Modeling Recreation Demand with Respondent-reported Driving Cost and Stated Cost of Travel Time

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ABSTRACT. Respondent-reported driving and time costs are used to represent the individual trip price for a solution to a calibration problem in the travel cost method (Randall 1994). After considering recreationists' perceptions of driving costs and travel time, models based on individual driving costs and stated costs of travel time are compared to standard-type specifications with wage-based time costs. Respondent-reported driving costs appear to be a working tool for calibrating the welfare measures. The willingness to pay to reduce travel time was logically related to respondent and trip characteristics and had reasonable effects on benefit estimates. (JEL Q51)

I. INTRODUCTION

The travel cost method (TCM) involves estimating a recreation demand function based on the number of trips taken as the quantity variable and the travel cost as the price variable. A potential strength of TCM is its being based on actual rather than stated choices. The downward sloping demand relationship is empirically robust and most plausible, as long as travel is costly and the cost increases with distance. However, there is also a major difficulty that was set forth by Randall (1994). The recreational travel is typically a non-homogeneous household-produced commodity, and unlike standard marketed goods, it has no observable price. Rather than being a third-party observable magnitude, the travel cost – in the sense of an individual's perceived cost that is relevant to trip decisions – is inherently subjective and unobservable (Randall 1994).

Thus, TCM practitioners have been obliged to substitute researcher-assigned travel cost estimates for the unobservable travel price. An annoying consequence of this practice is that along with the travel cost, welfare measures from the TCM are ordinally measurable (Randall 1994). In other words, a calibration problem arises from the use of prescribed travel cost estimates. If welfare measures from the TCM are in part artefacts that reflect the specific accounting conventions used, their validity for their intended use in benefit-cost analysis can be challenged.

Considering its importance, Randall's (1994) article has attracted surprisingly little further research. There are few published papers working directly from Randall's argument. Englin and Shonkwiler (1995a) focus on the implication that due to the ignorance of individual variation, the travel cost variable will be measured with error. Consequently, the associated parameter will be attenuated and its standard error inconsistent. Englin and Shonkwiler develop an econometric approach that views travel costs as an unobserved latent variable. Common, Bull, and Stoeckl (1999) illustrate the issue as an estimation problem and discuss the existence of a solution.

The perceived travel cost may vary significantly between individuals for the mere driving cost (Hagerty and Moeltner 2005), let alone the cost of travel time. Yet, the bulk of TCM applications have relied on researcher-assigned travel cost estimates. Applications using recreationist-reported (i.e., perceived as opposed to prescribed) travel or driving costs include Donnelly, Loomis, Sorg, and Nelson (1985); Bateman, Garrod, Brainard, and Lovett (1996); McKean, Johnson, and Walsh (1995); McKean, Walsh, and Johnson (1996); English and Bowker (1996); McKean, Johnson, and Taylor (2003); and Hagerty and Moeltner (2005). Common, Bull, and Stoeckl (1999) consider this option from a mainly skeptical viewpoint.

The importance of time cost was strongly introduced by Cesario and Knetsch (1970), suggesting that "for many if not most recreational trips the effect of time on visit rates is likely to be of equal or greater importance than the actual monetary cost incurred" and that there is "a serious conservative bias in the estimates, owing to improper accounting of the constraint imposed by time costs". What would subsequently be a standard rule used in applications, the practice of valuing travel time at a fraction of the wage rate (commonly one third), was established in Cesario (1976). Assuming equilibrium in the labor market the value of time at the margin will be equal to hourly wage, as people substitute time for money income. Using a model with constraints for money as well as time, Bockstael, Strand, and Hanemann (1987) showed that the wage-based rule breaks down with disequilibrium in the labor market. Consumers who can only work an institutionally fixed number of hours or do not participate in the labor market (students, retirees or unemployed persons) have no capacity to substitute time for money income. Thus, the marginal cost of time has no direct relationship with the wage rate.

For a potential solution to the calibration problem pointed out by Randall (1994), the present paper employs respondent-reported driving as well as time costs of travel to represent more closely the perceived individual trip price. We first consider empirical evidence on recreationists' perceptions of driving costs and travel time, including issues of whether recreationists actually estimate driving costs, what items they recognize as driving costs, and whether they perceive travel time as a cost, as well as the magnitude of these costs. The stated per-hour cost of travel time, based on respondents' willingness to pay to reduce travel time, is regressed on respondents' employment status, alternative time use, income, and trip specific factors to evaluate the validity of the approach. Second, results from estimated travel cost models with respondent-reported driving costs and a stated cost of travel time are presented. To evaluate the performance of our approach, estimates based on driving costs evaluated at the individually perceived rate and stated costs of time are compared with results using the average respondent-reported rate of driving cost and a wage-based time cost, a specification corresponding to the standard TCM application with researcher-assigned driving and time costs.

II. REVIEW OF PREVIOUS STUDIES

The maintained hypothesis of the present paper is that the case for a recreationist-reported rather than prescribed travel cost is conceptually compelling, because this is the closest we can get to the inherently subjective, perceived price of travel that is relevant to trip decisions (Donnelly, Loomis, Sorg, and Nelson 1985; Randall 1994; McKean, Johnson, and Taylor 2003). The perceived costs are likely to vary significantly between individuals. This goes for the mere driving costs (Hagerty and Moeltner 2005), which differ both on objective grounds and in terms of what cost items (fuel, maintenance, fixed costs such as depreciation) individuals consider relevant to recreational travel.

