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LEISURE AND THE NET OPPORTUNITY COST OF TRAVEL TIME IN RECREATION DEMAND ANALYSIS: AN APPLICATION TO GROS MORNE NATIONAL PARK

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Using count data models that account for zero-truncation, overdispersion, and endogenous stratification, we estimate the value of access to recreational parks. The focus is on the empirical estimation of the proportion of the wage rate that best approximates park visitors' opportunity cost of travel time within the cost of their trip and its effects on estimated consumer surplus. The fraction of hourly earnings that corresponds to the opportunity cost of travel time is endogenously estimated as a function of visitor characteristics, rather than fixed exogenously. In this case, which deals with a relatively remote recreational site, the relevant opportunity cost of time for most visitors appears to represent a smaller fraction of their wage rate than commonly assumed in previous similar studies.

JEL classification codes: Q24, Q26
Key words: opportunity cost of travel time, endogenous stratification, on-site sampling, overdispersion, recreation demand, travel cost method

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I. Introduction

In order to value properly natural protected areas that are recreational destinations, their benefits and impacts must be clearly documented and demonstrated. However, since access to natural recreational sites is often only subject to nominal entry fees that clearly underestimate the maximum willingness to pay by most visitors, their value to the public is unknown and must be estimated through non-market valuation methods.

The most commonly used valuation method applied to the case of natural recreation areas is the Travel Cost Method. This method relies on the estimation of a demand function that explains the number of trips according to the cost faced by the visitor to reach the site and other characteristics of the household. Recent applications of the Travel Cost Method are usually based on count data models, since the dependent variable in the demand function, the number of trips, can only take on nonnegative integer values.

Visitors to recreational sites face three main types of costs: non-time travel costs, travel time costs, and on-site time and non-time costs. The focus of this article is the estimation from the data of the relevant fraction of the wage rate that best approximates the perceived net opportunity cost of travel time as part of the household's overall cost of the trip. Following the literature, we assume that households respond to travel time costs exactly in the same way that they respond to non-time travel costs and we assume that the opportunity cost of time can be proxied by a proportion of the wage rate. Under these assumptions, we endogenously estimate that fraction of hourly earnings that corresponds to the net opportunity cost of travel time for each household as a function of its characteristics. We show that this approach proves to dominate the more restrictive ones often used in previous studies, which traditionally calculated the opportunity cost of time based on an arbitrary fraction of the wage rate fixed exogenously and common for all households. To our knowledge, there is no published study that uses a flexible approach like ours to the valuation of travel time while simultaneously addressing the problems of truncation, overdispersion, and endogenous stratification that affect studies based on data collected on site.

Section II briefly outlines the Travel Cost Method. This is followed by a description of the survey and the data collection procedures in Section III. The econometric and estimation issues are dealt with in Section IV, while Section V contains the description of the data and the definition of variables used for the econometric analysis. The estimation results (Section VI) and the conclusions (Section VII) follow.

II. The opportunity cost of time in the travel cost method

The Travel Cost Method (*TCM*) relies on the assumption that, although access to recreational sites often has a minimal or no explicit price, individuals' travel costs proxy the surrogate prices of their recreational experience. If households perceive and respond to changes in travel costs as they would respond to changes in an entry fee, the number of trips to a recreation site should decrease with the total travel cost, so a demand function can be obtained. Socioeconomic characteristics and information concerning substitute sites and environmental quality indicators can also be included in the demand function. This function can be used to estimate the total benefits derived by visitors and under certain assumptions extrapolated to the general population.

Many aspects of the Travel Cost Method have been the object of critique and subject to extensive research but one of the most intractable difficulties has to do with the calculation of the opportunity cost of travel time and on-site time. Time used for leisure, including the time taken to access a particular recreational site, always has an opportunity cost, since time used for recreation can be allocated to alternative uses.[1] The question of how to incorporate this opportunity cost in travel cost models has received much attention in the literature (Shaw 1992; Englin and Shonkwiler 1995a; Feather and Shaw 1999; Shaw and Feather 1999; Zawacki et al. 2000; Hesseln et al. 2003; McKean et al. 2003). The notion of opportunity cost means that visiting a site implies sacrificing not only cash but also the opportunity of using the time in an alternative manner. The working assumption here is that the time used traveling to and from the site and the time spent on the site could have been devoted to other endeavors, so the cost of time is the benefit of the next best alternative forgone.

In practice, time cost is most often estimated as a proportion of the visitor's wage in some way, following the suggestion made by Cesario and Knetsch (1976). However, something often overlooked is that there are many ways to conceive the opportunity cost of time used for recreation at a given site, other than the implicit cost given by the working time foregone. Beal (1995) suggest as alternatives to

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[1] Time traveling to the site as well as time spent on-site should be included in the calculation of time cost. The time at the site, however, is chosen by each individual, making it endogenous. Often on-site time is assumed to be constant across households and valued the same as travel time. Sometimes analysts use the sample average length of stay on the last trip as an estimate of the fixed on-site time. In this study, we focus only on the estimation of the opportunity cost of travel time.

recreation at a particular site voluntary work, other leisure activities such as sport, pottering around at home, doing manual crafts, reading, studying or indeed visiting another site.

The assumption that travel time has a positive opportunity cost originates in transportation studies dealing with commuting behavior. However, travel to and from a recreational site may well have consumptive value, so a correct measure of the *net* opportunity cost of travel time would be the result of having deducted these consumptive benefits. This is likely to apply in the case of traveling to a national park such as Gros Morne National Park (located in the Canadian Province of Newfoundland and Labrador), since most visitors are likely to derive some en route benefits from the trip. As Cesario (1976) warned, the valuation of travel time is highly subjective, varying from individual to individual and from situation to situation.

