AN ECONOMIC EVALUATION OF A MULTI-AREA RECREATION SYSTEM

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Researchers as well as planners have been concerned with the impact of augmenting an existing recreation system with new recreational areas. That is, they are concerned with the substitution or duplication of services stemming from additional numbers of recreational areas. The increase in benefits from a recreational system resulting from the introduction of new recreational areas are not the benefits accrued to new areas. This results from a substitution or duplication of services that leads to individuals shifting away from existing areas to the new areas. Thus, when measuring the net benefits resulting from introducing new areas, a loss in benefits accruing to the existing areas should be accounted for. This problem confronting both researchers and planners is addressed by determining the demand for individual recreational areas given a multi-area system.

A methodology for modeling a multi-area recreation system has been developed by Burt and Brewer; and Cicchetti et al. In both cases, the prices of recreational areas are employed as independent variables in the models. The problem of multi-areas addressed by these authors involved only six recreational areas each, and, thus, their models contained six independent price variables. As indicated by the authors, incorporating the recreational area prices separately into a demand equation does not pose an estimation problem when the number of recreational areas under consideration are relatively small. However, when there exists a relatively large number of recreational areas, problems with multicollinearity and possible degrees of freedom emerge. Thus, when researchers are confronted with a relatively large number of areas, some alternative model is required to circumvent this estimation problem.

But this problem of multi-area analysis is not unique to the field of recreation. Other fields, in particular international trade, are faced with the same evaluation problem. That is, the demand for both recreation activities and commodities traded in international markets are distinguished by their place of supply. Commodities traded in the world market are distinguished not only by the type of commodities, but also by their region of supply. Likewise, commodities or activities in recreation such as boating, fishing, and hiking are distinguished by the type of activities and also by their region of supply.

This paper develops a multi-area recreational model that systematically simplifies the demand functions so that they are relevant to the practical purposes of estimation. Specifically, a model is developed that circumvents the problems encountered by a relatively larger number of recreational areas. The procedure followed in developing the model is based on an international trade model by Armington. As an application for policy implications, the model is employed to measure the substitution of services, which results in individuals shifting away from existing recreation areas to new areas based on the price of this activity.

THEORY OF RECREATIONAL DEMAND

Recreation demand models are generally based on the idea that consumers and recreation activities are distinguished by their place of residence or origin. Consumer origins may be represented by a vector, $C = (C_1, C_2, \ldots C_n)$, and the different types of recreation activities can also be represented as a vector of activities, $A = (A_1, A_2, \ldots A_m)$. In addition, each activity is differentiated according to where it is supplied by a different recreational area, that is, $A_t = (A_{t1}, \ldots A_{tr})$, where r is the number of recreational areas. The vector of activities can then be represented as

$$(1)\quad A = (A_{11}, A_{12}, \ldots, A_{1r}, A_{21}, \ldots, A_{2r}, \ldots, A_{m1}, A_{m2}, \ldots, A_{mr}).$$

Thus, there are n demands for each activity and m•r activities, thus there exists n•m•r activity demands.

The general approach to deriving outdoor recreation demand functions identified above, is to express a separable utility function of all m•r activities, U = U(A), subject to a budget constraint. Clawson and Knetsch (1966) define outdoor recreation activities as those typically carried on outdoors and thus requiring space. Given this definition, it is assumed that preference

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structures for outdoor recreation generally fit the definition of weak separability. For a discussion of this assumption refer to Wetzstein. Thus, the demand functions for the i_{th} origin would have the following general form

(2) $A_{itj} = A_{itj}(I_i, P_{i11}, P_{i12}, \ldots, P_{i1r}, P_{i21}, \ldots, P_{i2r}, P_{im1}, P_{im2}, \ldots, P_{imr}), (i = 1, 2, \ldots, n)\ (t = 1, 2, \ldots, m)\ (j = 1, 2, \ldots, r).$

Where I_i is the aggregation of individual income in origin "i" allocated to outdoor recreation and P_{itj} is the price of activity "t" from recreational area "j" for origin "i." The close association of similar recreation activities available at different recreational areas is not implied in (2). For example, the recreation activity skiing may be obtained at a number of recreational areas. Thus, a utility function may be specified that incorporates this close association. In this regard, a utility function must be specified in such a manner that the utility U_t can be distinguished. That is, under what conditions can a utility function be specified as