Recreationist-reported costs retain the individual variation in the travel cost variable. From an application point of view the recreationist-reported driving cost, even if only used in selecting an average cost per mile, serves to calibrate the welfare estimates to an empirically justified level. Thus, the approach will at least give an idea of the proper accounting relationship so as to avoid welfare measures reflecting an arbitrary accounting convention, which is necessary for the results to claim any cardinal meaning.

Accounting for individual perceptions is even more important as regards the opportunity cost of travel time. The treatment of time cost has been the single trickiest TCM related issue and, despite a vast literature, still lacks a generally preferred solution.[1] As regards the theoretically justified way of incorporating the time cost, a division with important implications to the demand specification and variable selection is between equilibrium and disequilibrium in the labor market. Bockstael, Strand, and Hanemann (1987) showed that interior solutions due to flexible choice between work-time and leisure justify a combined travel cost variable with travel time valued at the wage rate, while corner solutions due to institutionally fixed work-time or non-participation in the labor force lead to a demand function with separate variables for the money cost and physical travel time. McKean, Johnson, and Taylor (2003) present a similar specification with separate travel time variables by categories of employment and work-time status to allow for differences in sensitivity to the time cost. While the breakdown of the wage-based rule due to a fixed work-time has been long recognized, most of the research has still been looking for the correct fraction of the wage rate, or whatever connection to the wage rate, to be used as the opportunity cost of time.

For those recreationists who have an institutionally fixed work-time or do not participate in the labor market, the alternative use of time is not working for money income but other activities that do not have an observable market-related price such as the wage rate. On the other hand, incorporating time cost through physical time units does not allow a comprehensive money measure (accounting for driving as well as time cost of travel) to be computed. A consumer surplus in terms of time has limited use and fails to fulfill the basic objective of making non-marketed recreational benefits commensurate with marketed goods. A further complication is that rather than being a cost, the time spent traveling can be perceived as a beneficial part of the recreational experience (e.g., Walsh, Sanders, and McKean 1990).

We suggest a different approach, using the stated cost of travel time based on recreationists' willingness to pay (WTP) to reduce travel time in a contingent valuation type setting. This type of stated-preference approach has been suggested in the recreation demand context by Mitchell and Carson (1989); Fletcher, Adamowicz, and Graham-Tomasi (1990); and Shaw (1992). Published applications include Casey, Vukina, and Danielson (1995) using a contingent valuation question and Earnhart (2004) based on contingent behavior. Stated-preference approaches to the value of time have also found applications in transportation economics (e.g., Hultkrantz and Mortazavi 2001; Calfee, Winston, and Stempski 2001) as well as health economics (Borisova and Goodman 2003). The WTP-based stated cost approach is worth trying for several reasons. First, since the stated cost of time approach is based on recreationists' perceptions, it takes into account their own individual perceptions of whether travel time is a cost item or part of the experience rather than assigning a standardized or imputed hourly cost. Second, if based on a properly designed WTP question, the stated cost of time can be expected to account for individual factors and constraints, such as employment and work-time status, available discretionary time, income and alternative uses of time, as a built-in feature. Third, a monetized cost of time can be used to construct a combined 'full-cost' travel cost variable and, consequently, a comprehensive consumer surplus measure in terms of money. Given the pertinent problem of multicolinearity between the driving cost and the time cost (whether monetary cost or physical time) that usually hampers their use as a separate variables, the combined travel cost variable can be the only practical way to account for travel time.

For an interpretation of the approach, recall the two cases examined in Bockstael, Strand, and Hanemann (1987). At a corner solution due to fixed work-time and no capacity to substitute leisure for money income, the marginal cost of time is not equal to the wage rate and its exact magnitude remains unobserved. For the estimated demand model, this results in separate variables for the money cost and travel time. On the other hand, an interior solution with the capacity to flexibly trade leisure for money income at the margin implies that travel time is valued at the wage rate and can be combined with the money cost for a full-cost variable. Following ideas underlying stated preference methods, such as contingent valuation (Mitchell and Carson 1989), our approach can be considered as being in between the two cases. While unable to actually trade time for money income due to a fixed work-time, the recreationist is provided with a capacity to hypothetically trade travel time for money through the contingent valuation scenario, and thereby to express his/her perceived scarcity value (opportunity cost) of travel time at the margin. In this sense, our case corresponds to an interior solution where the monetized cost of travel time can be combined with the driving cost to a full-cost variable.[2] Yet, travel time is not valued at the wage rate or any fraction of it, but at its stated scarcity value (opportunity cost) measured by the willingness to pay to reduce travel time. The WTP to reduce travel time reflects the value of time gained for an alternative use and, by gain–loss symmetry, the opportunity cost of time lost traveling (i.e., the forgone value of time in its best alternative use).[3]

For an empirical justification to our approach, we first consider evidence on recreationists' perceptions of travel time, employment and work-time status, and alternative time uses. To test whether the stated cost of travel time expectedly reflects such individual factors, the per-hour time cost is regressed on recreationists' employment status, alternative time use, income, and trip specific factors. Finally, the performance of the stated cost approach in estimated demand models is tested by comparing with results based on conventional researcher-assigned driving costs and wage-based time cost estimates.

