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Alternative treatments of the cost of time in recreational demand models: an application to whitewater kayaking in Ireland

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ABSTRACT

The measurement of travel costs in recreational demand modeling has been a contentious issue for many decades. This article explores the use of a number of alternative methods of incorporating time costs in the travel cost modeling process. Travel cost values where the opportunity cost of time is excluded, where it is included as a percentage of the individual's reported wage rate and where it based on an estimated wage from a secondary data source (the European Community Household Panel) are compared and then used in a conditional logit model to estimate the demand for whitewater kayaking in Ireland. We then evaluate the effect of different treatments of the cost of travel time on the welfare impacts of a number of different management scenarios for kayaking rivers in Ireland, and find that statistically significant differences emerge.

1. Introduction

The treatment of travel cost and travel time in recreational demand modeling has been a contentious issue for many decades (Clawson and Knetsch, 1966; Feather and Shaw, 1999). Nearly 40 years after Clawson and Knetsch's article, this issue has still not been "resolved": to quote Phaneuf and Smith (2004): "…travel time, its opportunity costs, and its role in the demand for trips remain unresolved questions in recreation modeling". This article addresses this issue by examining a number of the alternative specifications of travel cost that have been used in a recreation demand modeling framework. We do this in a novel application of the random utility site choice model to whitewater kayaking trips in Ireland.

As Randall (1994) famously commented, a major difficultly in applying the travel cost model to valuing environmental goods such as national parks or rivers is that the price of consuming this goods, in terms of recreational use, is not observable to the analyst. In other words, the analyst must make use of proxies (estimates) for what she believes to be the price of a trip as perceived by recreational users. One important aspect of this price is the opportunity cost of time used up in traveling to the recreational site.[1] Traditionally, methods for estimating travel costs include:

- the estimation of travel costs excluding the opportunity cost of time
- the estimation of travel costs with the opportunity cost of time being included as a percentage of the respondent's wage rate, derived from information provided by respondents as to the range within which their gross income falls.[2]

In this paper, we contrast these two approaches with a novel third option, which makes use of information from a secondary micro level data set, the European Community Household Panel (ECHP). We use this to incorporate the opportunity cost of time in the travel cost of the respondents in getting to the study sites, based on their estimated net wage from this secondary data set.

Rather few studies have examined how alternative specifications of the travel cost variable impact on the size of the travel cost coefficients or on subsequent welfare measures in their respective recreational demand applications. Early work by Bishop and Heberlein (1979) compared the impact of different specifications of

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[1] Another literature has considered the related issue of valuing on-site time.
[2] Another approach is to search for that value of time which maximises the fit of the trip generating equation.

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the travel cost variable on consumer surplus estimates with travel cost values based on real transactions. Other examples where alternative specifications of travel cost in recreational demand models have been compared including Ward (1984) and Smith et al. (1983). Our paper adds to this literature by proposing the use of an auxiliary wage regression from a secondary earnings data set which may be a more appropriate method to use in calculating the opportunity cost component of travel costs because it allows the researcher to take into account the fact that in a choice decision an individual will consider her opportunity cost in terms of what she can afford to pay, i.e. her net wage not her gross wage. This method is then compared to other methods of travel cost calculation often employed in the literature, in terms of the effect on the estimated parameters and the impact on resulting welfare estimates.

Analysis in this paper is based on the recreational pursuit of *whitewater kayaking*. Whitewater kayaking is becoming increasingly popular in Ireland. Figures from the Irish Canoe Union (ICU), the body that represents kayaking interests in Ireland, indicate that participation in kayak proficiency training courses increased by an annual rate of 15% from 2000 to 2005. The ICU estimate that the present number of whitewater kayakers in Ireland is around 5000. Whitewater kayaking may be defined in terms of the equipment used. In nearly all cases it requires the use of a decked kayak, a paddle, a buoyancy aid, a helmet and some form of waterproof clothing. The sport involves negotiating one's way through whitewater rapids on a section of river.

In the next section we briefly review the literature on the measurement of travel costs in revealed preference valuation studies. Section 3 then describes the design of our survey and presents some sample characteristics. The methodology used to model kayakers' decision-making process in terms of choices over alternative, substitute whitewater sites is reviewed in Section 4 while in Section 5, we review the empirical estimation process for the alternative measures of travel cost, whilst results from the conditional logit (CL) models and the welfare estimates of whitewater kayaking recreation on Irish rivers are presented in Section 6. Section 7 then concludes.

2. Travel cost specification in the recreation demand model

The standard method of calculating travel costs in recreational demand studies is to multiply the distance to the different sites with a per kilometre "out-of-pocket" cost, usually calculated on the basis of marginal vehicle operating costs. Although this cost has been used on its own as the measure of travel cost in recreational demand studies (Ward and Beal, 2000), many other studies add to this an estimate of the opportunity cost of leisure time; given that leisure time is a scarce resource. Despite the difficulty of extrapolating the classical leisure/work choice model to many individuals in a recreation data set (where individuals choose their hours of work to equate the marginal wage with the marginal value of leisure time), the most common practice in the treatment of the opportunity cost of time is to value it at the gross wage rate or some fraction thereof (Smith, 1997). In an alternative treatment of time costs in the literature, recreation and socio-economic data collected from respondents in conjunction with a specific model of the leisure/labour trade-off may be used to estimate time costs. Examples of this approach include McConnell and Strand (1994) and Bockstael et al. (1987).

