The Importance of Sample Discrimination in Using the Travel Cost Method to Estimate the Benefits of Improved Water Quality

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The travel cost method is a widely used technique for the valuation of recreation sites in the absence of organized markets. While it has been shown theoretically (Freeman 1979; Feenberg and Mills 1980) and empirically (Stevens 1966; Reiling et al. 1973) how travel cost can also be used to estimate the benefits from an improvement in environmental quality at a recreation site, the method is faced with a basic problem. Suppose the quality of recreation at a site has become degraded by pollution to the extent that many recreationists have shifted their water recreation to other substitute sites. An application of travel cost is to survey those entering the recreation site in question and to use the information gathered from the sample to construct an individual travel cost demand equation for the site in its current (degraded) condition. As part of the survey, a hypothetical description of the site in a cleaner state is presented and contingent behavior determined. This information is used to estimate a demand function for the site contingent on the higher quality. The area between the two demand curves and above cost for an individual is his consumer surplus from the provision of environmental quality at the site. Total consumer surplus is then found by aggregating across individuals.

This application of travel cost is appropriate for those who continue to use the degraded site. However, we have assumed that a fairly large number of individuals have ceased using the site due to the pollution. It is probable that at least some of these individuals will return if the site were to be cleaned up, but they have not been included in the travel cost model. Can it be assumed that the benefits they will receive from an improvement in environmental quality are the same as those for the recreationists who remain?

There are no a priori reasons to assume that those who continue to use the site and those who leave will receive the same benefits if quality is improved. Since the recreationists have separated themselves along pollution tolerance lines, it is implied that there are some fundamental differences in taste and/or behavior between those who remain and those who leave. The issue is whether or not a sample of current users can be used to make good inferences about the benefits realized by former users from an improvement in environmental quality. If inferences cannot be made, then benefits to current users and former users must be estimated separately.

A problem that arises is one of devising a sampling strategy which ensures that both current users and former users are included in the survey. An obvious solution would be to take a random sample from the population surrounding the recreation site in question (Freeman 1979). However, contingent valuation methods require that only those who are familiar with both the recreation site and a cleaner alternative be part of the sample. Otherwise, no confidence can be placed on

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the responses due to information bias (Bishop and Heberlein 1979). These conditions imply an extremely large survey of the population to collect enough observations to make the travel cost method statistically useful.

An alternative to this approach is to determine where those who are sensitive to pollution may have gone in lieu of the subject site. A suitable sample can be drawn by surveying recreationists at the subject site and at alternative sites. With a sample consisting of those who currently use the subject site despite the pollution problem and those who refuse to use the site under current conditions but may return if it were to become cleaner, the travel cost method can be applied separately to each of these groups to estimate benefits. Any statistically significant difference between the groups can then be determined.

It should be noted that there is a third group of recreationists which has not been included. This group consists of those potential users of the bay who have never used it, but who are familiar with its existence and potential for recreation through the news media or word of mouth. Some of these might use the bay if water quality were improved, and their benefits should also be included as part of the recreation benefits. Even though a sample of such individuals could be identified, they were not included because available contingent valuation methods introduce potentially significant biases when respondents are unfamiliar with the recreation site.

For current users, two demand curves would be generated, one for current conditions and the other for use if the site were hypothetically cleaner. Because of the weak complementary relationship between travel to the site and water quality, the area between the two curves and above cost would be a measure of consumer surplus attributable to an improvement in water quality (Mäler 1974). For former users, the situation is slightly different. The demand curve for the site in its current state lies below the current cost of a visit; hence, quantity demanded equals zero. Therefore, only one demand curve needs to be estimated, that for the use of the bay in the cleaner state. The area beneath the curve and above cost would be a measure of the benefits from improving water quality.[1]