Estimating the cost of time as a proportion of the hourly wage also assumes a flexible working schedule, so work time can be substituted for leisure time at the margin and the labor choice problem has an interior solution for everyone. However, most people are constrained by fixed work-holiday schedules and may have no opportunity to substitute paid work for leisure. For them, the leisure/work trade-off does not apply so simply, being also implausible for retirees, homemakers, students, and the unemployed. The trade-off may still apply to the self-employed and others who have discretion over their work schedules. As pointed out by Smith et al. (1983), the marginal value of on-site and travel time relates to the wage rate only indirectly through the income effect if, as it is often the case, recreation time cannot be traded for work time.

McKean et al. (2003) considered a two-stage/disequilibrium approach to value flat water recreation, assuming that those in the labor force either pre-allocate their time between work and leisure before deciding among consumer goods (Shaw and Feather 1999), or have employers set their work hours (Bockstael et al. 1987). Any of these conditions results in a corner solution whereby the wage rates do not equate the opportunity cost of time. This approach explicitly accounts for the fact that wage rates are rarely an accurate proxy for the opportunity cost of time.

Similarly, Bockstael et al. (1987) used a theoretically consistent approach to including time costs in recreational demand models. Their demand model is conditional on the recreationist's labor-market situation. For those at corner solutions in the labor market, utility maximization is subject to two constraints, leading to a demand function with both travel costs and travel time as independent variables. With interior solutions in the labor market, time is valued at the wage rate and combined with travel costs to produce one "full cost" variable.

Palmquist et al. (2010) also considered the notion that time is indivisible, most of all in a short planning horizon: free time is often only available in non-contiguous blocks, and the individual cannot move time easily between blocks. According to Palmquist et al. (2010), individuals make choices about their use of time using different choice margins.

A less common strategy is to try and infer values of recreation time from market data (Bockstael et al. 1987) or to estimate the wage fraction that results in the best fitting for a particular dataset (Bateman et al. 1996). As an example, Englin and Shonkwiler (1995b) treated the various determinants of site visitation costs as components of a latent variable, which they estimated using distance converted to money travel costs, travel time, and the wages lost in travel as indicator variables. Using this approach, they provided empirical evidence that using a fraction of hourly wages (in their case 33%) may be appropriate to measure the opportunity cost of time.

Despite the difficulties, the most commonly used approach to value time in travel cost models remains wage-based. First, most studies impute an hourly wage by dividing the reported annual income by the number of hours worked in a year –usually a number in the range 1800 to 2080 (Sohngen et al. 2000; Bin et al. 2005)–, while calculating travel time from the estimated travel distance by assuming a certain driving average speed. Then some fraction of the imputed wage is used to value time. A key choice at this stage is, however, the specific proportion of the wage rate used as a proxy for the opportunity cost of time. The fractions range from 0 to 1 in the literature, although it is quite common to use 1/3 of the wage as the opportunity cost of time (Liston-Heyes and Heyes 1999; Hagerty and Moeltner 2005). However, Feather and Shaw (1999) argue that for those on a fixed work week, the opportunity cost of time could actually exceed the wage. Cesario (1976) used 0.43 as the relevant fraction of the wage rate, Zawacki et al. (2000) and Bowker et al. (1996) used 0, 0.25, and 0.5, Sarker and Surry (1998) and Sohngen et al. (2000) used 0.3. Hanley (1989) and Bateman et al. (1996) found that using 0% (i.e. excluding time costs) and 0.025% provided them with the "best" fit for their data. The recreation demand literature has more or less accepted 25% as the lower bound and the full wage as the upper bound.

Another issue that complicates matters is that, in principle, one should be looking for the perceived opportunity cost of travel time as a determinant of the number of trips taken to a recreational site (although Common 1973, criticizes this approach). It is likely that, in practice, there is a difference between the real cost of travel time and the perceived cost of travel time. For example, infrequent visitors or those visiting the site for the first time may misperceive the time and costs involved in reaching it. In theory, the relevant cost of travel time that enters the demand or trip generating function is the perceived cost.

McKean et al. (1995) also point out that it is unrealistic to assume that the opportunity cost of time is independent of travel time needed to reach the destination. They test this assumption finding evidence that travel time is less valued for longer trip lengths.

In any event, measuring trip cost calls for considerable researcher judgment. As explained above, when the opportunity cost of travel time is estimated using the most common accounting-like procedure, based on a common fraction of the hourly wage estimated as a fraction of annual income, the following assumptions, which are rather restrictive when combined, are made:

- There is trade-off at the margin between leisure time and income (although in reality some visitors are not even employed, work fixed hours, etc.);
- All visitors work the same number of hours a year and are paid in the same manner for that job (even if different amounts);
- All visitors value travel cost at the same fraction of their hourly wage rate;
- All visitors equally enjoy or dislike travel time and they equally like or dislike their time at work;
- All visitors travel to the site at the same speed; and
- The cost of time per unit of time is constant and therefore independent of the length of the trip (McKean et al. 1995).
- All visitors perceive the cost of time as calculated by the researcher and can correctly calculate the relevant opportunity cost of time themselves.

Instead of that, we use a flexible specification of the cost of travel time, which although still based on the notion that the opportunity cost of travel time is given by a fraction of the wage rate, does not impose strong restrictions on what that fraction should be. We allow for the possibility that the opportunity cost of travel time be zero, higher than the equivalent wage rate, or even negative, since there could be a positive utility derived from traveling to the site. Furthermore, we allow the relevant fraction of the wage rate to vary across households, making it a function of trip and households' characteristics. Although this approach has been used before, we know of no previous works that apply it together with the correction for the effects of on-site sampling in the distribution of the dependent variable while allowing for the relevant fraction of the wage rate to differ across households. For example, McConnell and Strand (1981) assumed that the cost of time would be some proportion k of the visitor's wage rate and that k could be estimated from the data using regression analysis as the ratio of two estimated coefficients (they estimated k to be 0.6 of the wage rate). Common (1973) also considered a fixed k value for the whole sample, finding that in so far as it affected their behavior, the individuals he studies valued time spent en route to the recreation site negatively, that is, they positively enjoyed the travelling component of the total recreational experience.