For people in full time employment, most studies calculate an hourly wage using self-reported annual income, where self-reports are typically given as a range (e.g. "£15,000–£19,999 per year"). Reported annual income is then divided by the number of hours worked in a year, a number usually in the range of 2000–2080, to give a gross hourly wage (Hanley et al., 2001; Willis and Garrod, 1992). Another approach is to calculate the respondents' hourly wage using a simple wage regression over the subset of individuals in the sample earning an hourly wage (Smith et al., 1983). In this case, the wage rate is regressed on income and a vector of individual characteristics such as age, gender, and education. The fitted regression is then simulated over non-wage earners to impute a wage.

It is also common to see some *fraction* of the imputed wage used to value time for inclusion in the calculation of travel cost. This can be anywhere from 1/4 of the wage to the full wage.[3] Cesario and Knetsch (1976) are credited with first having suggested approximating the opportunity cost (value) of time as a fraction of an individual's wage rate in a recreational demand setting.[4]

In our study, we estimate three values for travel cost for each person in the sample. The first is simply equal to travel distances to each site multiplied by a per kilometre out-of-pocket cost for motoring (Ward and Beal, 2000). The second includes the opportunity cost of time calculated at 100% of the respondent's wage rate, measured by dividing reported annual gross income by 2000 (which represents the average number of hours worked in a year). The third method also includes the opportunity cost of time but in this case it is calculated following the example of Smith et al. (1983) by estimating a wage rate for each person in the sample. For this, a secondary data source, the European Community Household Panel, is employed to estimate a wage equation which is then used to impute wages in our kayaker data set. Whereas Smith et al. (1983) used a hedonic wage approach and imputed a wage for missing income information in their sample we impute a wage for *every* respondent in our kayaking data set using a panel data earning regression model. We then set each individual's opportunity cost of time equal to 100% of the hourly wage rate w.[5] Once the same percentage of the wage rate is employed for the different estimates of the wage rate across models (where these wage rates are being used to incorporate the opportunity cost of time into the calculation of travel cost) then a valid comparison can be made of

[3] Two reasons often cited for using a fraction of an individuals wage rate as the opportunity cost of time is that (i) individuals may receive utility from working time and more importantly (ii) the transit time in getting to the recreational site produces may have joint products; for instance, if the drive is of particular scenic beauty, or if the transit time allows me to enjoy the company of my driving companions. These additional benefits suggest that using a fraction of the marginal wage rate may be more appropriate than using 100% of the wage. According to Feather and Shaw (1999), this fractional approach to the opportunity cost of time in the travel cost specification stems from early transportation literature.

[4] In much of the travel cost literature time is separated out into the components of travel time and on-site time (Smith et al., 1983, Shaw, 1992) but for our purposes we ignore the latter and concentrate solely on travel time. A whitewater kayaking trip also requires carrying out a car shuttle where one car is left at the take out of the river and the other car is left at the top. Since Irish rivers are very short in character, the travel time involved in a shuttle is usually only in the region of 15–20 min. For this reason we do not include this portion of travel time in our study but it could be a significant consideration for whitewater kayaking in countries such as the U.S. or Canada where the whitewater runs are much longer and a shuttle could take anything up to 1.5 hours of additional travel time

[5] This is done on the grounds that the opportunity cost of time could be greater than (given the reasons discussed below), less than (as with the fractional wage approach that arises from a desire to incorporate the disutility of work time) or equal to the hourly wage rate (from the classical economic perspective that the opportunity cost of other activities equals the marginal wage rate). Feather and Shaw (1999) show that, for those on a fixed work schedule, it is possible for the value of leisure time to be greater than the wage. There is also evidence that people are in corner solutions in the labour market where they are forced to work more hours than they would wish. For example, Feather and Shaw (1999) report that almost 50% of their respondents stated that they were "over-employed". In any case, in terms of the analysis presented in this paper if one assumes that the estimate of consumer surplus per visit is linear in the percentage of the wage rate used, then it is arbitrary which percentage rate one picks if the object of the exercise is to show up the sensitivity of consumer surplus values to alternative functional specifications of the travel cost variable.

the effects of the alternative specifications of travel costs on the welfare impacts of changes in resource management policy.

3. Study design

The initial steps in the empirical part of this study were to identify the population of interest, the recreation choice sets and their relevant attributes for kayaking. The population of interest was the community of active kayakers in Ireland. Eleven principal whitewater sites were identified and are shown in Table 4. With regards to site attributes, we chose to use respondents' perceived or subjective measures for all attributes (using a 1–5 likert scale system for each attribute) other than travel cost, following the procedure set out in Hanley et al. (2001). The site attributes chosen for use were: quality of parking at the site, degree of expected crowding at the site, quality of the kayaking experience as measured by the star rating system used to rate whitewater rapids, water quality, scenic quality, and reliability of water level information.