An application of the travel cost method with emphasis on surveying current users and former users was made at St. Albans Bay in Vermont. St. Albans Bay is located on the northeastern portion of Lake Champlain about 30 miles north of Burlington, Vermont. It is approximately 1,700 acres with a maximum depth of 40 feet and a mean depth of 27 feet. Until recent years, the bay has been a major recreational site, providing swimming, boating, fishing, and other recreation opportunities. Over the past 10–15 years, however, there has been an increasing problem with phosphorus loading in the bay, resulting in extensive, increasingly troublesome rooted and floating plant growth. As a result of the problems associated with nutrient loading, recreational use of the bay has declined. This is demonstrated by the decline in attendance at St. Albans Bay State Park, located at the head of the bay. In 1960 total attendance for the park was 27,456, and in 1970 it was 25,982 (Vermont Department of Forests, Parks and Recreation 1982). After 1970, as the eutrophication problem accelerated and became noticeable, attendance steadily declined to a total of 3,261 in 1979. As a result of declining use, the State of Vermont ceased active management of the park in 1980.

There are a number of alternatives to St. Albans Bay where recreationists can enjoy comparable recreation. These are Kill Kare State Park, Sand Bar State Park, Knights Point State Park, Grand Isle State Park, and North Hero State Park. Since public access to this portion of Lake Champlain is severely limited, it is probably safe to assume that most displaced users of St. Albans Bay would utilize these sites. Kill Kare is the closest and most likely substitute, being 2 miles away. The furthest is Grand Isle at 38 miles. Sand Bar has a sandy beach with a shallow wading

[1]It should be noted that, when estimating the benefits from improving water quality at a recreation site, there is no need to take into account changes in recreation use of other sites, assuming that there are no changes in quality at these other sites (Freeman 1979, 199). These are captured by the area between the two demand curves and above cost.

and swimming area similar to St. Albans Bay, while the other parks have gravel or rocky swimming areas. All parks also have picnic areas and fishing opportunities. While St. Albans Bay State Park is located at the head of a narrow bay, all of the alternative sites are on Lake Champlain and have better water quality than St. Albans Bay.

STUDY DESIGN

The survey was conducted in the northeastern portion of Lake Champlain during the summer of 1982. Personal interviews of randomly selected recreationists at recreation sites were used to gather information. Interviews were conducted at St. Albans Bay, the alternative sites listed above, and on the open lake itself. Most of the survey time was spent at St. Albans Bay and at Kill Kare, the nearest substitute. This was to ensure that enough past and present users of the bay would be found. Those owning land adjacent to the bay were excluded from the survey since it was assumed that recreation benefits to these users realized from an improvement in water quality would accrue to the value of the property. These benefits were captured by a part of the overall study which examined the impact of water quality on land values.

The questionnaire was designed so that the individual observation approach described by Gum and Martin could be used. In this approach, the number of trips to St. Albans Bay can be specified as a function of round-trip travel cost to the bay, round-trip travel cost to the substitute site, and income.

The 311 respondents who had recreational experience with St. Albans Bay were included in the travel cost model. The respondents were asked to imagine that the bay would become as clean as other parts of the lake with which they were familiar. Since many of these individuals were interviewed at cleaner sites, because the pollution problem in the bay is fairly recent, and because cleaner water exists just outside the bay, it was assumed that all of the respondents had at least some experience with cleaner water. The number of trips demanded by the group was determined both for the bay in its current state (polluted) and in a hypothetically cleaner state.

Following the outline procedure, the sample was divided into two groups; those who used the bay in 1982 (202) and those who had been former users but no longer use the bay (109). The travel cost method was applied separately to each group.

COMPARISON OF THE GROUPS

The fact that a group of recreationists has ceased to use St. Albans Bay is reason enough to justify treating the two groups separately. A comparison of the two groups along socioeconomic and recreation behavior lines may reveal additional benefits from separating the sample. If significant differences appear between the groups for several variables, then separation would increase the homogeneity of each group, thus reducing aggregation problems and increasing the reliability of the results.