(3) $U = U(U_1, U_2, \ldots, U_m)$, where

$$U_t = U_t(A_{t1}, A_{t2}, \ldots, A_{tr})$$

Equation (3) states that all combinations of A_{t1}, $A_{t2}, \ldots, A_{tr}$) which result in the same value of U_t are equally preferred. The necessary and sufficient condition for (3) is that marginal rates of substitution between any two activities of the same characteristics must be independent of the quantities of the activities composed of all other characteristic sets. Specifically, this means independence among activities. That is, individuals' preference for different activities cannot be influenced by their consumption of other activities.[1] For example, individuals' preference for hiking are not influenced by their consumption of swimming. The resulting demand functions are

(4) $A_{itj} = A_{itj}(I_{it}, P_{it1}, P_{it2}, \ldots, P_{itr}),$

where I_{it} is the aggregation of individual income in origin i allocated to activity t.

Burt and Brewer applied (4) in their estimation of six recreational areas. If there exists many more alternative recreational areas (4) becomes too complicated for applied use, and, thus, further simplifying assumptions must be imposed for estimation. Researchers in international trade confronted with this same problem assume that consumers in a country consider all the alternative origins of supply for a given commodity imported from a particular country as a single alternative (Armington). Applying this assumption to recreation, it is assumed a consumer who engages in activity t at area j considers all the alternative areas for acquiring activity t as a single alternative to acquiring t at area j. For example, an individual skiing at a certain ski resort considers all the alternative ski resorts as a single alternative to skiing at this resort. Thus, the utility function is represented as

(5) $U_t = U_t(A_{tj}, Q_{tj}),$

$$Q_{tj} = Q_{tj}(A_{t1}, A_{t2}, \ldots, A_{tj-1}, \ldots, A_{tj+1} \ldots, A_{tr}),$$

for a consumer who engages in activity t at area j. Note that Q_{tj} is a function of all the recreational areas associated with the t^{th} activity, excluding A_{tj}. Therefore (5) will result in the following demand function for each n origins

(6) $A_{tj} = A_{tj}(I_t, P_{tj}, W_{tj}),$

where W_{tj} is a function of the t^{th} activity prices from their recreational areas, excluding P_{tj}.

In order to estimate the degree of substitution between recreation activities at various areas, assume that the elasticities of substitution between A_{tj} and Q_{tj}, for individuals who engage in activity t at area j, are constant. An additional assumption for estimation is that an individual's elasticity of substitution between any two alternative activities competing in a market is the same as that between any other pair of alternative activities competing in the same market. That is, given four ski resorts, an individual's elasticity of substitution between resort a and b is the same as between resort c and d. These assumptions are equivalent to the specification that U_ts are constant-elasticity-of substitution (CES) functions having the general form

(7) $U_t = [\delta A_{tj}^{\rho t} + (1-\delta)\ Q_{tj}^{\rho t}]^{1/\rho_t},$

$$Q_{tj} = \sum_{k \neq j}^{r} (A_{tk}).$$

The price index associated with Q_{tj}, W_{tj} must not be specified as any function of alternative activity prices. The prices of alternative activities must correspond with the optimum allocation of the alternative activities. This condition is fulfilled if

(8) $W_{tj} = P_{tk}/(\partial Q_{tj}/\partial A_{tk})$ for all $k \neq j$

which corresponds to the first order equimarginal conditions for optimum mix of the alternative activities (Solow). Equation (7) implies

(9) $\partial Q_{tj}/\partial A_{tk} = 1.$

Substituting (9) into (8) results in

(10) $W_{tj} = P_{tk}$ for all $k \neq j$.