The sampling frame was provided by two Irish kayaker email lists obtained from the Outdoor Adventure Store (one of the main kayak equipment outlet stores in Ireland) and the Irish kayaking instruction company, H2O Extreme. A random sample of these email addresses was selected, and questionnaires were emailed to these individuals, who were asked to complete and return the questionnaire via email. To widen the sample in terms of representativeness and increase the number of completed surveys, the questionnaire was also posted up on the homepage of the Irish Canoe Union website (www.irishcanoeunion.com) and administered at an organized kayaking meet on the Liffey river in January 2004. Hynes and Hanley (2006) have previously demonstrated using a Wald test that the internet based sample and the on-site sample may be pooled into one data set. A total of 315 surveys were send via email. The response rate to the email shot was 64%. From all collection points a sample of 279 useable responses from kayakers were acquired (202 from the email shot, 42 from the on-site survey and the remaining 35 from questionnaires downloaded from the website). Descriptive statistics for the sample and a description of the kayaking activity and frequency of trips to each site is provided in Hynes et al. (2007).

Haab and McConnell (2002) point out that many single and multiple-site recreation demand models suffer from sample selection bias due to the fact that "it is much cheaper to gather samples on-site than to contact people by phone, mail, or in person". As previously demonstrated by Hynes and Hanley (2006) for a single-site truncated negative binomial travel cost model, we argue that because we have collected information from respondents where they were asked to rate multiple whitewater sites via email and the internet, our sample does not suffer significantly from this problem. To paraphrase Haab and McConnell (2002, p. 213), in our sample, "all inferences about population parameters are… *not* …based on the fact that individual *i* was interviewed at site *j*". Also, because the 42 respondents from the on-site portion of survey were asked to give information on all the sites in the survey, we have information on those sites where the respondent made zero trips in the previous year. Having said all this, as with many examples of travel cost recreation demand studies (see for example Hanley et al., 2001 and Willis and Garrod, 1992) we could not identify the reference strata within the population and randomly select from these in sampling. Also the sample size is relatively small, so a cautious view needs to be taken of how representative our sample is of the true population of kayakers.

4. The random utility model of kayaking recreation

We use the Random Utility Model (RUM) to model kayakers' decision-making process in terms of choices over alternative, substitute whitewater sites. The RUM approach models the choice of a recreation site from among a set of alternative sites as a utility-maximizing decision, where utility includes a stochastic component. The basic choice model for our kayaker is given by

$$U_i = V_i(X_i, y - p_i) + \epsilon_i \tag{1}$$

here U_i is indirect utility from visiting whitewater site i, $V_i(.)$ is the deterministic part of the indirect utility function and ϵ_i is the stochastic part. X_i is a vector of site attributes, y is income and p_i is travel cost. Whenever the utility from visiting site i is greater than the utility from visiting all other sites k, site i will be chosen, i.e. if

$$V_i(X_i, y - p_i) + \epsilon_i \geq V_k(X_k, y - p_k) + \epsilon_k \quad \forall k \tag{2}$$

then site i will be chosen. The RUM model just described is a utility maximization model attributable to McFadden (1974). Randomness occurs due to omission of explanatory variables, random preferences and errors in measurement. The individual is believed to know her preferences but from the point of view of the investigator, preferences are random variables. The RUM model can be specified in different ways depending on the distribution of the error term. If the error terms are independently and identically drawn from an extreme value distribution, the RUM model is specified as a conditional logit. This implies that the probability of choosing site i is given by

$$\mathrm{pr}_i = \frac{\exp(V_i)}{\sum_{k=1}^{N} \exp(V_k)} \tag{3}$$

where pr_i is the probability that site i is chosen. If V_i is written as $V_i = \beta X_i$, where X_i is a vector of characteristics of whitewater site i (parking quality, crowding, star rating, water quality, scenic quality, water reliability and travel costs) and β is the associated parameter vector, then the conditional logit model can be expressed as:

$$\mathrm{pr}_i = \frac{\exp(\beta X_i)}{\sum_{k=1}^{N} \exp(\beta X_k)} \tag{4}$$

The modeled probability of an individual selecting any given site depends on all the characteristics of that site as well as those of all sites in the choice set not visited. The decision to visit a recreational site, among a number of alternative sites, is mutually exclusive on every choice occasion. Therefore, choices can be regarded as discrete, i.e. the dependent variable takes the value 1 (if a site is chosen) or 0 (otherwise). The model is estimated by the method of maximum likelihood.

5. Estimation of the alternative specifications of respondents' travel cost

In this section we compare and contrast three alternative specifications of the travel cost variable. Prior to the calculation of travel costs using the information from a secondary data source a number of steps first needed to be conducted. A series of potential hourly wage functions were estimated for each respondent using data on the Irish labour force from the European Community Household Panel data set (ECHP). The ECHP is a comparative household panel data set covering European Union Member States. The data include information on demographics, income, employment status, education, and health (at the individual as well as the household level). The data set for Ireland extracted from the ECHP consists of 5444 individuals for the years 1994–1999. After taking attrition into account, this comprises 15,091 individual year observations. The hourly earning figures in the ECHP for these years have been adjusted to 2003 earnings using the Central Statistics Office (CSO) Irish industrial earnings index.