III. Data collection

The data come from an on-site survey[2] of summer visitors to Gros Morne National Park, which covers 1,805 Km^2 on the Southwestern side of the Great Northern Peninsula in the Canadian province of Newfoundland and Labrador. This national park was declared in 1987 as a UNESCO World Heritage Site, due to its rather unique geological features, and it is considered one of Canada's most spectacular and unspoiled locations. It is most often used during the peak summer season for a variety of activities such as hiking, angling, swimming, and whale watching.

A team of interviewers approached visitors daily (except Sundays) at park entrances and at a series of hotspots within the park. Interviewers were distributed across the park according to a sampling plan ensuring that visitors from all origins and using different facilities had some likelihood of being interviewed. The data were not collected randomly but rather follow a sampling plan developed by Parks Canada that oversampled visitors from rare origins, so the analysis uses sampling weights to correct for this.[3]

Visitors were briefly interviewed (mainly place of residence) and then asked to take a questionnaire and mail it back after their visit to the Park. A total of 3140 questionnaires were administered and 1213 returned, giving a response rate of 0.386.[4] We acknowledge that this is a relatively low response rate, due mainly to the format of the survey, which prevented the use of reminders (because interviewers only collected zipcodes and postcodes, not actual names and addresses). However,

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[2] The full text of the four-page 27-question survey is available upon request.

[3] However, no correction was possible for oversampling of visitors who stayed longer at the park or who visited more locations within the park (so they would have a higher likelihood of being interviewed).

[4] We eliminated from the sample 12 respondents living farther than 7500 Km away from the Gros Morne, because long-haul travelers are rarely well described by the recreational demand model applicable to visitors from closer areas (Beal 1995; Bowker et al. 1996; Bin et al. 2005). In particular, long-haul travelers are much more likely to visit the park as part of a multipurpose/multisite trip.

whether or not our sample is representative of the whole population of park visitors is not an issue for the present contribution.[5]

The questionnaire included, among others, questions on the main reasons for the trip, the number of times the respondent had visited the park in the previous five years, home location, duration of visit, attractions visited, income, travel cost, size and age composition of the travel party, distance to substitute sites, and other sites visited[6] during the same holiday.[7]

IV. Econometric methods

The dependent variable in this analysis is the product of the number of people in the traveling party during the current trip and the number of visits made to the site during the previous five years. This variable takes only nonnegative integer values so it is best modeled as a count variable. Count data models are now commonly used in the estimation of single-site recreation demand models (Creel and Loomis 1990; Englin and Shonkwiler 1995b; Gurmu and Trivedi 1996; Shrestha et al. 2002).

A basic approach to modeling count data is to extend the Poisson distribution to a regression framework by parameterizing the relation between the mean parameter (or visitation rate in this case) and a set of regressors. However, a limitation of this

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[5] This is because relative differences in the consumer surplus and in measures of goodness of fit are not affected by low sample response (just the absolute levels of consumer surplus are affected) or the associated issue of non-response bias and because in this article we are not concerned with generalizing our results to all park visitors, but rather with investigating the effect of alternative ways to model the opportunity cost of time.

[6] Another complication of the travel cost method is how to deal with multipurpose and multisite trips. Some of the questions in the questionnaire asked about the household's reasons for visiting Newfoundland and Labrador and the relative influence of Gros Morne in the decision to visit this province. This helped us identify and remove households from outside the province whose decision to visit the province had little to do with their visit to Gros Morne. Similar variables were also used by Beal (1995) and Liston-Heyes and Heyes (1999). We eliminated 123 households who planned the visit to the park after leaving home and, to err on the conservative side, we also dropped 16 observations with a missing value for this variable, assuming that those respondents had decided to visit Gros Morne after leaving their home. We also screened off those households from outside Newfoundland for whom Gros Morne did not strongly influence their coming to Newfoundland. On a scale of 0 (no influence) to 10 (primary reason) we only kept those households who indicated a value of at least 3, excluding about 19% of the 1213 original observations. We refer the reader to Martínez-Espiñeira and Amoako-Tuffour (2009) for an application that deals more fully with multipurpose and multisite trips using the same dataset we use here.

[7] For further details about the survey effort, the questionnaire, and the data see Martínez-Espiñeira and Amoako-Tuffour (2008).

approach is that the first two moments of the Poisson distribution, the mean and the variance equal each other (a property known as equidispersion), while data on the number of trips to a recreation site are often overdispersed, because a few households make many trips and many make few trips. The Poisson estimator under overdispersion is still consistent, but it underestimates the standard errors and inflates the t-statistics in the usual maximum-likelihood output. If the overdispersion problem is severe, the negative binomial model should be applied instead. The negative binomial is commonly obtained by introducing an additional parameter (usually denoted by α) that reflects the unobserved heterogeneity that the Poisson fails to capture.

When the data are collected on-site, the distribution of the dependent variable is also truncated at zero, since non-visitors are not observed. This feature of the dependent variable leads to biased and inconsistent estimates, because the conditional mean is misspecified (Shaw 1988; Creel and Loomis 1990; Englin and Shonkwiler 1995b) unless it is accounted for by using a truncated negative binomial model. Examples of applications of this model include Bowker et al. (1996); Liston-Heyes and Heyes (1999); and Shrestha et al. (2002).

Furthermore, since a household's likelihood of being sampled is positively related to the number of trips made to the site, data collected on-site are affected by endogenous stratification. Under the assumption of equidispersion, standard regression packages can be used to run a plain Poisson regression on the dependent variable modified by subtracting 1 from each of its values, which corrects for both truncation and endogenous stratification, as shown by Shaw (1988). This model has been used in several applied studies under the assumption of no significant overdispersion (Hesseln et al. 2003; Loomis 2003; Hagerty and Moeltner 2005; Martínez-Espiñeira et al. 2006).