From (7) it can be shown that the optimal value

[1] For a general discussion of independence among commodities, refer to Green; Gorman; Strotz. For applications of independence to recreation activities, refer to Cicchetti et al.; Rausser and Oliveira; Wilson 1970, 1972.

of C_{tj}, given P_{tj} and W_{tj} as prices for C_{tj} and Q_{tj}, respectively, is

$$(11) \qquad A_{tj} = b_{tj}^{-\sigma t} Q_{tj} (P_{tj}/W_{tj})^{\sigma t},$$

where σ_t is the elasticity of substitution in the t^{th} market for consumers engaged in activity t at area j, and b_{tj} is a constant.[2] For estimation purposes (11) can be written in a number of forms. For example, as a market share equation, V

$$(12) \qquad V = A_{tj}/Q_{tj} = b_{tj}^{-\sigma t} (P_{tj}/W_{tj})^{\sigma t}.$$

For empirical estimation, a random disturbance term μ is introduced in (12) to account for measurement and stochastic errors. Assuming that the terms can be entered multiplicatively, equation (12) can be estimated from the following loglinear stochastic specification

$$(13) \qquad \ln(V) = -\sigma_t \ln(b_{tj}) + \sigma_t \ln(P_{tj}/W_{tj}) + \ln(\mu).$$

VALUATION OF ACTIVITIES

For illustration purposes, an empirical application of the above theoretical model is presented. The multi-area recreation system considered is the 24 wilderness, primitive, and wilderness back country areas in California, where the recreation activity C_t considered is wilderness area recreation. Thus, the market share for a wilderness area is defined as

$$(14) \qquad V = A_{ij}/\Sigma_{k \neq j} A_{ik},$$

where A_{ij} is the number of visits incurred by origin "i" to wilderness area "j".

With regard to the price variable, a number of authors have expressed this variable in terms of travel costs, while others have it in terms of highway miles (Burt and Brewer; Sinden). In this paper, no attempt was made to convert distance into travel cost.

An additional problem in identifying an appropriate price variable, is the heterogeneous nature of the activities. Wilderness areas in California are not homogeneous; therefore, distances are weighted by an attractiveness variable, S, to account for this heterogeneous nature. The attractiveness variable is a principal component index that accounts for wilderness area variations in miles of streams and trails; forest; and number of peaks, lakes, entry and exit nodes, and campground unit characteristics (Wetzstein and Green). Thus the price of a wilderness activity is expressed as distance, D, weighted by attractiveness. The independent variable is then expressed as

$$(15) \qquad (P_{ij}/W_{ij}) = (D_{ij}/S_{.j}) \; / \; \Sigma_{k \neq j}(D_{ij}/S_{.k}).$$

This variable measures the alternative opportunities to the j^{th} area from origin "i." The denominator expresses the hypothesis that the farther area "k" is away from origin "i," the less of a competing factor it becomes, regardless of its attractive features. However, this competitive factor is relative to the area's attractiveness. The more attractive an alternative wilderness area is, as measured by the principal component index $S_{.k}$, the more competition it poses for the j^{th} area. Thus, distance is divided by $S_{.k}$ with the result then summed over all of the alternative areas. The attractiveness and distance of alternative areas are relative to the given area; hence the denominator of equation (15) is divided into $D_{ij}/S_{.j}$ to account for this property.

Similar proxies have been employed previously. For example, Grubb and Goodwin employed.

$$(16) \qquad \sum_{j=1}^{N} \ln S_j/D_{ij}$$

to account for the alternative areas' substitution effect for water recreational activities, where S_j is the area of the j^{th} lake and D_{ij} is distance.

AN APPLICATION AND RESULTS

All 58 origins (California counties) for 22 existing wilderness areas were combined from cross-sectional data for years 1972–75.[3] Ordinary least squares was the estimation technique applied independently to each separate wilderness area. The results of estimating the market share equations are presented in Table 1. As expected, the price coefficients exhibit negative signs. That is, the further a recreation area is from an origin and the less attractive the area is relative to alternative areas, the lower is the level of use at that area. The t-values indicate that all of the coefficients are significant at the .001 level, except the price coefficient associated with Hoover, which is significant at the .005 level. Furthermore, no serial correlation or structural changes over time are apparent in the wilderness data (Wetzstein et al.).[4] The overall goodness of fit R^{-2} ranges from a low of 0.035 for Hoover wilderness area to a high of 0.733 for High Sierra wilderness area.

[2] Derivation of this result can be found in the mathematical appendix to Armington's paper.

[3] A number of wilderness areas were aggregated due to the inability of separating their representative permit use. These adjacent wilderness areas are Lassen and Caribou, John Muir and Sequoia-Kings.