The potential hourly wage functions from the Irish ECHP panel data set were then used to generate a value of *w* for each kayaker in the sample. A Mincer-type specification was used, with the log of the net hourly wage rate as the dependent variable and schooling dummies, occupation dummies, experience, experience squared, a public sector worker dummy and a region dummy as the explanatory variables (Mincer, 1974). Following Mincer's example we use an Experience variable that is equal to Age minus Schooling minus 5, to capture the interaction between schooling and experience. Since the ECHP is a panel data set that follows the same individuals over time we fit the random effects cross-sectional time-series regression model.[6] College students currently working part-time are allocated a value of *w* from a part-time workers hourly wage model. This is also how we treat students not currently working part-time, since we assume this is a choice they make in allocating non-study time. Unemployed people (there are nine such individuals in the sample) are given a shadow wage of zero[7]; no retired people were present in the sample.

Table 1 contains the results of our estimated Random Effects wage equations from the ECHP data set. Separate models are estimated for employed men and women, and for male and female students. In terms of interpretation we estimate that having completed secondary level education has a return of 15% and having completed college gives a return of 43% compared to the base case of no secondary education.[8]

Because of the significance of the unobserved effects (as found using the Breusch–Pagan Lagrange Multiplier Test) we chose the random effects model over a pooled cross-sectional model. Although our random effects model is rejected by the Hausmann test, we still choose to use it rather than the fixed effects model as we wish to predict earnings for another sample. Also, the size and significance of the coefficients in the random effects model are almost identical to the pooled cross-sectional model. Table 2 presents a comparison, by occupational category, of the potential wage as predicted by our alternative net wage function to the wage rate derived by dividing each respondent's reported gross earnings by 2000[9] and to the wage rate derived by dividing each respondent's estimated reported net earnings by 2000. On average, the alternative net wage function predicts potential wages that are 49% lower than the wage rate derived by dividing each respondent's gross earnings by 2000 (€7.03 compared to €13.81) and 43% lower than the wage rate derived by dividing each respondent's net earnings by 2000. We interpret this as an indication that "standard" approaches to valuing travel time may be rather inaccurate.

Table 1
Random effects hourly earnings regressions

ln *W*	Men employed	Women employed	Men students	Women students
University level education achieved	0.436	0.399	0.65	0.757
	(20.77)**	(15.89)**	(8.83)**	(9.87)**
Upper secondary level education achieved	0.151	0.177	0.331	0.464
	(10.98)**	(9.51)**	(5.97)**	(7.03)**
Experience (age minus years of education minus 5)	0.051	0.03	0.088	0.079
	(25.08)**	(12.41)**	(6.83)**	(6.81)**
Experience squared	−0.001	−0.001	−0.002	−0.002
	(−16.97)**	(−9.45)**	(−3.40)**	(−3.29)**
Working Part-time (0-part-time worker, 1-full time worker)	0.441	0.31		
	(10.38)**	(13.50)**		
Public sector worker (0-private sector, 1-public sector)	0.171	0.204		
	(10.44)**	(11.70)**		
Professionals	0.1	0.157	0.072	0.266
	(4.06)**	(4.81)**	(0.73)	(2.91)**
Technicians and associate professionals	0.037	0.045	0.062	0.229
	(1.61)	(1.38)	(0.63)	(2.37)*
Clerks	−0.052	−0.004	−0.087	0.073
	(2.02)*	(−0.12)	(−0.84)	(0.79)
Service workers and shop/sales workers	−0.085	−0.186	−0.01	0.087
	(−3.35)**	(−5.99)**	(−0.1)	(0.93)
Skilled agricultural and fishery workers	−0.194	−0.449	−0.386	−0.612
	(−4.69)**	(−2.88)**	(−2.03)*	(−1.39)
Craft and related trade workers	−0.046	−0.046	0.026	−0.057
	(−2.01)*	(−0.85)	(0.27)	(−0.28)
Plant and machine operators and assemblers	−0.103	−0.054	−0.067	0.015
	(−4.45)**	(−1.51)	(−0.66)	(−0.14)
Elementary occupations	−0.158	−0.15	−0.208	−0.03
	(−6.65)**	(−4.09)**	(−2.10)*	(−0.25)
Armed forces (base case is legislators, and senior managers)	−0.068	−0.044	−0.086	0.373
	(−1.38)	(−0.16)	(−0.5)	(1.13)
1995	0.037	0.06	0.058	0.042
	(3.48)**	(4.26)**	(0.98)	(0.83)
1996	0.014	0.062	0.009	0.086
	(1.26)	(4.24)**	(0.15)	(1.66)
1997	0.028	0.087	0.175	0.052
	(2.42)*	(5.73)**	(2.86)**	(0.92)
1998	0.045	0.104	0.125	0.052
	(3.75)**	(6.73)**	(2.12)*	(0.95)
1999	0.078	0.11	0.249	0.046
	(6.21)**	(6.81)**	(4.13)**	(0.79)
Regional dummy (0-border, midlands and west, 1-east/south east)	0.045	0.02	0.121	−0.043
	(3.11)**	(1.11)	(2.26)*	−0.91
Constant	1.249	1.258	0.876	0.725
	(40.55)**	(31.54)**	(7.53)**	(5.98)**
Observations	7980	5454	858	799

Value of *z* statistics in parentheses; *significant at 5%; **significant at 1%.