However, as explained for the general case above, the Poisson is too restrictive under overdispersion also when data collected on-site are used. Therefore, a zero-truncated negative binomial adjusted for endogenous stratification must be used. However, the density of this distribution cannot be rearranged into an easily estimable form, so it used to require custom programming as a maximum likelihood routine, with the associated increase in computational burden.[8]

The density of the negative binomial distribution truncated at zero and that corrects endogenous stratification for the count (Y) was derived by Englin and Shonkwiler (1995b) as:

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[8] Further details on the evolution of these count data models, their theoretical properties, and their empirical application can be found in Martínez-Espiñeira and Amoako-Tuffour (2008).

$$\Pr[y=y\,|\,Y>0]=y_i\frac{\Gamma(y_i+\alpha^{-1})}{\Gamma(y_i+1)\Gamma(\alpha_i^{-1})}\alpha_i^{y_i}\mu_i^{y_i-1}(1+\alpha_i\mu_i)^{-(y_i+\alpha^{-1})}, \tag{1}$$

where y_i is the particular value of the count considered; μ_i is the expected visitation rate, as usual modeled as a function of explanatory variables, and α is the overdispersion parameter.

The corresponding log-likelihood function, which was the basis for the maximum likelihood analysis below, is given by:

$$\begin{aligned}\ln L=\textstyle\sum_{i=1}^{n}&[\ln y_i+\ln(\Gamma(y_i+1/\alpha))-\ln(\Gamma(y_i+1))-\ln\Gamma(1/\alpha))+y_i\ln\alpha+(y_i-1)\ln\mu_i\\&-(y_i+1/\alpha)\ln(1+\alpha_i\mu_i)].\end{aligned} \tag{2}$$

Examples of the use of variants of this model, often with α constrained to be equal across observations, include Ovaskainen et al. (2001); Curtis (2002); McKean et al. (2003); and Martínez-Espiñeira and Amoako-Tuffour (2008). We not only allow the overdispersion parameter α to vary according to characteristics of the household[9] but, as described in the next section, we extend previous research by allowing the data to suggest a value for the fraction of the wage rate that represents the opportunity cost of travel time and by making this parameter a function itself of households' characteristics.

V. Model specification and variable definitions

In terms of our model specification, our single-site demand function is of the form:

$$Y=f(CTC,\ SUB,\ education,\ income,\ expenses,\ daysatGM,\ satisfied), \tag{3}$$

where *CTC* is the combined travel cost composed of the "out-of-pocket" travel cost (*TC*) and the cost of travel time (TTC_i, where i = 1,2,3 refer to the three alternative ways in which we calculated this cost component, as explained in detail below); *SUB* is a binary variable about perceived availability of substitutes sites; *education* denotes the respondent's level of educational attainment; *income* is an indicator of the household's annual income; *expenses* refers to the respondent's estimate of total out-of-pocket spending in the Gros Morne area per member of the visiting party

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[9] We are indebted to Jeff Englin for very useful suggestions on which covariates to use to estimate α in our sample.

during the current trip; *daysatGM* is the length of their stay at the park; and *satisfied* is a binary variable that indicates whether the respondent considered to be satisfied with the current visit to the park.

The dependent variable (Y_i) was defined as the number of *persontrips*, calculated as the product of the size of the household (*size*), defined as those sharing travel expenses[10] during the current trip, times the number of times it visited Gros Morne during the previous five years (including the current trip). Bowker at al. (1996) proposed the use of this type of variable to circumvent the problem of lack of dispersion endemic to individual Travel Cost Method models (Ward and Loomis 1986). Bhat (2003) also used this format for the Florida Keys because, as it is the case of Gros Morne, group travel by car is very common in the Florida Keys (Leeworthy and Bowker 1997). Given the geographical size of the relevant market, many long-distance visitors would not travel to the park several times during one season, so a multi-year time frame was deemed appropriate to balance the need to get variability in the dependent variable while retaining the ability of the respondents to recall how many times they had visited the park.

The independent variables in equation (3) were constructed on the basis of information obtained from the questionnaire.The travel cost (*TC*), measured in CAN$ 1000, was calculated following the approach commonly taken in the literature (e. g. Hesseln et al. 2003), as the number of round-trip kilometers from the household's residence to the park times 0.35 $CAN/Km if the visitor entered Newfoundland by ferry. For those who entered Newfoundland by air, we assumed that the flight originated in the visitor's hometown and we valued the cost of flying at 0.20 $CAN/Km for one-way distances less than 4000 Km and 0.10 $CAN/Km for one-way distances over 4000 Km (a similar calculation was performed by Bhat 2003).[11]

The estimated travel cost (*TC*) was then divided by *size* to normalize it according to household size. This normalization was not applied to the time costs, since they cannot be as non-time costs are. However, it should be clarified that time costs for the household were based only on the respondent's time costs and ignore that other

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[10] Although the respondent had the option to count household members under the age of sixteen, it is unlikely that most would include their children as contributing to the travel expenses, so our definition of household does not really include children, although it does account for teenagers among the decision makers.

[11] Unfortunately, we only knew about the point of entry in Newfoundland, not about modes of transportation for the whole trip. Probably some of the visitors we classified as having driven all the way to the park actually flew from their destination to the main hub in Eastern Canada (Halifax) or one of the main hubs

individual household members might have lower or higher time costs. This type of simplification, whereby some of the characteristics and the behavior of the respondent are assumed to be representative of the household's, is implicitly adopted in travel cost method studies when defining model variables, both dependent and independent, in order to simplify the task of the respondent when completing the questionnaire. In line with previous studies, and for similar reasons, we assumed that the household composition remained constant and the characteristics of the current trip were representative of all the previous trips during the five-year time framework considered.[12]

Central to the aim of this study is the treatment of the opportunity cost of travel time. Three different specifications were used and compared in order to value the opportunity cost of travel time. Following the most common approach in the literature, we used the product of round trip time times a fraction of the wage rate. The wage rate was roughly approximated as the ratio of the annual income divided by 1880 hours of work per annum (Sohngen et al. 2000, Bin et al. 2005). Travel time was calculated from the estimated travel distance to the Park by assuming a driving average speed of 80 Km/hour and a flying[13] average speed of 600 Km/hour.