[4] A possibility of heteroskedasticity exists in the model specification because of aggregation of the data, as mentioned by an anonymous reviewer. Therefore, the estimated coefficients, although unbiased, may not be efficient. Generally, past research in recreation has not been concerned with this problem. One exception is Wetzstein and McNeely, who applied weighted least-squares to aggregated data in order to obtain unbiased and efficient estimators.

TABLE 1. Estimated Recreation Market Share Functions and Elasticity of Substitutions for Wilderness Areas in California

Wilderness Area	Dependent Variable (A_{ij}/Q_{ij})	Constant	Price (P_{ij}/W_{ij})	Price t-ratio	Degrees of Freedom	$\bar{R}^{2a}$
Cucamonga		- 9.422	-1.308	6.880	43	0.513
Desolation		- 8.224	-2.000	10.041	204	0.328
Dome Land		-10.498	-2.826	4.955	47	0.329
Hoover		- 7.653	-0.516	2.771	183	0.035
Marble Mountain		- 9.415	-2.009	15.583	179	0.573
Minarets		- 7.194	-0.756	3.600	182	0.057
Mokelumne		- 9.126	-2.287	13.111	147	0.536
San Gabriel		-10.838	-1.479	6.512	39	0.509
San Gorgonio		- 8.670	-2.069	14.326	104	0.660
San Jacinto		- 8.307	-2.116	6.916	86	0.350
San Rafael		- 9.710	-2.809	9.237	86	0.492
South Warner		- 8.594	-1.321	6.079	166	0.177
Thousand Lakes		- 8.345	-1.807	10.827	137	0.457
Vantana		- 8.107	-1.543	9.961	182	0.349
Yolla Bolly		- 8.522	-1.854	10.283	129	0.446
Agua Tibia		- 9.332	-2.464	7.087	42	0.534
Emigrant Basin		- 9.575	-1.935	12.980	180	0.481
High Sierra		- 8.043	-2.685	11.282	45	0.733
Salmon-Trinity		- 8.719	-1.502	7.808	196	0.233
Yosemite		- 7.991	-1.920	13.519	216	0.456
Lassen and Caribou		- 8.382	-1.556	9.211	136	0.380
John Muir and Sequoia-Kings		- 9.681	-1.907	12.497	216	0.417

[a]$\bar{R}^2$ is the adjusted R^2 value.

TABLE 2. Percentage Change in Proportion of Visitor Days in Existing Wilderness Areas Resulting From Introducing All the New Wilderness Study Areas (WSA)

Wilderness Area	County: Los Angeles	Sacramento	San Diego	San Francisco	Shasta
Cucamonga and WSA	- 1.3%	- 4.0%	- 1.7%	- 3.4%	1.1%
Desolation	- 18.1	- 25.9	- 13.1	- 23.4	- 19.2
Dome Land	- 25.1	- 29.7	- 17.6	- 28.1	- 21.3
Hoover and Hoover Extension	25.1	27.2	27.1	26.6	27.3
Marble Mountain and WSA	110.4	90.4	122.4	105.0	102.4
Minarets and WSA	19.8	16.6	22.6	17.3	20.0
Mokelumne and WSA	1.6	13.6	5.3	11.0	5.1
San Gabriel	- 15.4	- 16.5	- 10.9	- 15.7	- 11.7
San Gorgonio	- 20.2	- 20.8	- 14.9	- 19.9	- 14.4
San Jacinto	- 20.2	19.8	- 15.4	- 18.9	- 12.9
San Rafael and Madulce	158.0	69.9	126.4	56.5	80.9
South Warner	- 9.2	- 15.9	- 5.9	- 14.5	- 13.0
Thousand Lakes	- 8.0	- 20.9	- 3.2	- 19.0	- 17.7
Ventana	- 14.4	- 19.2	- 10.1	- 18.6	- 14.6
Yolla Bolly	- 15.9	- 23.1	- 11.1	- 21.8	- 18.5
Agua Tibia	- 22.4	- 19.3	- 17.9	- 18.6	- 11.0
Emigrant Basin	- 17.8	- 24.1	- 12.9	- 22.7	- 18.3
High Sierra and WSA	164.8	139.2	186.2	142.8	162.0
Salmon-Trinity Alps and Salmon-Trinity Alps Addition	56.4	50.4	63.1	50.1	75.6
Yosemite	- 19.6	- 24.4	- 14.8	- 23.2	- 19.1
Lassen and Caribou	- 14.0	- 19.9	- 10.0	- 18.6	- 15.9
John Muir and Sequoia-Kings	- 19.7	- 24.3	- 15.0	- 23.1	- 19.1