III. DATA AND ESTIMATION

Study area and data

The empirical data used in the present study are based on an on-site survey conducted in Teijo National Hiking Area in Finland during summer 2008. The respondents returned the questionnaire via mail with a postage paid envelope. Responses were obtained from a total of 235 visitors arriving at the area by car, amounting to 66.7% of the questionnaire forms distributed on-site.

The seven national hiking areas in Finland are versatile areas suited for hiking and other outdoor recreation with limited commercial forestry that takes into consideration nature conservation and the needs of outdoor recreation. The areas provide hiking trails, ski tracks, nature trails, camping sites and lean-to shelters within hiking areas. Many areas also have a visitor centre or a tourist centre or rental cabins. The case area of this study, Teijo National Hiking Area, is the southernmost hiking area, located in South-Western Finland less than 200 kilometers from Helsinki metropolitan area as well as from the cities of Turku and Tampere. Several small lakes offer good fishing opportunities for the visitors. In 2008 Teijo hiking area had a total of 75,000 visits, which makes it the second most popular national hiking area in Finland (Metsähallitus 2009).[4]

The survey contained the typical questions necessary for travel cost models, such as the number of visits to the area during the last 12 months (the dependent variable), travel distance to the site, and one-way travel time. On an average, the respondents had visited Teijo National Hiking Area four times during the last 12 months. However, almost half of the visitors (46%) had taken only one trip while every fifth visitor had more than five visits. The average round-trip travel distance to the area was 135.6 kilometers with an average round-trip travel time of 2.3 hours.

What is different from most TCM surveys is the information gathered on the driving and time costs of travel. For the driving costs, the respondents were asked whether they had estimated the cost of operating the car and whether this had an effect on the trip decision. Those who had taken the driving costs into account were asked about which cost items they included in their estimate (fuel, maintenance, interest and depreciation, risk of damage to the car). Finally, all those who had estimated the driving cost (whether or not these had an effect on the trip decision) were asked about their estimate on the fuel consumption (liters per 100 km), fuel cost, and overall driving cost (euro per 100 km). In addition, the number of persons sharing the driving costs during the present trip to Teijo Hiking Area was requested.

The respondents were then asked about their perceptions of the time spent traveling to the area. The screening question was whether they, while making the trip decision, perceived travel time as a cost (disadvantage or hindrance), neither a cost nor a benefit, or as a pleasant part or the trip (benefit) (Appendix 1, question 12). For those respondents who perceived travel time as a cost or took an indifferent position (neither cost nor benefit), two contingent valuation (CV) questions about their willingness to pay for saving travel time were posed (Appendix 1, questions 13, 14). The first CV question asked about the WTP per visit for saving travel time assuming that a new recreation area corresponding to Teijo would be attainable in half of the travel time to Teijo. The second CV question of WTP for time saving was framed to a new road connection to Teijo that would shorten the travel time to half of the current travel time. In both questions the WTP was asked in a payment card form with bids €0, €2, €5, €10, €15, €20, €30, €40, €50, €60, €70 and more than €70.

Constructing travel cost variables

The travel cost variables applied in this study are presented in Table 1. The variables differ along two dimensions. The first dimension distinguishes between mere driving costs and combined travel cost variables with driving as well as time costs. The other distinction is between variables based on an average respondent-reported driving cost, with a conventional wage-based estimate for the time cost, and those using respondents' individually reported values for the driving as well as time cost. All the variables use the respondent-reported round-trip distance and round-trip travel time, and also adjust for the reported number of persons sharing the driving cost.

Table 1. Construction of the alternative travel cost variables

	Driving cost only	Combined travel costs
Average-rate based	ADC: Driving cost at average respondent-reported rate	ADC_{wage}: Average driving cost + wage-based cost of travel time
Individually perceived	IDC: Driving cost at individually perceived rate	IDC_{WTP}: Individual driving cost + WTP-based cost of travel time
		IDC_{PWTP}: Individual driving cost + Predicted value of WTP-based cost of travel time

First, the variable labeled ADC contains the mere driving cost based on the average respondent-reported rate of driving cost per kilometer. Second, the IDC variable is the driving cost at the individually reported rate per kilometer. Third, the variable ADC_{wage} combines the average driving cost (ADC) with the cost of travel time conventionally evaluated at one third of the respondent's hourly wage (Cesario (1976). Fourth, IDC_{WTP} combines driving cost at the individually reported rate (IDC) and the individually perceived WTP-based cost of travel time. Finally, IDC_{PWTP} is the sum of the individual driving cost and the cost of travel time evaluated at the predicted rather than directly reported value of the WTP-based cost of time.

To evaluate the validity of the willingness to pay for saving travel time as a measure for the cost of travel time, we analyzed if the WTP per unit of time was associated with the expected background variables, such as employment status or income. First, the WTP figure stated in the payment card was divided by one-way travel time to obtain WTP per hour.[5] Since possibly negative values were not observed but set to zero, the censored regression (Tobit) model was an appropriate modeling approach. The two WTP questions for each respondent were used in a panel data form in a single Tobit model. The predictions from the model were used as one alternative for the time cost variable in IDC_{PWTP}.