When choosing the relevant fraction of the hourly wage rate to apply as the net opportunity cost of time, we followed three different strategies that yielded three different measures of the cost of travel time. *TTC1* is based on a fraction of the wage that was kept constant across households and arbitrarily set at 1/3. That is, for each individual household *j*:

$$TTC1 = 1/3 \cdot w_j \text{ for all } j. \tag{4}$$

TTC2 is based on a fraction *K* of the wage constant across households, but now estimated from the data:

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in central Canada (Montreal, Toronto, or Ottawa) rented a car and drove through the Maritime Provinces. Distances traveled were calculated based on postal codes for Canadian residents, zipcode for US residents, and country for residents of other countries.

[12] For example, we cannot account for the fact that the household had a different composition in some or all of the previous trips, that the visitor could have moved or changed vehicles in the last five years, those variables like the price of gasoline could have changed during the same period, and so on. However, the associated issue of measurement error is less of a problem in our sample, since the average number of trips is quite low and the importance of observations with higher numbers of trips downweighted by the procedure used to correct for endogenous stratification.

[13] For those whose point of entry was one of Newfoundland's airports.

$$TTC2 = K \cdot w_j \text{ for all } j. \tag{5}$$

Finally, *TTC3* is based on a fraction of the wage that was allowed to vary across households and estimated from the data as a function of characteristics *Z* of the household and the trip ($K_j = f(Z)$):

$$TTC3 = K_i \cdot w_j = f(Z)\, w_j \text{ for all } j, \tag{6}$$

where *Z* included a constant and the variables *distance*, *income* and its squared value, *budgaccom* (which measured the influence on the household decision to visit Gros Morne of the availability of accommodation rated 3.5 star or less), *propou17* (the proportion of members of the travelling party under 17), *hikeback* (which identified households whose decision to visit Gros Morne was influenced by the prospect of being able to hike and backpack at the park), *fjord* (which measured how strongly a household's decision to visit the park was affected by the possibility of enjoying the Western Brook fjord), *campgrounds* (which indicated households who used campgrounds at the park), *museums* (which identified households who visited museums and exhibitions at the park), and *flew* (which indicated who used air travel to reach Newfoundland during the current trip).

The two last specifications were obtained by introducing a variable composed of travel time times the wage rate as a separate argument in the maximum likelihood program. In all three cases, we built our model under the assumption that changes in *TC* have the same effect as changes in *TTCi*. This is the assumption that the money value of time and the out-of-pocket expenses related to traveling to the site affect the number of trips in the same manner. Therefore, the whole rationale of estimating *K* for the sample or for each individual hinges on the assumption that the out-of-pocket component of travel costs can be proxied using the traditional accounting-like method. Moreover, since out-of-pocket driving costs are calculated based on the same \$/Km for every household, the differences in efficiency among modes of transportation will be also accounted for as a side product of making *K* more flexible.[14]

The estimation of both *TTC2* and *TTC3* is close in spirit to the approach followed by McConnell and Strand (1981) and Common (1973). However, our analysis extends these earlier works by making the proportion of the income

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[14] Hagerty and Moeltner (2005) propose two alternative approaches to introduce household-specific driving costs into recreation demand models: one based on a refined measurement of driving costs based

attributed to the opportunity cost of time a function of visit and household characteristics (in the case of *TTC3*), by using a maximum likelihood approach that directly estimates *K*, so its asymptotic properties are well known (McConnell and Strand 1981), and by simultaneously correcting for the overdispersion, zero-truncation and endogenous stratification that characterize the distribution of the dependent variable *Y*.

It should be noted that the treatment of the cost of travel time is based on an demand specification rather than a theoretical derivation, usually based on a utility maximization problem under a doubly constrained budget (e. g. Larson and Shaikh 2001). In this sense, it should be stressed that the contribution of this analysis is limited to the empirical estimation of the fraction of the wage rate that best fits the data at hand, while a more theoretical contribution lies beyond the scope of this paper.

Those living near a substitute recreational site will likely make fewer trips to the site analyzed. We failed to obtain a measure of the distance to the next best alternative recreational site for most respondents, so following Bowker et al. (1996) we used in equation (3) a dummy (*SUB*), that takes the value of one if the respondent suggested an alternative site or the distance to it.

The sign of the effect of the level of educational attainment (*education*) was expected to be positive, although Shrestha et al. (2002) found a negative effect. The questionnaire elicited the level of *income* (in $CAN 1000) of the respondents we use in equation (3). Although recreation may be considered a normal good, often the influence of income is found to be weak in travel cost studies (Creel and Loomis 1990; Sohngen et al. 2000; Loomis 2003). Liston-Heyes and Heyes (1999) even find visits to a national park an inferior good, although Bin et al. (2005) find a significant positive effect of income on the number of trips to North Carolina Beaches. Given the remoteness of Gros Morne, we expected income to exert a positive effect on the *Y*, even though residents of Newfoundland, whose average income is relatively low, would have of course visited very often.

We asked respondents to provide an estimate of total out-of-pocket spending in the Gros Morne area per member of the visiting party (variable *expenses*, in thousands of $CAN). We could not hypothesize whether this variable would exert a negative

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on engineering considerations and the second on estimated perceived per mile cost as a function of vehicle attributes in an empirical framework. They find that driving costs are a household-specific concept, and that prescribed and perceived costs differ substantially, but welfare measures generated by these alternative specifications are not statistically different from those produced by the standard model in their empirical application.

or a positive effect on the number of visits. Similarly, the sign of the expected effect of *daysatGM* (time spent on the site) was uncertain *a priori*, although Shrestha et al. (2002) and Creel and Loomis (1990) find that the longer the duration of the trip the fewer the trips taken.

The final model also includes a dummy variable describing whether the respondent declared to be *satisfied* with the current visit to the park. We also used information on the number of people in the household –the size of the visitor group sharing travel expenses during the current trip (*size*), as in Liston-Heyes and Heyes (1999) and Hesseln et al. (2003)–, and the household's age composition. The former was used in the construction of the dependent variable and the latter helped us model, together with *income,* the overdispersion parameter α.

