pay higher travel costs and still visit the particular beach of the interview. The question is in the dichotomous choice (i.e., yes/no) format with randomly assigned values for higher travel costs as the payment vehicle. Survey respondents were asked: "Some beach trips cost more than others. For example, on an overnight beach trip you may spend money for food, travel expenses, and lodging. On a day trip you may only spend money for gas. What do you expect will be your total expenses as an individual for this beach trip?" and "Beach trip costs change over time. For example, gas prices fell during the 1990s and rose during the first part of 2003. Would you have come to this island for your beach trip if your total trip costs were $A more than the amount you just reported?"

Answer categories included "yes", "no" and "don't know". Don't know responses are recoded as "no" responses (Groothuis and Whitehead, 2002). Each survey receives a randomly assigned value for $A. The enumerator chose from $5, $10, $25, 50, or $75. The percentage of respondents who answer "yes" declines as the bid amount rises (Table 2). The nonparametric Turnbull willingness-to-pay estimate of the value of beach access is $33.53 (standard error = 4.04).

The RP site selection data indicates that Emerald Isle, North Topsail Beach, Atlantic Beach and Surf City are the most popular beaches in the sample (Table 3). These four beaches are also those with the greatest number of parking spaces and length (Table 4). Other site characteristics variables are beach width and population. The travel cost variable is measured as $f + cd + \gamma w(d / mph)$, where f is the contingent valuation bid amount, c is the cost per mile driven ($0.35/mile), d is round-trip distance, γ is the opportunity cost of time (0.33), w is the hourly wage rate estimated as household income divided by 2000 hours worked and mph is miles per hour (50). Distance is measured using the ZIPFIP correction (i.e., a 10% increase) for "great circle" (i.e., straight line) distances from the home zip code to the launch site (Hellerstein et al., 1993).The mean of the travel cost component of the trip cost variable across all RP alternatives and trips (n = 3870) is $84 with a range of $1 to $301.

The SP site selection variable is constructed from the dichotomous choice willingness-to-pay data in Table 6-3 and the RP data in Table 3. The respondents who stated that they would not visit the island with the higher access cost are coded as taking no trip. Our assumption is that if the respondent stated they would not visit the island then they would not take the trip. A number of respondents at each beach state that they would not take the trip when faced with the higher cost. In total, 34% of respondents would not take the trip.

Results

In Table 5 we present the independently estimated RP and SP models and the jointly estimated RP-SP model. In addition to the beach characteristics variables we include travel cost, an alternative specific constant for the no trip option and income interacted with alternative specific constants. The travel cost variable is constructed in the same way as that described in the previous section with two differences. First, the cost per mile is $0.35 instead of $0.37 reflecting the earlier date for data collection. Second, the contingent valuation bid amount from Table 6-3 is included instead of the party/charter fee.

Our results are as expected. The scale parameter is significantly greater than one which indicates that the variance in the stated preference data is greater than the variance in the revealed preference data. A likelihood ratio test between the RP-SP scaled and unscaled (not presented) model indicates that the scaled model is a statistical improvement (χ^2 = 13.62 [1 df]). Beach recreation site choice is negatively affected by the travel cost and resident population and positively affected by the number of parking spaces, beach length and beach width. Demonstrating a gain from joint estimation is the parking spaces coefficient, which becomes statistically significant only in the jointly estimated model. In the SP and RP-SP models, the no trip option generates positive utility considering respondents avoid higher trip cots. In the RP model, when the income variables are estimated relative to the omitted beach, all but two coefficients are statistically significant. In the SP model the income variables are estimated relative to the no trip alternative specific constant and only the Surf City coefficient is positive and statistically significant suggesting that respondents failed to fully consider their income constraints when considering the contingent valuation question. In the RP-SP model, the income effects pattern is similar to the RP data model.

The travel cost coefficients vary across RP, SP and RP-SP models. The variation is reflected in the willingness-to-pay estimates (Table 6). Willingness-to-pay for site access and site characteristics is significantly greater in the SP model relative to the RP model, perhaps reflecting hypothetical bias in the contingent valuation data. None of the willingness-to-pay values for site characteristics are statistically significant from the SP model. The willingness-to-pay estimates from the jointly estimated model are between the RP and SP estimates but closer in value to the RP model estimates. Note that willingness-to-pay for site access to Bogue Banks and Topsail Island is no different from the Turnbull estimate. These results suggest that by including the no trip option, increasing the range of costs considered by survey respondents, reveals a higher value for beach site access and characteristics than that revealed by variation in travel costs across beaches. When faced with even greater travel costs at their chosen beaches, respondents may be willing to pay even more to visit. With this interpretation, the RP model estimates are downwardly biased.