It is not unexpected that the alternative net wage function predicts potential wages that are lower than the wage rate derived by dividing each respondent's gross earnings by 2000 since the potential wage predicted by our auxiliary wage equations is a net figure (only net hourly wage figures are given in the ECHP data set) whereas the wage rate derived by dividing each respondent's gross earnings by 2000 is a gross figure. We would contend that this is an advantage over the more tradition method of calculating the opportunity cost of time. In a choice decision an individual will consider her opportunity cost in terms of what she can afford to pay, i.e. she will consider her net wage not her gross wage. Therefore, the more tradition approach to measuring the wage rate in travel cost studies may be overestimating the opportunity cost of time which will introduce a bias into the travel cost coefficient which in turn will result in an overestimate of any resulting welfare estimates.

Using a reported net wage to calculate the opportunity cost of time (calculated by dividing each respondent's gross earnings by 2000 and adjusting for tax credits and tax exemption limits) would be an alternative approach of merit, but this is not generally done as

[6] The results of alternative wage estimation techniques (a pooled cross-sectional model and a first differenced OLS regression) are not reported here put are available from the authors upon request.

[7] Even though their potential wage may be positive to reflect the fact that these individuals have attributes that should allow them to earn a certain wage in the labour market, it was assumed that with a situation of full (or near to full) employment in the Irish labour market it must be the case that these unemployed persons choose to be unemployed. Therefore, we take their opportunity cost of time to be zero.

[8] The interpretation is for the wage equation of male workers not in full time education as this is the dominant group in the ECHP data set and also, this group caters for 68% of the individuals in our kayaking data set.

[9] In calculating the derived gross hourly wage from reported gross earnings, 2000 was assumed to be the average number of hours worked per year by the average industrial worker in Ireland (http://www.cso.ie/releasespublications/documents/earnings/current/indearn.pdf).

Table 2
Comparison of wage estimates for sample of kayakers by occupation

Occupation catergory	Wage estimated using ECHP earnings function	Wage equals reported gross income/2000	Wage equals reported net income/2000
	Mean (S.D.)	Mean (S.D.)	Mean (S.D.)
Legislators, senior officers and managers	9.43 (2.42)	27.24 (10.58)	20.22 (6.34)
Professionals	9.51 (1.92)	20.59 (8.18)	16.11 (5.20)
Technicians and associate professionals	7.71 (1.3)	15.28 (5.36)	12.62 (3.76)
Clerks	8.37 (1.86)	17.5 (5.12)	14.13 (3.57)
Service/shop/market sales workers	5.69 (3.11)	9.64 (5.14)	8.27 (3.98)
Skilled agricultural and fishery workers	6.65 (0.52)	9.17 (2.39)	7.96 (1.91)
Craft and related trade workers	6.36 (2.96)	15.42 (6.94)	12.60 (5.25)
Plant and machine operators and assemblers	6.67 (0.31)	10.83 (2.39)	9.30 (1.91)
Elementary occupations	6.04 (1.08)	11.14 (3.1)	9.54 (2.47)
All categories plus students	7.02 (3.00)	13.81 (10.89)	11.02 (7.64)

Standard deviation in parenthesis.

it would involve collecting information on pension contribution, tax credits, tax allowances, tax position of spouse, etc.[10] for every person in the recreational site choice sample. This would be a very expensive and tedious exercise within the context of a recreation demand survey. Also, asking respondents to directly state their net hourly wage in a questionnaire is not feasible as most individuals who are paid a salary or who are on a piece-rate or commission basis will not have any idea what that net rate is equal to. The alternative wage estimation approach adopted in this paper that uses information from a secondary survey dedicated to collecting earnings information is a method that can be used to derive this preferred net wage in a cost effective manner.

Table 3 presents summary statistics of the three alternative travel cost specifications for the sample of 2805 kayaker-whitewater site observations. Travel cost including the opportunity cost of leisure time, as measured using the predicted wage figure, has the average value of €37.60. This is 1.72 times greater than the travel cost specification that excludes the opportunity cost of time altogether and 30% lower than the travel cost specification that includes the opportunity cost of leisure time derived by dividing each respondent's gross earnings by 2000.

6. Site choice models

Three conditional logit site choice models have therefore been estimated in this paper using the alternative specifications of travel cost summarised above and in Table 3. In all models the choice probabilities of going to whitewater kayaking sites are regressed on travel cost and six site attributes; parking, crowding, star rating, water quality, scenery and prior information on water levels. The other regressors are dummy variables for all whitewater sites except the Liffey, which allows us to pick up unobserved site attributes that explain variations in site choice.

The only way in which the specification of the three models differs is in the treatment of travel cost. The first model (CL1)

[10] In calculating the reported net wage used in Table 2, we took into account the income tax credits that existed in Ireland for the reference year and the marginal tax rates of 20 and 42% We were unable to account however for issues such as pension contributions or other tax allowances which may be unique to certain individuals in our sample as this information was not, as one would expect, collected in the survey. For this reason, our net estimates may still be an overestimate of the true hourly earnings of our sample. This fact is born out by the lower estimates for the wage rate from the alternative net wage function.