Of the socioeconomic variables examined (age, occupation, and income), the income distribution of the two groups was significantly different. The 1982 users tend to have lower incomes than former users. This could be an indication that those with higher incomes can afford to travel elsewhere to find suitable replacements.

There were no significant differences between the two groups in distance between St. Albans Bay and a home address. Nor was there a significant difference in distance between St. Albans Bay and a local address (camp, motel, or relative's home different than respondent's home address).

There was no significant difference between the two groups in the types of recreation behavior engaged in. However, there was a significant difference in the perception of water quality between the two groups. Former users viewed the water quality of the bay as being worse than did 1982 users. For former users the median evaluation was "very poor," while for current users it was "fair." There are two possible explanations for this result. Current users may truly believe that the water in the bay is of acceptable quality, implying that the separation of the two groups is because of quality. Alternatively, current users may be reluctant to admit that the water quality is poor, since that admission would reflect poorly on their standards for recreation. They would, therefore, be overly generous in rating the quality of the bay. If the latter is true, then there may be some other reason besides quality why one group stopped using the bay while another continued to do so. Income is a likely candidate.

Familiarity with other sites was examined to ascertain whether failure to use the bay in 1982 implied having located more alternatives. This was borne out by the results, as there was a significant difference between the two groups in familiarity with other sites. A recreationist may be less reluctant to stop using the bay if it is only one of several sites at which he regularly recreates. However, there may be another reason for the results. Those who have become disenchanted with the bay may have engaged in a search for alternatives, thus acquiring greater familiarity with other sites.

There was no significant difference in the total number of trips per season made to northeastern Lake Champlain for water-based recreation between the two groups (19.88 for current users vs 19.37 for former users). This is an indication that one group does not have a greater propensity to recreate than the other. When asked to estimate the number of visits to the bay if it were as clean as other parts of the lake, the resulting numbers of visits for each group were significantly different (20.63 for current users vs. 9.18 for former users). This difference is probably due to the former users being composed of both those who had never made St. Albans Bay a major part of their recreation plans and those former, frequent users who have now found other recreation sites that they do not wish to give up.

It should be noted that most known users in the sample indicated that they would return to recreating at St. Albans Bay if it were to become cleaner (although not necessarily to the previous level of use). This supports the need to identify former users and to include their benefits as part of the total recreation benefits from improving water quality.

This review of the two groups in the sample revealed that they differ not only in whether or not they use St. Albans Bay, but also in perception of water quality in the bay, income, familiarity with other sites, and number of visits they would make if the water in the bay were cleaner. Based on these results, it appears that the two groups are sufficiently different such that the estimated demand curves will differ.

VARIABLES

Number of Trips in 1982

The number of trips in St. Albans Bay during the 1982 season was obtained directly from the questionnaire. Since the survey took place in July, the number of visits for 1982 is an estimation on the part of the respondents. In many instances the respondent could only estimate weekly use. These responses were expanded by a factor of 10 to approximate total seasonal use. The expansion factor approximates the average number of weeks between Memorial Day and the middle of September suitable for recreation, and was calculated using daily temperature and precipitation data provided by the U.S. Environmental Data and Information Service.

Number of Visits if Clean

The number of visits to St. Albans Bay with hypothetically cleaner water quality was obtained from the questionnaire. As with number of trips in 1982, weekly attendance estimates were expanded by a factor of 10.

Travel Cost to St. Albans Bay

The travel cost variable accounts for both the vehicle operating costs and time costs borne during travel to the site. The vehicle cost is calculated by multiplying round-trip distance in miles by the variable cost of operating an automobile, which includes the costs of gas, oil, maintenance, and tires. The average variable cost of the four sizes of car reported is 0.086 dollars per mile (American Automobile Association).