Finally, different additional aspects of the household's experience during the current trip were considered. Respondents were asked about the time of decision to visit the park and the degree of influence of different activities (hiking, backpacking) within and different features (the fact that it is a World Heritage site, etc.) of the park in the decision to make the visit. When estimating *TTC3*, we made use of some of these household variables, as described in equation (6).

VI. Results

Summary descriptives of the variables used by the demand models are reported in Table 1. A proportion of questionnaires were discarded due to item nonresponse, out of the 1213 completed. Only households who planned the visit to Gros Morne "before leaving home" were included in the analysis, as explained in Section III.

Some households did not report their *income* and/or their estimated on-site *expenses*. For these, missing values were substituted by the mean sample values calculated from the available observations. For these observations affected by item nonresponse, we assigned a value of one to the variables *missincome* and/or *missexp* respectively, so we could then test the impact of imputing the missing values in the final estimations. The final sample contained 854 observations.

Table 2 shows the results of five specifications, all of which correct for both truncation at zero and endogenous stratification due to the oversampling of frequent visitors.[15] Model *TSPOI* assumes equidispersion, since it is based on a zero-truncated Poisson model. We suspected the presence of significant overdispersion at the outset,

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[15] Frequency weights were used to adjust the sampling proportions for the fact that Parks Canada's sampling plan was not random, but rather attempted to oversample visitors from the rarest origins.

Table 1. Summary descriptives of sample analysed (*N*=854)

Variable	Definition	Mean	Std. dev.	Min	Max
Y	Number of *persontrips* (visits in the previous five years times size of current travelling party)	3.782	6.228	1	91
CTC	Combined travel cost (CAN$1000) which combines travel cost (*TC*) and travel time cost (*TTC1*), which assumes that the opportunity cost of time is 1/3 of the wage rate for all households (See Section V).	1.370	1.231	0.006	8.851
SUB	Binary variable that takes the value 1 if a substitute recreational site was identified by the respondent	0.636	0.481	0	1
education	Level of educational attainment	4.133	1.097	1	6
income	Mid-point of household income brackets (CAN$1000)	88.548	42.304	20	160
expenses	Self-reported estimated out-of-pocket spending during current trip (CAN$1000)	0.275	0.470	0	12
daysatGM	Days spent at the Park during current trip	3.949	2.710	0.5	40
satisfied	Binary variable that takes the value 1 if respondent considered to be satisfied with the current visit to the park	0.523	0.499	0	1
distance	Calculated distance (Km.) from respondent's home to Gros Morne	2776.335	1839.730	21.01	18,199
size	Size of current travelling party (those sharing expenses)	2.597	1.311	1	15
budgaccom	Influence of the availability of accommodation rated 3.5 star or less on the household's decision to visit Gros Morne	3.344	1.557	1	5
propu17	Proportion of members aged 16 and under in the travelling party during current trip	0.066	0.170	0	1
hikeback	Influence of the possibility of hiking and backpacking on the household's decision to visit Gros Morne	5.576	3.813	0	10
fjord	Influence of the possibility of enjoying the Western Brook fjord on the household's decision to visit Gros Morne	6.150	3.492	0	10
campgrounds	Binary variable that takes the value 1 if respondent used the campgrounds at Gros Morne during current trip	0.375	0.484	0	1

Table 1. (continued) Summary descriptives of sample analysed (N=854)

Variable	Definition	Mean	Std. dev.	Min	Max
museums	Binary variable that takes the value 1 if respondent visited museums and exhibits at Gros Morne during current trip	0.362	0.481	0	1
flew	Binary variable that takes the value 1 if respondent flew into Newfoundland during current trip	0.381	0.486	0	1
missincome	Binary variable that takes the value 1 if *income* was missing	0.090	0.287	0	1
missq20	Binary variable that takes the value 1 if *expenses* was missing	0.093	0.290	0	1

since most households made few trips to the site while a few made many trips. The effect of overdispersion is confirmed by the improvement in goodness of fit achieved by Model *TSNB*, as shown in Table 2.[16] The value of the log-likelihood improves further as we allow, in the generalized negative binomial model (Model *GTSNB*), for the overdispersion parameter (α) to vary across households and as a function of the proportion of members under sixteen in the household and of income.[17] These three specifications use as a price variable *CTC*, which combines travel cost (*TC*) and travel time cost (*TTC1*). As explained in Section V, *TTC1* is based on the assumption that the opportunity cost of time is 1/3 of the wage rate for all households ($K = 0.33$).

The last two specifications, Models *OPTK* and *GOPTK,* correspond to generalized truncated and endogenously stratified negative binomial models too. However, *OPTK* is based on a regression that, rather than assuming the cost of travel time to be 1/3 of the wage rate ($K = 0.33$), allows the maximum likelihood routine to find the optimal value of K for our data. That is, under *OPTK* the combined travel cost variable is constructed as $\widehat{CTC} = TC + \widehat{TTC2}$. As shown at the bottom of the table, the value of K was estimated as -6.7%, not only much lower than 33%, but actually negative. This suggests that in this case most households would have attached very little opportunity cost to their travel time and enjoyed the trip substantially. This is probably due to a combination of the facts that some households traveled to the park during vacation time or during weekends, when they could not be earning income, that some were

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[16] This regression was run with the routine NBSTRAT (Hilbe and Martinez-Espiñeira 2005) for Stata 9.1.

[17] This regression was run with the routine GNBSTRAT (Hilbe 2005) in Stata 9.1.