Table 3
Summary statistics of alternative travel cost specifications

	Mean	Std. deviation	Minimum	Maximum
Travel cost including opportunity cost of leisure as measured using ECHP data[a]	37.6	20.76	1.22	151.07
Travel cost excluding opportunity cost of leisure time[b]	21.8	12.12	0.32	66.3
Travel cost including opportunity cost of leisure as measured using derived gross hourly earnings from kayaker survey[c]	53.01	39.57	1.077	363.8

[a] Travel cost = ((2 × (distance × €0.25))/2.3) + ((travel time/60) × estimated net hourly wage).
[b] Travel cost = ((2 × (distance × €0.25))/2.3).
[c] Travel cost = ((2 × (distance × €0.25))/2.3) + ((travel time/60) × ((gross earnings/2000))).

ignores the opportunity cost of leisure time completely, i.e. travel cost is simply travel distance times the average kilometre cost of travel divided by the average number of passengers in the vehicle travelling to the whitewater site. The second model (CL2) uses the parameter estimates from the hourly earnings equations estimated on the ECHP data set which were then applied to our sample of kayakers to calculate and include the opportunity cost of time in the TC variable calculated at 100% of each kayakers estimated net wage. For model CL3, we use the methodology most frequently followed in the literature when including some measure of the opportunity cost of time. In this case, $TC_{ij} = ((2 \times (\text{distance} \times €0.25))/2.3) + ((\text{travel time}/60) \times ((\text{Gross Income})/2000))$, i.e. we divide each kayaker's gross income by 2000 labour hours to get an estimate for each respondents hourly wage.[11]

Results from the three CL models estimated across all choice options are presented in Table 4. The independence of irrelevant alternatives (IIA) assumption (Luce, 1959) assumes that the ratio of probabilities of choosing any set of alternatives remains constant no matter what happens in the remainder of the choice set. Under the IIA assumption, we would expect no systematic change in the coefficients of our CL models if we excluded one of the whitewater sites from our model. To test this hypothesis we re-estimated the parameters of model CL2, excluding Cliften Playhole as a whitewater site option, and performed a Hausman–McFadden test against our fully efficient, complete model. On examination of the test results we found no evidence that the IIA assumption had been violated ($\chi^2(16) = 10.51$, prob = 0.8389) and thus accepted our null hypothesis that the differences in the coefficients between our complete and restricted model were not systematic.

The estimated coefficients (other than the travel cost coefficient) vary slightly in magnitude in all three models. Travel cost, star rating, scenic quality and the whitewater site dummies are statistically significant at the 1-per cent level for all models, whereas crowding and parking are significant at the 5-per cent level for models CL2 and CL3 but marginally insignificant for model CL1. The site dummies represent the somewhat unique physical characteristics of each kayaking site and are all found to be highly significant.

The variables *water quality* and *prior information* are statistically insignificant in all three models. *Water quality* has the expected sign and its insignificance is not that surprising. It may be explained by the fact that Irish kayakers will kayak at almost any whitewater site regardless of pollution levels so long as the quality of the kayaking feature or its "star rating" is high. Indeed in 2002, eight kayakers

[11] The value 2.3 in the travel cost specification refers to the average number of passengers per vehicle that journey to the kayaking site.

Table 4
Random utility site choice models with different treatments of travel cost

Variable	Model CL1	Model CL2	Model CL3
Travel cost	−0.121	−0.07	−0.039
	(−19.33)**	(−17.98)**	(−15.42)**
Quality of parking	−0.096	−0.145	−0.151
	(−1.24)	(−2.04)*	(−2.04)*
Crowding	0.101	0.153	0.158
	(1.45)	(2.19)*	(2.31)*
Star quality of the whitewater site	0.409	0.351	0.367
	(3.25)**	(2.82)**	(3.04)**
Water quality	0.186	0.142	0.11
	(1.79)	(1.39)	(1.1)
Scenic quality	0.289	0.285	0.285
	(2.99)**	(2.99)**	(3.09)**
Availability of information on water levels prior to visiting the site	−0.077	−0.08	−0.066
	(−0.88)	(−0.92)	(−0.79)
Clifden Playhole	−1.38	−0.905	−1.085
	(−3.78)**	(−2.47)*	(−3.03)**
Curragower wave on the Shannon	−1.838	−1.413	−1.247
	(−6.80)**	(−5.34)**	(−4.85)**
The Boyne	−2.003	−1.772	−1.562
	(−6.51)**	(−5.93)**	(−5.42)**
The Roughty	−2.134	−1.641	−1.916
	(−5.34)**	(−4.10)**	(−4.89)**
The Clare Glens	−4.016	−3.387	−3.185
	(−10.11)**	(−8.63)**	(−8.29)**
The Annamoe	−2.597	−2.076	−1.829
	(−7.55)**	(−6.25)**	(−5.70)**
The Barrow	−3.491	−2.914	−2.669
	(−10.93)**	(−9.27)**	(−8.69)**
The Dargle	−5.787	−5.011	−4.502
	(−13.80)**	(−12.33)**	(−11.52)**
The Inny	−2.35	−1.769	−1.478
	(−7.86)**	(−6.04)**	(−5.19)**
The Boluisce (Spiddle)	−2.643	−2.344	−2.253
	(−7.73)**	(−6.96)**	(−6.83)**