Model estimation

A class of statistical models suitable for dependent variables with nonnegative integer values Y = (0,1,2,...) are known as count data models (Cameron and Trivedi 1986; Cameron and Trivedi 1998). The simplest model for a random variable with nonnegative integer values is the Poisson model. The other common count data model is the negative binomial model, which is an extension of the Poisson and allows the variance to differ from the mean. Overdispersion (i.e., variance greater than the mean) results in biased parameter estimates and downwardly biased standard errors for the truncated Poisson. As overdispersion was strongly present in our data, the negative binomial model was applied.[6] More specifically, models for on-site data must account for sample truncation at the zero level (e.g., Creel and Loomis 1990; Grogger and Carson 1991). Since non-participants are not observed, all observed users must have taken at least one trip so we have Y = (1,2,3,...). Further, the appropriate model needs to adjust for endogenous stratification, which refers to the fact that frequent visitors are more likely to be sampled on-site (Shaw 1988).

The density function for the truncated and endogenously stratified negative binomial (TSNB) model (Englin and Shonkwiler 1995b; Ovaskainen, Mikkola, and Pouta 2001; Martínez-Espiñeira and Amoako-Tuffour 2008) can be written as

(1) $\text{prob}(Y=y|Y>0) = F_{TSNB}(y|\lambda, \alpha, Y>0)$

$= y\,[\Gamma(y + 1/\alpha) / \Gamma(y + 1)\Gamma(1/\alpha)]\; \alpha^{y}\, \lambda^{y-1}\, (1 + \alpha\lambda)^{-(y + 1/\alpha)}$,

where λ is the Poisson parameter, α is the overdispersion parameter, and Γ denotes the gamma function. The distribution of $Y = (1,2,...)$ is defined with conditional mean $E(Y|X, Y>0) = \lambda + 1 + \alpha\lambda$ and variance $\text{var}(Y|X) = \lambda(1 + \alpha + \alpha\lambda + \alpha^2\lambda)$. The log likelihood function used for maximum likelihood estimation is the logarithm of (1) and takes the form

(2) $\ln L = \ln[\Gamma(y_i + 1/\alpha)] - \ln[\Gamma(y_i + 1)] - \ln[\Gamma(1/\alpha)]$

$+ y_i \ln(\alpha\lambda_i) - (y_i + 1/\alpha)\ln(1 + \alpha\lambda_i) + \ln(y_i) - \ln(\lambda_i)$.

The dependent variable Y in our study was the *number of trips taken during the last 12 months*. The basic independent variables were the *travel cost* (i.e., ADC, IDC, ADC_{wage}, IDC_{WTP} or IDC_{PWTP} as shown in Table 1), demographic factors like the visitor's *age* and *income, visitation history*, and *main outdoor activity* in the area.

The reported parameters for the TSNB model were estimated at two stages using the NLMIXED procedure in the SAS statistical software package (SAS Institute Inc. 2008).[7] First, the truncated negative binomial (TNB) model, including the overdispersion parameter, was estimated using the relevant log-likelihood and coefficients for the truncated Poisson from LIMDEP 8.0 (Greene 2002) as starting values. Second, the TSNB model was estimated using the log-likelihood given in Equation (2) with the overdispersion parameter (α) fixed at the value obtained from the respective TNB model. Sensitivity analysis showed that the value of the nuisance parameter had little or no effect on the parameters of interest. The estimated coefficients were used to calculate the consumer surplus per predicted trip defined as $-1/\beta_{TC}$, where β_{TC} is a parameter estimate for the travel cost variable.

As goodness-of-fit measures the pseudo-R^2 and R^2 (regression) were calculated. The pseudo-R^2 is defined as $1 - L_m/L_0$, where L_m is the log-likelihood for the full model and L_0 is the log-likelihood for a restricted model. Following Martínez-Espiñeira and Amoako-Tuffour (2008) the log-likelihood of the full TSNB model was compared to the restricted log-likelihood of the respective Poisson model (TSP). The Poisson was corrected for endogenous stratification and truncation by using $w_i = y_i - 1$ as the dependent variable in a standard Poisson regression (Shaw 1988). R^2 (regression) is based on a regression of predicted values on actual values following McKean, Johnson, and Taylor (2003). In addition, the Akaike and Bayesian information criteria AIC (Akaike 1974) and BIC (Schwarz 1978) are provided.

IV. RESULTS

Visitors' perceptions of the driving cost and travel time

At the core of the travel cost method is the negative significant effect of the travel cost variable in the trip demand model, which is necessary for the computation of consumer surplus measures.

While empirically robust, the price effect driven by the travel distance provides no more than an ordinal measure of benefits (or, where distance as such is used as the travel cost variable, a cardinal measure of consumer surplus in terms of miles or kilometers). For a cardinal measure in terms of money a justifiable calibration is required. Given our maintained hypothesis that the price variable relevant to trip decisions is the perceived rather than prescribed travel cost, it was interesting whether the recreationists themselves considered travel costs as important to trip decisions, whether and how they actually estimated the driving cost, and whether they perceived travel time as a cost.