Table 2. Results of the different regressions, *N*=854

Equation	Variables	*TSPOI*	*TSNB*	*GTSNB*	*OPTK*	*GOPTK*
		$(\alpha=0; K=1/3)$	$(\alpha; K=1/3)$	$(\alpha_i; K=1/3)$	$(\alpha_i; K)$	$(\alpha_i; K_i)$
Y	*CTC*	-1.3077***	-0.6346***	-0.5680***	-1.7192***	-2.4807***
	SUB	0.2830	0.2078	0.0869	0.0587	0.1279
	education	-0.0034	-0.0250	-0.0019	0.0189	0.0312
	income	0.0027	0.0018	0.0063*	0.0005	0.0054**
	expenses	-1.4072**	-0.6633	-0.5141*	-0.3506*	- 0.3086**
	daysatGM	0.1224***	0.1046***	0.0955***	0.0847***	0.0803***
	satisfied	-0.4118***	-0.5465***	-0.4607***	-0.4334***	-0.3422***
	missincome	0.243	0.3001	0.3972	0.3196	0.1407
	missexp	0.2924	0.3548	0.3490	0.3577	0.3622
	constant	2.8082***	1.1372***	0.7066***	1.6095***	1.5042***
$\ln(\alpha)$	*propu17*			2.3764***	4.8244**	3.8471**
	income			-0.0093	-0.0077*	-0.0052***
	constant		1.2897**	1.443**	1.6191***	1.0855***
K	*distance*					$-0.047\cdot10^{-3}$***
	income					0.0053***
	income^2					$-0.019\cdot10^{-3}$***
	budgaccom					0.0078*
	propu17					0.1949***
	hikeback					-0.0048***
	fjord					0.0052***
	campgrounds					0.0359**
	museums					-0.0306**
	flew					0.1298
	constant				-0.0667***	-0.2415***
Statistics	Log-likelihood	-3516	-2089	-2042	-1976	-1894
	χ^2	57.67	106	84.79	99.83	205
	CS/trip	$764.70	$1575.80	$1760.56	$581.67	$403.11
	Estimated mean *K*	33%	33%	33%	-6.7%	0.8%

Note: *p <0.1; **p < 0.05; ***p <0. 01. *TSPOI* = Truncated Endogenously Stratified Poisson; *TSNB* = Truncated Endogenously Stratified Negative Binomial; *GTSNB* = Generalised (variable α) Truncated Endogenously Stratified Negative Binomial; *OPTK* = Generalised (variable α) Truncated Endogenously Stratified Negative Binomial with estimated but fixed *K; GOPTK* = Generalised (variable α) Truncated Endogenously Stratified Negative Binomial with estimated and variable *K*.

retired, students, or unemployed, and that they enjoyed the time used to travel to the park. It is reasonable to assume that these are circumstances affecting this type of remote site more strongly than other, more commonly visited, sites.

Finally, the specification was generalized further by allowing K to vary across households. The results (Model *GOPTK*) reveal that the proportion of the wage rate that each household finds relevant when deciding how many trips to make to the site depends on characteristics of the trip and of the household. As expected, those traveling from farther distances attached a lower value to their travel time, probably because they traveled during vacation time. The value of travel time varies non-linearly with income. The value of K rises with income, but falls beyond a threshold level of income of CAN$ 140,000. Somewhat surprisingly, those who travel with children and teenagers find the opportunity cost of their travel time relatively higher in terms of their wage rate. This may be explained, however, by the fact that we are measuring the cost of travel time net of any utility or disutility from travel time itself. It is understandable that those traveling with children will find driving time to the site more expensive both because of the out-of-pocket expenses associated with traveling with them, but also perhaps because of the decreased utility of traveling with children or teenagers (most of all in the case of those who drive to the site). Those whose decision to visit Gros Morne was influenced by the availability of accommodation rated 3.5 star or less (*budgaccom*) and by the prospect of enjoying the Western Brook Pond fjord boat tour (*fjord*) faced a higher K. Similarly, those who used campgrounds faced a higher K. We expected that those who *flew* (rather than drive) to Newfoundland, would face a higher K. We found this positive effect of variable *flew* on K, but it is not significant. On the other hand, those whose decision to visit the park was influenced by the availability of *museums* and the opportunities for hiking and backpacking (*hikeback*) faced a lower K.

The main trip generation equation in the upper part of Table 2 shows that, as expected, the coefficient on the combined travel cost *CTC* (calculated as $TC+TTCi$, where i-1,2,3) variable takes a negative sign, which results in a negatively sloped demand curve for person-trips (Y). This means that the further away someone lives, the fewer the visits to the park in the past five years and/or the smaller the visitor party in the current trip. We report the values of consumer surplus per *persontrip* in Table 2, calculated as $\$1000(-1/\beta_{CTC})$.[18] For example, the value of -2.4807 yields an estimate of consumer surplus for users of the park of $403.11 per *persontrip*. As

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[18] Multiplying by $1000 translates the value of the consumer surplus into dollars, since the variable CTC is measured in thousands of dollars.

expected, since the travel time cost appears overestimated under specification *TTC1* (used in Models *TSPOI*, *TSNB*, and *GTSNB*) of the wage rate (based on a common $K = 0.33$), the estimates of consumer surplus per *persontrip* are corrected downwards under Model *OPTK* (based on *TTC2*) and Model *GOPTK* (*TTC3*).

The dummy variable *SUB* has a non-significant positive sign. In theory, we would have expected that those respondents who came up with a next best alternative to Gros Morne would visit this park less frequently. However, it is also possible that avid recreationists have a more readily available mental list of recreational destinations than those who travel less frequently. Many respondents failed to successfully come up with a valid substitute for Gros Morne,[19] since it offers a rather unique combination of features. The fact that nearly 92% of the respondents made it a point to visit Gros Morne before leaving home suggests for many the single minded purpose of the trip and the irrelevance of substitute sites. The variable *satisfied* presents a negative sign, suggesting that those who were not satisfied with their current trip may have made more frequent trips during the last five years.

The variable on educational attainment (*education*) presents alternate and non-significant signs. It is likely that income and education are too collinear to allow for independent estimation of the effect of *education*. When the value of *K* is allowed to vary across households as a function of different variables (including *income* itself), *income* appears significant at the 5% level and has a positive sign in the trip generation function. Often income is found to be non-significant in travel cost studies. It is likely that the remote location of Gros Morne makes the visit expensive enough that for many households visits is a normal good. Bin et al. (2005) find a significant positive effect of income on the number of trips to North Carolina beaches.