Value of z statistics in parentheses; *significant at 5%; **significant at 1%. Models CL1, CL2 and CL3 have log likelihood values of −865.11, −913.95 and −970.12, respectively. The Liffey is not included as a site specific constant as it is the whitewater site used as the comparative base case.
Attributes rated on a scale of 1–5, where 1 is poor and 5 is excellent. In the case of crowding 1 means very crowded and 5 means uncrowded.

contracted Weil's disease[12] through kayaking in "the sluice" on the river Liffey. Even though nothing has been done to improve the water quality at this whitewater site since this incident, it still remains one of the most frequented whitewater sites in the country due mainly to its proximity to the large urban centre of Dublin city. This site was also the most visited site for our sample of kayakers. The Curragower wave on the Shannon is also a feature noted for its poor water quality but because it is one of the best standing wave features from a kayaking perspective in Europe, Irish kayakers still frequent it regularly.

All the statistically significant variables (in all models), except for *parking*, also have the expected signs. Travel cost is expected to have a negative impact on the choice probability that a site is visited, whereas *star quality*, *scenic quality* and how *uncrowded* a whitewater site is, are all expected to have positive impacts on the choice probability. The fact that parking has a negative sign would seem to indicate that the poorer the quality of parking at a whitewater site the higher the probability of visiting that site. Even though at first this fact may seem counterintuitive, it may in fact be correct. Many respondents in the survey highlighted remoteness of the whitewater site as a characteristic that added significantly to their whitewater kayaking experience. If this is indeed the case, then it is not an unreasonable assumption that the more secluded whitewater sites are, the poorer the associated parking facilities will be.

The one major difference among CL1, CL2 and CL3 is the values attached to the coefficients of travel cost. As already stated, the opportunity cost of travel (or leisure) time is included in models CL2 and CL3 but excluded in CL1. This results in higher travel costs, and thus in lower coefficient values in CL2 and CL3. The travel cost coefficient for model CL2 is just over one half of the travel cost coefficient associated with model CL1, in absolute terms, coefficient values being −0.07 compared to −0.121, respectively. However, CL2's estimate of the travel cost coefficient may be a better indication of a kayakers' true marginal cost of travel as it takes into account each individuals unique characteristics and what they could potentially earn in the labour market, through the use of the ECHP hourly earnings equation in calculating the opportunity cost of travel time. The travel cost coefficient for model CL3 is approximately one third of CL2's, in absolute terms, at −0.036. This lower absolute value should result in higher estimates of welfare changes when different whitewater site management options are considered.

To illustrate the effects of different treatments of travel time on welfare estimates, we calculated the consumer surplus (CS) for a change in the characteristics or attributes of one or several of the whitewater sites using the standard log-sum formulae (Hanemann, 1984). Table 5 displays a number of different policy scenarios for which consumer surplus is calculated under the three different travel cost scenarios, ranging from the loss of access to a site to a change in the attribute of a particular site. The site attribute changes considered were a (a) 50% reduction in the star rating of the Roughty river due to the building of a hydro-electric scheme and (b) 25% improvement in water quality at the Curragower wave on the Shannon. Estimates showed that the fall in CS per person per trip changed from €0.13 to €0.24 to €0.52 in scenario (a) when using the travel cost coefficient and results of models CL1, CL2 and CL3, respectively, and €0.14 to €0.18 to €0.22 in scenario (b) in moving from model CL1 to model CL2 to model CL3.[13]

The actual welfare estimates themselves have important implications for whitewater resource management. It is obvious from the results that resources should be allocated first to increasing sites' star ratings before any whitewater cleanup projects are implemented as kayakers do not seem to be overly concerned with the quality of the water they kayak on. Also, in the debate on using the natural flows of rivers for hydro-electric power, losses to society are often put in terms of the loss in the scenic value of the river, loss in terms of a fishing resource, the impacts on the indigenous flora and fauna and perhaps the impacts on local residents. The welfare estimates presented here confirm there are also significant opportunity costs to the kayaking community of allowing such developments at popular Irish kayaking sites such as Clifden Playhole and the Boluisce river.

From a methodological point of view, the results highlight the impact on welfare estimates of decisions over how one measures the travel cost component in a recreational demand modeling framework. It is interesting to note that there is no overlap in the confidence intervals for any welfare scenario across models. This would suggest that there is significant difference among all the welfare estimates across the three models according to the treatment of travel time. Poe et al. (1997) however, demonstrate that such conclusions cannot simply be drawn by means of a non-overlapping confidence interval. Following Poe et al. (1997) and Foster and Mourato (2003), we test the null hypothesis of equality

[12] Weil's disease is an infection carried in rats urine which contaminates water and banks of lakes, ponds and rivers. The disease, which is notifiable in Ireland, is serious and requires hospital treatment. Symptoms start 3–19 days after exposure to contaminated water. Early symptoms are similar to 'Flu'.

[13] Ninety-five percent confidence intervals for each welfare estimate are presented in Table 5.