Table 2. Distribution statistics for perceptions of driving and time costs, WTP to reduce travel time, employment and work-time status, and alternative time use

Variable	% of respondents	n
Importance of driving costs		
Had never estimated the driving cost	42.5	193
Had estimated the driving cost but it has no effect on recreational trips	50.8	
Took the driving cost into account in trip decision	6.7	
Perceptions of travel time		194
Perceived travel time as a cost	6.2	
Neither cost nor benefit	58.8	
Perceived as a pleasant part of the trip	35.1	
Willing to pay for new site at shorter distance		
No	63.0	189
Yes	37.0	
Willing to pay for faster road connection		
No	69.8	189
Yes	30.2	
Employment status		
Not employed	14.8	198
Employed	85.2	
Work-time status		
Full-time fixed work schedule	65.5	165
Flexible or part-time work schedule	34.5	
Alternative time use		
Other leisure activities outside home	41.1	197
Leisure time at home	38.1	
Home duties	15.2	
Working with extra payment	2.0	
Working without extra payment	3.6	

When asked whether they had estimated the driving cost and whether this had an effect on the trip decision, over 40 percent of respondents said they had never estimated the driving cost (Table 2). Around half of the respondents reported that they had, generally speaking, estimated the driving costs but these had no effect on their recreational trips. As few as 6.7 percent of the respondents answered that they took the driving costs into account while making their trip decision. While this finding might seem striking, it must be borne in mind that the question only referred to the single latest trip to Teijo National Hiking Area. Had we asked about the effect of driving costs on the total number of trips during the last 12 months, their perceived importance could have been different (yet, almost half of the visitors reported only one trip to Teijo during the season). As these respondents were asked about what cost items they included in their estimate, fuel was reported by 77, maintenance by 8, fixed costs such as interest and depreciation on the car by 0, and risk of car damage by 23 percent. Finally, all those who had estimated the driving cost (whether or not this had an effect on the trip decision) were asked about their estimate of the fuel cost and overall driving cost in euro per 100 km. Among those reporting an estimate for the driving cost, 20 percent included the fuel cost only, and 80 percent also other cost items such as maintenance. On an average, the overall driving cost was estimated at €0.16 per km. Given average fuel consumption and prices, the respondent-reported estimates can be considered realistic.

As for the time spent traveling, only 6 percent of respondents perceived travel time as a cost. Almost 60 percent were indifferent (neither cost nor benefit), and 35 percent perceived the time spent traveling as a pleasant part of the trip. The typical respondent was not willing to pay to reduce travel time through a substitute site with shorter distance (zero WTP for 63%) or through a faster road connection (zero WTP for 70%). Among employed persons (85% of all respondents), two out of three had full-time employment with fixed work-time schedule, while every third was employed on a part-time basis or with a flexible work-time schedule. Notably, for almost 95 percent of respondents the alternative time use was other leisure activities outside home, leisure at home, or home duties. The finding that time spent working was an actual alternative to the trip for very few respondents (5.6%) suggests that hourly wage is not the empirically obvious basis for measuring the opportunity cost of travel time.

Factors explaining the stated cost of travel time

The stated cost of travel time (WTP per hour of travel time saved) was modeled by the censored regression model (Tobit model for panel data), since possibly negative values were not observed but set to zero. Several possible variables were included in the preliminary model but excluded as non-significant from the final model. The results (Table 3) show the positive association of the per-hour WTP with the personal income. The alternative time use also had a significant effect on WTP. Those respondents who would have used the time for working without extra payment were willing to pay significantly less for an hour saved. That is, for them the perceived opportunity cost of time spent traveling was lower than for those whose alternative use for the saved time was leisure or working for extra payment. Further, the persons who were drivers on the trip were clearly more willing to pay to reduce travel time. The employment status (not employed) was not statistically significant. An experiment was made to exclude the alternative time use and income that may be correlated with the employment status. In this model (not reported), the employment status was also significant at the 10% level, suggesting that that respondents with a more flexible time budget were less willing to pay for an hour saved. A faster road connection seemed like a less desired way to reduce travel time than a substitute area at a shorter distance, yet the difference was not significant at the 10% level.

Table 3. Estimation results for a Tobit model explaining WTP to reduce travel time (panel data, n = 336)

	Coefficient	Standard error
Constant	-25.608***	5.562
Driver	12.159***	3.815
Not employed	-8.354	6.539
Alternative time use: work without extra payment	-20.852*	11.331
Income	0.003**	0.002
WTP mode (new road = 1)	-5.474	3.506
sigma	26.157	1.833
Pseudo-R^2	0.074	

* Significant at 10%; ** significant at 5%; *** significant at 1% or beyond

Although the pseudo-R^2 for the model was relatively low, the significant explanatory variables and the directions of their association with the WTP followed *a priori* expectations. Another important finding was that experiments made with the travel distance (or travel time) and the frequency of trips taken did not suggest any significant associations between these factors and the WTP for time. Overall, no nonlinearities or similar anomalies in the stated time cost were observed (cf. Hultkrantz and Mortazavi 2001). This suggests that the stated willingness to pay to reduce travel time provides a feasible alternative to the conventional wage-based time cost estimate.

Based on the Tobit model the mean predicted WTP per hour was €5.57. The predicted WTP, ranging from €0.17/hour to €14.86/hour, had considerably smaller variation than the observed WTP which varied from €0/hour to as much as €120/hour (the standard deviation for predicted values was 2.92 as against 13.51 for the observed values). As the predicted values cut off the extreme upper values, they may provide a more robust, conservative estimate for WTP. Thus, the predicted WTP was used as one alternative for the time cost of travel in the following demand models.

Estimated demand models and benefits per trip with alternative travel cost variables

Descriptive statistics for the variables used in the estimations are shown in Table 4. The average driving cost at the average respondent-reported as well as individually perceived rate was around €11–12. By adding the wage-based or WTP-based cost of travel time the combined travel cost more than doubled to €24–26 on an average. As the use of predicted values for the WTP-based cost of travel time cuts down the extreme upper values, the average combined travel cost decreased to €18. As additional regressors all estimated models included visitor age, income, and dummy variables for visitation history (new visitor) and main activity (fishing). Every fourth respondent visited the area for the first time, and the main activity in the area was fishing for around 27 percent.