The variable *expenses* presents the expected negative sign, which suggests that those who tend to spend more on a visit to the park, tend to make fewer trips. The length of the stay at the park (*daysatGM*) exerts a significant and positive effect on *persontrips* (*Y*) as in Bowker et al. (1996) . However, this result is at odds with the findings of Creel and Loomis (1990) and Shrestha (2002). They find that the longer the duration of the trip the fewer the trips taken. People living far away make fewer trips but longer stays. The fact that the length of stay appears positively correlated with the frequency of visits may be associated with the remote geographical location of Gros Morne and the numerous types of recreational activities that it offers.

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[19] This problem of item non-response forced us to use a dummy variable for substitutes instead of the distance to the substitute, as originally intended.

Finally the non-significant effect of both *missincome* and *missexp* confirms that substituting the missing values of *income* and *expenses* by their sample averages obtained from those respondents who did provide that information did not lead to significant biases. This is because the distribution of *income* and *expenses* values for those who did not answer those two questions may not be systematically different from the rest of respondents'. The generalized versions of the truncated and endogenously stratified negative binomial specification (*GTSNB, OPTK*, and *GOPTK*) model the overdispersion parameter α as a function of income and the proportion of members under seventeen years of age in the household. In this equation, the coefficient on *income* becomes significant only when *K* is not forced to take the arbitrary value of 0.33. Table 3 shows the likelihood ratio test results that confirm that the improvements in goodness of fit obtained as the model is made more flexible are significant.

Table 3. Likelihood ratio tests

Comparison	Test statistic	Significance
TSNB vs *TSPOI*	$\chi^2(1)=2855.16$	Prob>χ^2=0.000
GTSNB vs *TSNB*	$\chi^2(2)=94.46$	Prob>χ^2=0.000
OPTK vs *GTSNB*	$\chi^2(1)=130.47$	Prob>χ^2=0.000
GOPTK vs *OPTK*	$\chi^2(10)=164.66$	Prob>χ^2=0.000

Note: *TSNB* = Truncated Endogenously Stratified Negative Binomial; *GTSNB* = Generalised (variable α) Truncated Endogenously Stratified Negative Binomial; *OPTK* = Generalised (variable α) Truncated Endogenously Stratified Negative Binomial with estimated but fixed *K; GOPTK* = Generalised (variable α) Truncated Endogenously Stratified Negative Binomial with estimated and variable *K*.

VII. Conclusions

In this article we applied the individual travel cost method to examine how estimates of the value of travel time to recreational sites affect the efficiency of the estimation of recreation demand models and the size of estimates of consumer surplus. We used data collected on-site from Gros Morne National Park and analyzed them with count data models which account not only for zero-truncation and overdispersion in the distribution of the dependent variable but also for endogenous stratification due to oversampling of frequent visitors.

We based our analysis on the usual assumption that the relevant price of a trip can be approximated by travel expenses consisting of monetary outlays and of the cost of the time needed to reach the site. Following the previous literature, we assumed the relevant opportunity cost of time for this purpose to be a fraction of the hourly wage rate. However, rather than choosing an arbitrary fraction, we allowed the data to determine the fraction that would result in the best fit for our sample. Our approach builds on the work by McConnell and Strand (1981) and Common (1973) in three ways. First, we make the fraction of the wage rate that accounts for the opportunity cost of time a function of visit and household characteristics. Second, we use maximum likelihood to directly estimate that fraction. Third, we correct simultaneously for overdispersion and the effects of on-site sampling (zero-truncation and endogenous stratification) on the distribution of the variable that measures the number of visits to the site.

Allowing for a heterogeneous opportunity cost of time proved useful to improve the goodness of fit and confirmed that the proportion of the wage rate that accounts for the perceived value of travel time is an empirical question. Furthermore, our analysis also confirmed that different households will respond to travel time costs differently, so imposing a common value for this component of travel costs can be significantly restrictive.

Our results also suggest that the travel cost literature has often overestimated the proportion of income that best proxies the opportunity cost of travel time. However, it should be noted that Gros Morne is a relatively remote location, so generalizing our results should only be attempted with caution. In fact, it is reasonable to assume that the usually chosen fractions of the wage rate are valid approximations in *most* studies of less remote sites that are surrounded by less appealing landscapes. A low opportunity cost of travel time is likely to apply particularly to sites that, due to their remoteness and the appeal of the surrounding areas, require a long trip through areas that might provide a positive utility from traveling. It is also likely that, given that many visitors travel as a group to Gros Morne, they will derive further utility as a by-product of the trip to the site from the interaction with fellow members of the travel party. Finally, a visit to Gros Morne usually requires taking time from a long vacation period, perhaps adding a further element of disconnection between the opportunity cost of travel time and the marginal wage rate. For all these reasons, it would be difficult to claim that the results of this study could be generalized to the average recreation site. Further research should help confirm the intuition that the usual approximations are valid for more conventionally located sites. It would be advisable to attempt to empirically estimate on a case-by-case basis the relevant fraction of the wage rate that households consider when planning their trips to remote recreational sites and future research will benefit from further efforts to collect information on individuals that help estimate their relevant opportunity cost of time.

In this study we have focused on the analysis of a highly punctual aspect of the set of tasks faced by researchers involved in Travel Cost Method, namely how to best handle the translating of a level of hourly income into a value for the opportunity cost of time. We acknowledge the limitations of our study in terms of other aspects. For example, we are aware that our measure of income was in itself the result of a series of commonly followed, but still *ad hoc,* simplifications and subject to error. The same applies to the calculation of the monetary costs of travel.

However, although these and other limitations imposed by data availability would affect any conclusions relying on the absolute values of welfare measures obtained above, they should have no major systematic impact on the conclusions of our analysis. This is because we have confined the aim of our research to the comparison of alternative ways to model the appropriate fraction of the wage to consider as a proxy for the opportunity cost of time.

Further research should also consider estimating separate regression models for visitors who reached Gros Morne by air and for visitors who arrived by car. Other extensions beyond the scope of the current article, but deserving further attention, include explicitly accounting for the fact that the length of visit is endogenous when deriving the visit demand function.

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