Table 5
Welfare impact of different policy scenarios

Scenario	Change in consumer's surplus per visit for Model CL1 (€)	Change in consumer's surplus per visit for Model CL2 (€)	Change in consumer's surplus per visit for Model CL3 (€)
Closure of individual whitewater sites:			
Loss of Clifden Playhole due to the building of a hydro scheme	−0.92 (−0.83, −1.01)	−1.74 (−1.57, −1.95)	−2.91 (−2.63, −3.40)
Loss of the Boluisce river due to the building of a hydro scheme	−0.59 (0.53, 0.65)	−0.94 (−0.85, −1.06)	−1.44 (−1.30, −1.63)
Reduction (50%) in star rating of the Roughty due to water diversion for agricultural use	−0.13 (−0.12, −0.14)	−0.24 (−0.22, −0.27)	−0.52 (−0.47, −0.61)
Improvement (25%) in water quality at Curragower wave on the Shannon	0.14 (0.13, 0.15)	0.18 (0.16, 0.20)	0.22 (0.20, 0.26)

Source: calculated from models reported in Table 4.

among the three welfare measures for each of the models of Table 4, for the four scenarios of interest.

In the first step of the test, the Krinsky and Robb (1981) procedure is used to simulate the distribution of each welfare measure by taking 1000 random draws from the underlying distribution of parameters in each model. For each set of random draws a difference between each welfare measure (WM) from the three models is calculated. Finally, following the example of Foster and Mourato (2003), a significance level is obtained by calculating the proportion of the values in the vector of differences with negative or positive signs – depending on whether the alternative hypothesis is that $WM_{CL3} > WM_{CL2} > WM_{CL1}$ or in the case of scenario 4 vice versa. The pattern of results is very clear. Irrespective of which travel cost specification is used in the RUM model, there is a very strong rejection of the null hypothesis of equivalence between the welfare measures. The 95% confidence intervals indicate that the differences were large and significant. In all cases, the consumer surplus estimates are significantly lower (significantly higher) when the opportunity cost of time is excluded (when the opportunity cost of time is included as 100% of the respondents reported gross wage) in the TC calculation compared to when the opportunity cost of time is included as 100% of the estimated net wage derived from the secondary dataset.

7. Conclusions

This article has shown that the welfare effects of changes in recreational site quality and access are sensitive to the specification the "price" in travel cost models of recreation demand. The results presented here have important implications for recreational demand policy and data collection. A model where the travel cost variable includes a measure of the opportunity cost of time as calculated from an auxiliary data set and using net hourly wage rates produce significantly lower estimates than when the opportunity cost of time is calculated using the standard reported annual gross earnings approach (where one divides by the assumed labour hours to give a gross hourly wage rate for each respondent).

Which is the correct method of calculating travel costs? There would appear to be a general consensus in the literature that some recognition of the opportunity cost of time should be included in any travel cost specification. Given this fact, we would favor the method developed in this paper where the opportunity cost of time is calculated using an auxiliary data set to estimate wage regressions, the coefficients of which are in turn used to estimate a net hourly wage for each individual in the recreation data set. This seems more robust than ad-hoc adjustments based on partial and imprecise responses on a respondent's labour market situation as are likely to be revealed in most recreation demand studies.

Also, we would contend that the auxiliary wage regression approach may be a more appropriate method to use in calculating travel costs of recreational demand studies because in a choice decision an individual will consider her opportunity cost in terms of what she can afford to pay, i.e. she will consider her net wage rather than her gross wage. The more traditional approach to measuring the value of time in travel cost studies may be overestimating the opportunity cost of time, which will introduce a bias into the travel cost coefficient which in turn will result in an overestimate of welfare effects. As we demonstrated in Table 2, even if one can make some ad-hoc assumptions in relation to marginal tax credits to derive a net wage rate for respondents, this is not a very accurate or cost effective solution due to the lack of knowledge and expense in collection information on pension contributions or other tax allowances which may be unique to certain individuals in a sample. This fact is born out by the lower estimates for the wage rate from the alternative net wage function.

The auxiliary wage regression approach may also be a more appropriate method to use in cases where (a) secondary labour market and earnings data are readily available, (b) the item non-response for labour market questions in a recreation demand survey is high or (c) for whatever reason, accurate labour market information is not gathered in the recreation survey. As a caveat, however, it could be the case that the kayaker population might be quite different than the average sample population from the ECHP in regards to characteristics that we do not have explanatory variables for in our auxiliary regression. Perhaps kayakers are simply brighter, more efficient workers and so they are better paid on average than their non-kayaking counterparts. If so, the reported wage (especially if adjusted to make it a net (all-be-it over estimated) wage) might be as accurate as our predicted wage. Further research on this point is warranted.

Since large micro-data sets of labour markets are now becoming more and more available, they could be utilized to get a better estimate of the wage rate of recreationalists, especially when the sample size collected in the recreation demand study is limited, as was the case here, or when there is limited information in the recreational data set on the income situation of respondents. In this regard the methodology for calculating the opportunity cost of time using an auxiliary data set is not just an once-off method due to some uniquely available data set, rather, it is a process that could be implemented in the field with relative ease when carrying out travel cost studies due to the current widespread availability of labour market data sets in most developed countries. Randall (1994) claimed that a fundamental problem with the travel cost method is that true travel cost is unobservable. This indeed continues to be the case and as demonstrated by this paper, how one specifies the travel cost variable has potentially important implications for welfare estimation and recreational demand policy.

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