Table 4. Definitions and summary statistics for variables used in the demand models

		Mean	Standard deviation	n
Dependent variable				
Number of visits during last 12 months		3.97	5.14	192
Travel cost variables				
ADC	Driving cost at average respondent-reported rate	11.9	12.77	190
IDC	Driving cost at individually perceived rate	11.2	15.17	190
ADC_{wage}	Average driving cost + wage-based cost of travel time	23.9	24.63	148
IDC_{WTP}	Individual driving cost + WTP-based cost of travel time	26.2	39.68	181
IDC_{PWTP}	Individual driving cost + predicted value of WTP-based cost of travel time	18.4	23.34	167
Additional regressors				
Income	Grouped, 1 ≤ €1000, ... , 9 = over €6000/month	3.7	1.88	176
Age	Age, yrs	46.7	12.40	195
New visitor	1 if first visit to Teijo, 0 if visited previously	24.7 [a]		198
Main activity fishing	1 if main activity fishing, 0 if other activity	27.3 [a]		198

[a] % of visitors

Table 5. Estimation results for recreation demand models with alternative travel cost variables, TSNB regression model (standard errors in parentheses)

	Driving cost only		Combined travel costs		
	ADC	IDC	ADC_{wage}	IDC_{WTP}	IDC_{PWTP}
Constant	–0.7295* (0.4142)	–0.7836* (0.4161)	–0.5334 (0.4251)	–1.1119** (0.4254)	–1.0810** (0.4288)
Travel cost (trip price)					
Driving cost at average respondent-reported rate	–0.0398*** (0.0084)				
Driving cost at individual perceived rate		–0.0337*** (0.0080)			
Average driving cost + wage-based cost of time			–0.0356*** (0.0059)		
Individual driving cost + WTP-based cost of time				–0.0169*** (0.0041)	
Individual driving cost + predicted WTP-based cost of time					–0.0216*** (0.0050)
New visitor (first time in Teijo)	–2.5308*** (0.3497)	–2.5952*** (0.3485)	–2.3232*** (0.3587)	–2.5944*** (0.3498)	–2.5506*** (0.3528)
Age	0.0162** (0.0076)	0.0154** (0.0076)	0.0177* (0.0091)	0.0175** (0.0080)	0.0172** (0.0080)
Income	0.0141 (0.0432)	0.0199 (0.0431)	0.0542 (0.0470)	0.0319 (0.0439)	0.0393 (0.0445)
Main activity fishing	0.5171** (0.2042)	0.4625** (0.2026)	0.7485*** (0.2330)	0.4635** (0.2133)	0.4939** (0.2152)
Alpha (fixed parameter)	3.2622	3.3675	2.4106	4.0217	4.0740
n	164	164	144	157	155
Pseudo-R^2	0.524	0.522	0.543	0.534	0.535
R^2 (regression)	0.250	0.252	0.325	0.244	0.261
AIC	659.1	662.5	558.9	622.8	616.9
BIC	677.7	681.1	576.7	641.1	635.2

* Significant at 10% ; ** significant at 5% ; *** significant at 1% or beyond

We next turn to the estimated demand models (Table 5). For the implications of alternative travel cost specifications, we focus on the changes in the estimated travel cost coefficient which provides the estimate for the recreational benefits from the hiking area, consumer surplus per predicted trip. A first reference case is the ADC model involving a mere driving cost evaluated at the average respondent-reported rate and additional regressors. Based on a uniform driving cost across visitors, this is the closest to the standard TCM application, yet with the important difference that the rate of driving cost per km is respondent-reported rather than researcher-assigned. A comparison of the ADC with the IDC model suggests that it makes relatively little difference whether the driving cost was evaluated at the average respondent-reported rate or at the individually reported values per km. For both cases, the driving cost variable had negative coefficients that were equally very significant (at the 0.1% level). The coefficient for IDC was slightly smaller in absolute value. The benefit estimates at the average and individual rate of driving cost become €25.13 and €29.68 per trip, respectively (Table 6).

Table 6. Consumer surplus per predicted trip (CS/Y) based on alternative travel cost variables

	Driving cost only		Combined travel costs		
	ADC	IDC	ADC_{wage}	IDC_{WTP}	IDC_{PWTP}
Point estimate, €	25.13	29.68	28.10	59.31	46.32
Standard error, €	5.55	7.46	4.77	15.12	11.23
Standard error, %	22.1	25.1	17.0	25.5	24.2

Second, the effect of the cost of travel time can be considered by comparing the ADC and IDC, including the driving cost alone, with the respective specifications with combined driving and time costs. All of the combined travel cost variables had negative coefficients that were statistically very significant (at the 0.1% level). The basic ADC specification is most naturally contrasted with ADC_{wage} that involves the average driving cost with a conventional wage-based estimate for the cost of travel time. The comparison shows that apart from a reduced standard error, the wage-based time cost had little effect on the travel cost coefficient. Consequently, the consumer surplus estimate

(€28.10) also changed only slightly. Turning to the specifications with a stated cost of travel time, the IDC_{WTP} contains the driving cost at the individual rate and the cost of travel time evaluated at the directly reported WTP to reduce travel time. In this case, the inclusion of the time cost had a more pronounced effect, roughly doubling the consumer surplus estimate from €29.68 for the IDC to €59.31 per trip. Finally, IDC_{PWTP} incorporates the cost of travel time through the predicted WTP for travel time. The use of a predicted rather than directly reported WTP resulted in a slightly smaller effect with a consumer surplus of €46.32 per trip. This suggests that predicted values, by cutting off extreme upper values, tend to produce more conservative benefit estimates.