Simulations

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Conclusions

In this section we combine and jointly estimate revealed preference data collected with an on-site survey and stated preference data eliciting the trip participation decision. The models are implemented using the scaling technique designed for choice experiments. We find that there are potential gains from joint estimation. Future research should explore additional applications for joint estimation with the random utility model.

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Table 1. Characteristics of Beachgoers

Variable	Mean	Std Dev
Household Income ($1000)	51.94	27.32
Male	45%	---
One-way distance	56.3	50.80
Hours Spent at Beach	4.36	2.05
Number in Party	3.56	3.6

Sample size = 387

Table 2. Willingness-to-Pay Responses

Bid	Yes	Cases	%Yes
5	85	96	88.54
10	93	102	91.18
25	40	74	54.05
50	22	60	36.67
75	16	55	29.09

Table 3. Site Selection

	RP		SP	
Beach	Frequency	Percent	Frequency	Percent
Atlantic Beach	70	18.09	43	11.11
Pine Knoll Shores	19	4.91	13	3.36
Indian Beach/Salter Path	17	4.39	11	2.84
Emeral Isle	82	21.19	58	14.99
North Topsail Beach	81	20.93	58	14.99
Surf City	53	13.70	33	8.53
Topsail Beach	17	4.39	9	2.33
Caswell Beach	20	5.17	14	3.62
Oak Island	13	3.36	8	2.07
Holden Beach	15	3.88	9	2.33
No trip	0	0.00	131	33.85

Table 4. Beach Characteristics

Beach	Parking Spaces	Beach Length	Beach Width	Population (1000s)
Atlantic Beach	662	4.90	135	1.781
Pine Knoll Shores	111	4.80	110	1.524
Indian Beach/Salter Path	44	2.50	90	0.095
Emeral Isle	325	11.50	130	3.488
North Topsail Beach	539	9.70	82	0.843
Surf City	317	5.10	90	1.393
Topsail Beach	172	4.00	110	0.471
Caswell Beach	56	2.80	80	0.37
Oak Island	816	7.50	120	6.571
Holden Beach	194	6.80	90	0.787

Table 5. Random Utility Site Selection Models

	RP		SP		RP-SP	
	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat
Travel cost	-0.088	-12.07	-0.004	-1.93	-0.018	-10.97
Parking Spaces	0.001	1.43	0.001	1.24	0.001	2.07
Beach Length	0.127	2.71	0.189	3.51	0.156	4.50
Beach Width	0.030	3.56	0.019	2.21	0.017	3.09
Population	-0.369	-2.70	-0.367	-2.44	-0.313	-3.24
No Trip			4.587	4.84	3.600	5.78
Atlantic Beach x Income	0.026	2.84	0.008	1.24	0.018	3.43
Pine Knoll Shores x Income	0.028	3.26	0.003	0.43	0.011	1.93
Indian Beach/Salter Path x Income	0.028	3.34	0.008	1.00	0.015	2.57
Emerald Isle x Income	0.023	2.87	0.008	1.41	0.017	3.52
North Topsail Beach x Income	0.022	2.88	0.010	1.70	0.017	3.44
Surf City x Income	0.023	3.41	0.019	3.50	0.025	5.51
Topsail Beach x Income	-0.004	-0.42	-0.014	-1.46	-0.005	-0.80
Caswell Beach x Income	0.015	2.03	0.010	1.32	0.020	3.25
Oak Island x Income	0.011	0.84	0.006	0.47	0.012	1.34
Holden Beach x Income			-0.005	-0.66	0.006	0.98
Scale					1.130	20.47
Log-Likelihood	-608.39		-765.17		-2034.52	
Cases	387		387		774	
Alternatives	10		11		21	

Table 6. Willingness-to-pay per Beach Trip

	RP		SP		RP-SP (Scaling)	
	WTP	t-ratio	WTP	t-ratio	WTP	t-ratio
Bogue Banks	5.49	12.07	126.16	1.93	27.33	10.97
Topsail Island	4.41	12.07	101.34	1.93	21.95	10.97
Brunswick County	1.40	12.07	32.20	1.93	6.98	10.97
Parking Spaces (100)	0.92	1.41	22.27	1.03	5.29	2.03
Width (10 ft)	3.44	3.62	49.56	1.48	9.77	2.88
Population (1000)	-4.16	-2.67	-95.41	-1.50	-17.59	-3.01