POLICY IMPLICATIONS

The estimated market share functions provide important policy implications related to the introduction of additional recreational areas. That is, the coefficient associated with the price variable is a measure of the elasticity of substitution between a particular recreational area and all the alternative recreational areas available. If an additional area is added to the system, the relative prices of existing areas may be altered, which would directly affect the proportion of use to existing areas.

As an illustration, Forest and National Park Service have a number of land tracts that are considered as possible additions to the California wilderness area system. These possible additions are called new wilderness study areas (WSA). If all of the new wilderness study areas are introduced into the system, the percentage change in the proportion of visitor days from a county to a wilderness area can be determined given the results of estimating (13). Table 2 presents a number of examples in which the introduction of new wilderness study areas produces a change in the proportion of use. Five out of the 58 counties are presented in the table, representing different regions in the state (Los Angeles and San Diego counties, the southern; Sacramento and San Francisco counties, the central; and Shasta county, the northern part of the state). The recreational areas are listed in the first column. In a number of cases, the addition of a new wilderness study area is adjacent to an existing wilderness area and merely an enlargement of the area. Therefore, the introduction of the new wilderness study area results in an increase in the proportion of use at the existing wilderness area. For example, incorporating Salmon-Trinity Alps Addition into the wilderness system increases the size of the existing wilderness area, Salmon-Trinity Alps. The additional land area will increase the attractiveness of the destination and thus increase the proportion of use at the wilderness area. The proportion of visitor days from Shasta County to Salmon-Trinity with respect to all other wilderness areas will increase by more than 75 percent, given the introduction of all the new wilderness study areas.

A number of interesting results from the introduction of new wilderness study areas are apparent from Table 2. For example, even with the enlargement at the Cucamonga wilderness area, the proportion of use to that wilderness area declines for four out of five of the counties. This is the result of new wilderness study areas in close proximity to Cucamonga, such as Madulce and Upper Kern, becoming substitutes for Cucamonga. The proportion of visitor days from Los Angeles to San Rafael and Madulce wilderness areas would increase by more than 158 percent. In addition, most of the new wilderness study areas are located in the northern central regions of the state; therefore, the proportional change in price has a greater effect on central and northern counties than on southern counties. This results from the fact that the closer an origin is to a wilderness area, the greater the effect will be when a new wilderness study area is introduced in close proximity to the existing wilderness area. For example, assume that the distance between a county and a wilderness is 100 miles, and that a new wilderness study area is introduced 10 miles from the existing area in line with the county. The percentage decrease in distance is then 10 percent. However, if the distance between the county and wilderness area is 200 miles, the percentage decrease in distance is only 5 percent. Sacramento and San Francisco in most cases exhibit a higher percentage decrease than Los Angeles and San Diego.

These results represent the maximum effects because it is assumed that little, if any, use currently exists at the wilderness study areas. Therefore, the actual effects probably are somewhat lower than the estimated effects, depending upon the present level of use at the new study areas. However, data are not available to measure the current level of use at these areas.

CONCLUSIONS

As an aid to planners in considering additions to an existing recreation system, researchers have developed demand-functions accounting for alternative recreational areas. However, these demand functions tend to become too complicated for estimation when the number of areas in a system are relatively large. This paper suggests an alternative model, borrowed from international trade theory, which further simplifies demand functions for estimating a relatively large number of areas. The alternative recreational areas are aggregated into one explanatory variable based on separability and constant elasticity of substitution. An application of this model is applied to California wilderness areas. The elasticity of substitution for each wilderness area is estimated in order to evaluate the effects of creating additional wilderness areas in California. The results indicate that additions to this recreation system either greatly reduce or increase use at the existing areas. Thus, in order to obtain a true reflection of the benefits that will flow from a new recreational area, planners should account for the degree of substitution resulting from augmenting the recreation system.

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