Time cost is a measure of the opportunity cost of time spent in travel to and from the site. Cesario reported that an approximate measure of the value of time spent on leisure activities is one-third the hourly wage rate. To calculate time cost, the median value of the household income interval from the questionnaire was divided by 2,000 hours, then by three.[2] This hourly cost was then multiplied by the time of travel (in hours) to arrive at a dollar cost of travel time. Vehicle cost and time cost were summed to give the total cost of travel. Including these variables separately resulted in severe multicollinearity.

Cost of Substitute

Sand Bar State Park was selected as an appropriate substitute site. Driving cost and time costs were calculated in the same manner as for cost to St. Albans Bay. Also, the $1.50 entrance fee charged at Sand Bar was added to total travel cost.

Kill Kare State Park was also examined as a possible substitute. However, due to its proximity to St. Albans Bay, and because one can get to Kill Kare only by going past the bay, its cost was almost perfectly collinear with that of St. Albans Bay. Because of this, cost of travel to Kill Kare State Park was dropped from the model.

Income

Household income was used in the model and was determined from the questionnaire. Since income categories were specified in the questionnaire, the midpoint of each interval was used to represent the range. The category $50,000 and above was entered as $75,000. The arbitrary nature of this value was not deemed to be a major source of error, as less than 3% of the sample fell in the category. The income of Canadians was reduced 25% to account for the exchange rate between Canadian and U.S. currencies at the time of the survey.

Functional Form

Selection of a functional form for the model can have a significant impact on the estimated benefits (Ziemar et al. 1980). There are several a priori characteristics desirable in demand models which aid in the selection of functional form.

The relation between cost and the number of trips is not expected to be linear. One would expect that the impact on quantity decreases as cost (distance) increases. Most past research has supported this view. Also, economic theory suggests that the cross-partial derivative of quantity with respect to price and income must be nonzero (McConnell 1975). These two characteristics eliminate the simple linear model as an acceptable alternative.

More importantly, the assumption of a weak complementary relationship between travel and environmental quality places a restriction on the shape of the demand curves. The estimated demand curves, either compensated or ordinary, must cross the price (cost) axis (Feenberg and Mills 1980). Otherwise, the results shown by Mäler for using weak complementarity to estimate benefits from providing environmental quality cannot be used.[3] The semi-log function with the independent variables in log form was chosen even though the cross-partial derivative is implicitly zero. Tests on the data with other functional forms indicated that the coefficient for income is zero, so the failure to satisfy this requirement was not critical. The semi-log form was chosen because it is nonlinear and crosses the price axis.

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[2]The use of one-third the hourly wage rate as a measure of the value of leisure time is arbitrary and was selected on the basis of Cesario's work. However, it was found that the results in this study are insensitive to changes in the value of time between the range of one-half to one-fourth the hourly wage rate, so the use of one-third is not deemed to be a major source of error.

[3]There may be instances when a functional form that does not intersect the price axis, such as log linear, is preferred, due to a substantially better fit. It may be possible to use the results of weak complementarity if the function is asymptotic to the price axis itself (where $X=0$). A cut-off point where the function becomes arbitrarily close to the axis can then be selected. It should be recognized, however, that the selection of the cut-off point may have a substantial impact on the estimated benefits.

RESULTS

Ordinary least squares regression was used to estimate the demand equations. Three equations were estimated; two for 1982 users and one for nonusers. The results are shown in Table 1.

In each of the estimated equations, the expected relationship between the number of trips and cost to St. Albans Bay is seen. In all cases the estimated coefficients for travel cost is significant at the 1% level. The sign on the substitute good is positive in all three equations, and significant at the 10% level or higher in two. Income was significant at the 10% level in only one equation. The implication of this is that recreation at St. Albans Bay is an inferior good, even in the cleaner state. As a check, the total number of trips to northeastern Lake Champlain was used as the dependent variable in the travel cost model. The coefficient for income was both positive and significant, implying that water recreation on Lake Champlain as a whole is a normal good.