For a rough idea of the precision of the benefit estimates, Table 6 also reports the standard errors of the consumer surplus measures based on the second-order Taylor series approximation presented in Englin and Shonkwiler (1995a). Considering the relative standard errors (in % of point estimate), there was little difference in the precision of the CS/Y estimates apart from a considerably smaller standard error for the ADC_{wage} variable. The estimates from the ADC, IDC, and ADC_{wage} variables fell within one standard error and clearly did not differ significantly.[8] Similarly, the IDC_{WTP} and IDC_{PWTP} estimates were at about one standard error from each other and did not differ significantly. Differences that are likely to be statistically significant, with point estimates differing by more than two standard errors, appeared between the former group of three models and the latter two models, especially IDC_{WTP}. That is, any major differences hinged on the inclusion of the WTP-based cost of travel time.

The dummy variable related to new visitors was very significant (at the 0.1% level) with a negative sign in all models. The purpose of this variable was to control for respondents that visited Teijo National Hiking Area for the first time ever and, by definition, could not have taken more than one trip during the season. A higher age increased the frequency of visits to Teijo. The effect was significant at the 5% level in all models except for ADC_{wage} (at 10%). The income variable had no significant effect in the present data.[9] The finding that fishing being the visit's main activity had positive coefficients (significant at 5%) in all models supports the expected importance of fishing activity for regular visitation.

Besides conceptual validity, differences in the models' fit with the observed data are a potential criterion for selecting the appropriate variable specification. That is, a particularly poor fit could result in the rejection of a 'theoretically correct' specification. According to the fit measures and information criteria the best fit with the observed data was gained by the ADC_{wage} variable involving the average driving cost plus wage-based cost of travel time (Pseudo-R^2 = 0.5433, R^2 (regression) = 0.3246, AIC = 558.9, and BIC = 576.7). However, this model fitted only slightly better than the IDC_{PWTP} based on the individual driving cost plus the predicted WTP-based cost of travel time, or the IDC_{WTP} with the WTP-based cost of time as such. Overall, the combined travel cost variables gave a better fit than did the variables with the driving cost alone. As the differences in statistical performance beyond the fact that any of the combined travel cost variables tended to improve the fit turned out to be minor, the decisive role in the selection of an appropriate variable specification is left to the conceptual validity of the specification and information directly received from the respondents.

V. CONCLUSION

For a potential solution to the calibration problem inherent in the travel cost method (Randall 1994), we employed respondent-reported driving as well as time costs of travel to represent the perceived individual trip price. The final question is whether the suggested use of respondent-reported travel costs provides an advantage over the conventional usage with researcher-assigned driving costs and a wage-based cost of travel time, whether the approach is promising as a solution to the calibration problem, and especially whether the stated preference approach to the cost of travel time is valid. We need to compare the approaches from several points of view, including statistical performance in terms of model fit with the data, conceptual validity, empirical justification, and implications for practical valuation research, such as the magnitude and precision of the benefit estimates.

The most interesting comparison is between specifications with individual driving costs and stated costs of travel time, on one hand, and those using the average rate of driving cost and a wage-based estimate for the time cost, on the other hand. This is because the latter uses a uniform rate of driving cost across individuals formally corresponding to the conventional researcher-assigned driving cost. Based on models with driving costs alone, the use of individually perceived cost estimates did not raise any particular data problems, such as nonresponse, and even the individual driving cost alone performed quite well in terms of statistical significance and model fit. For combined travel costs, models based on the average rate of driving cost and a wage-based time cost gave a slightly better fit and benefit estimates with smaller standard errors than those with individual driving cost and a stated cost of time. However, the differences in fit and precision of estimates were minor. What is more, an improvement in the formal statistical performance as such may matter little. If a better fit is only driven by the effect of travel distance showing up in a more "undisturbed" fashion, it cannot contribute to solving the calibration problem. If the results remain only ordinally valid, knowing the ordinal relationship with higher statistical precision is of limited usefulness.

Following this line of thought, the decisive role in evaluating the approaches should be given to conceptual validity, empirical justification, and implications for valuation research. According to these criteria the respondent-reported, stated cost of time approach provides advantages over the researcher-assigned, wage-based approach. First, Randall's (1994) argument for perceived rather than prescribed travel costs underlying our maintained hypothesis seems conceptually compelling. Second, the stated cost approach to travel time seemed empirically justified and logically valid. The finding that working for a wage is not a relevant alternative to leisure time spent on a recreational trip lends direct support to the stated cost as opposed to the wage-based approach. Respondents' WTP to reduce travel time was expectedly related to respondent and trip characteristics, with no anomalies that have appeared in valuation studies of time in transportation, for example. Third, the respondent-reported driving cost provides a simple working tool for coping with the calibration of the benefit measures (i.e., establishing a proper accounting relationship). Even if the individual values would turn out to be unusable due to excessive dispersion, the average respondent-reported driving cost seems like a statistically robust yardstick for selecting an empirically justified rate of driving cost. Finally, the estimated effects of introducing the cost of travel time seemed intuitively reasonable, with no extreme effects such as fourfold consumer surplus estimates that have been reported in previous studies based on various wage-based approaches. This was particularly true when the more robust, less volatile predicted WTP for travel time was used.