The positions of the estimated demand curves for 1982 users are as expected. The demand curve for the hypothetically cleaner bay lies to the right of the demand curve for the bay in its present condition, implying an increased demand for the site.

A Chow test was used to test whether the two demand functions estimated for the hypothetically cleaner site are the same. The resulting F-statistic with 4 and 247 degrees of freedom has a value of 5.83 which is significant at the 1% level. This rejects the hypothesis that the two estimated equations are the same. The results strongly support the separate treatment of former users and current users in estimating benefits.

The area beneath each estimated demand curve was calculated by taking the integral under the curve between travel cost to St. Albans Bay and the cost at which the number of visits falls to zero. This procedure was followed for each observation, using the individual's travel costs and income to position the estimated functions and to determine maximum cost. For current users, the areas beneath the demand function for the bay in the two quality states were calculated and the difference taken. The mean level of benefits is $123.00. For former users, the area beneath the demand function for the bay in the cleaner state was calculated. For this group the mean level of benefits is $97.00. These are the annual benefits attributable to an improvement in water quality. A *t*-test revealed that these mean benefits are significantly different from each other at the 1% level. This result implies that inferences about benefits realized by former users cannot be made from the results using a sample of only current users. The separate treatment of current and former users was justified in this particular study.

The danger in using only a sample of cur-

TABLE 1

REGRESSION RESULTS FOR TRAVEL COST DEMAND EQUATIONS

Group	Intercept	Cost to St. Albans Bay	Cost to Sand Bar	Income	R^2
1982 users					
Present condition,	29.698	−6.315	6.581	−2.818	.258
174 obs.	(2.06)**	(−6.22)***	(2.70)***	(−1.71)*	
1982 users					
If clean,	44.199	−8.619	6.134	−2.937	.316
165 obs	(2.30)**	(−6.46)***	(1.90)*	(−1.33)	
1982 nonusers					
If clean	17.987	−4.524	4.120	−1.151	.129
90 obs.	(0.78)	(−3.40)***	(1.24)	(−0.44)	

t-statistics in parentheses. *** denotes significance at the .01 level, ** denotes significance at the .05 level, and * denotes significance at the .10 level.

rent users to estimate benefits is clearly seen. Suppose it is determined by some method that 5,000 individuals will use the bay if it were cleaned up, without any regard to whether they are current users or former users. Recreation benefits would be calculated as $123 (5,000) = $615,000 per season. However, 3,000 of these individuals are actually former users. Taking this fact into account results in a benefit estimate of $123 (2,000) + $97 (3,000) = $537,000. Failure to account for former users results in a 14.5% overestimate of benefits.

CONCLUSIONS

The improvement of water quality in St. Albans Bay appears to be desirable for recreationists. Substantial benefits for both current users and nonusers would be generated. Within the framework of benefit-cost analysis, however, these results must be viewed in light of several considerations. First, the results represent only a portion of the total benefits. Benefits to homeowners in the form of increases in property values are ignored by the travel cost model. As pointed out earlier, potential users who have never used the bay, but who are familiar with its existence, are also ignored.

No attempt was made to account for the effects of congestion on recreation. Extra benefits from an improvement in quality at St. Albans Bay may accrue to users of other sites due to a decrease in congestion at those sites. Conversely, the benefits of cleaner water for current users of St. Albans Bay may be lessened due to an increase in congestion at the bay. A much more sophisticated model would be necessary to account for these congestion effects.

The results tend to support the sampling approach used and the subsequent application of the travel cost model. Statistical tests on the sample population indicate significant differences in most of the relevant socioeconomic and recreation behavior variables tested. Also, the estimated benefits for each group are significantly different from each other. The estimate for aggregate benefits is more accurate than if only current users had been included in the model. The overestimate that results is not very dramatic in this example. However, there is no reason to expect that this will always be the case. It would be worthwhile for future research to examine the issue in other settings to see if the apparent benefits of separate treatment are widespread.

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