An interesting, not to say puzzling, finding is the apparent contradiction between respondents' statements of the importance of travel costs and the effect of travel costs in their observed behavior as manifested in the estimated demand models. Only few respondents reported having taken the travel costs into account in their trip decision. Similarly, few respondents actually considered travel time as a cost but still, every third respondent was willing to pay to reduce travel time. What is more, the driving cost alone (whether at the individually perceived or average rate) had a clearly significant negative effect on the number of trips taken, and the effect of travel cost was further strengthened when the stated cost of travel time was included on top of the driving cost. This raises the fundamental issue "do people do what they say". However, this meta-theoretical question is something we do not attempt to address but leave for future investigation.

Appendix 1. The contingent valuation questions on the cost of travel time

THE IMPORTANCE OF TRAVEL TIME

12. When you decided to travel to Teijo, how did the time spent traveling appear to you in advance?

1 □ as a cost (hindrance or obstacle)
2 □ neither a cost nor a benefit
3 □ as a pleasant part of the visit (benefit); **move to question 15**

In the following you are asked to evaluate more precisely how "expensive" the time spent traveling is for you.

13. Let us assume that a new recreation site corresponding to Teijo would be opened closer to you residence or a place of departure. The new site would be achievable in a half of the time needed to reach Teijo. The site would be financed with entrance fees.

How much would you be willing to pay at most for the reduction in travel time per one visit?

□ €0	□ €30
□ €2	□ €40
□ €5	□ €50
□ €10	□ €60
□ €15	□ €70
□ €20	□ more, how much_____€

14. Let us assume that a faster new road connection would shorten the travel time from your residence or place of departure to Teijo so that the travel time would be a half of the present. The costs of road improvement would be covered by user charges collected during 10 years after the completion of the road.

How much would you be willing to pay at most for the reduction in travel time per one visit?

□ €0	□ €30
□ €2	□ €40
□ €5	□ €50
□ €10	□ €60
□ €15	□ €70
□ €20	□ more, how much_____€

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Notes

[1] For a recent review of the literature, see Amoako-Tuffour and Martínez-Espiñeira (2008). Studies focusing on the time cost issue include Cesario and Knetsch (1970); Cesario (1976); Wilman (1980); McConnell and Strand (1981); Smith, Desvousges, and McGivney (1983); Bockstael, Strand, and Hanemann (1987); Walsh, Sanders, and McKean (1990); Shaw (1992); Larson (1993); Casey, Vukina, and Danielson (1995); McKean, Johnson, and Walsh (1995); Feather and Shaw (1999); Earnhart (2004); and Larson and Shaikh (2004), among others.

[2] Earnhart (2004) uses a different stated-preference method, contingent behavior, to explore the implicit trade-off between travel time and money. Earnhart also discusses and employs the assumption that "money is money". That is, the recreationist responds to changes in driving costs and time costs similarly. Then, if transportation costs and time costs are properly measured in monetary terms, each cost should affect demand in the same way.

[3] This interpretation implies that travel time is considered as an input only or, if time spent traveling brings utility as part of the visitation experience, the WTP to reduce the time spent traveling measures the cost of travel time net of its consumptive value.

[4] Both national parks and national hiking areas are managed by Metsähallitus. Nature protection plays a key role in the management of state owned areas, but more strictly in national parks. For example national hiking areas provide more commercial services like fishing licences for catching the restocked fish.

[5] Notice that the WTP figure is per visit (i.e., corresponds to a round-trip), and because half of the current travel time is assumed to be saved both ways, the total saving in travel time per visit equals the current one-way travel time.

[6] The presence of overdispersion in the data is readily apparent, since with a standard deviation of 5.14 the sample variance (26.42) vastly exceeds the sample mean 3.97 (see Table 4 below). As a formal test for overdispersion the regression based tests proposed in Cameron and Trivedi (1990) were used. As the values of the two test statistics, readily reported in the output for the Poisson model in LIMDEP 8.0 (Greene 2002, p. E20-12), were well above 4.00 and 5.00 for all models, the negative binomial model is clearly preferable over the Poisson.

[7] The TSNB model has been relatively difficult to estimate, and estimation modules have been presented only recently (Hilbe 2005; Hilbe and Martínez-Espiñeira 2005). With our data set, experiments with the user-defined optimization in LIMDEP, the STATA modules NBSTRAT and GNBSTRAT, and the NLMIXED procedure in SAS all failed to simultaneously account for overdispersion and endogenous stratification. Either there were convergence problems and a solution was not found at all, or the estimated alphas stayed at an unrealistic level.

[8] Given that the welfare measures are nonlinear functions of random variables, with likely asymmetric distribution functions (Creel and Loomis 1991), the approximate standard errors as such do not allow the computation of accurate confidence intervals or exact testing of hypotheses about the estimates from alternative models.

[9] The finding that the income coefficient is not statistically significant is not exceptional in travel cost models (e.g., Englin and Shonkwiler 1995a). Income was still kept in the reported model because the coefficient seems to take the expected positive sign and because it is needed if Hicksian welfare measures are to be computed.