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Sensitivity of Whitewater Rafting Consumers Surplus to Pecuniary Travel Cost Specifications

Donald B. K. English and J. M. Bowker

USDA–Forest Service, Southern Research Station, 320 Green Street, Athens, Georgia 30602-2044, U.S.A.

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Considerable research has examined how different ways of accounting for onsite and travel time affect surplus estimates from travel cost models. However, little has been done regarding different definitions of out-of-pocket costs. Estimates of per trip consumer surplus are developed for a zonal travel cost model for outfitted rafting on the Chattooga River. Nine price definitions are used for each of three functional forms. Three price definitions are based on mileage rates times round-trip distance, plus outfitter fees. The remaining six definitions are based on reported spending, using three different sets of expenditures and two methods of imputing prices for zero-visit zones.
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1. Introduction

The non-commodity values of publicly owned resources are receiving increased attention and scrutiny by agencies and groups who are interested in how those resources are managed. Increasing competition for various conflicting uses of the resources is a primary reason for this trend. Ward (1987) noted that important example of this kind of resource is the instream flow of wild rivers. Agriculture, hydropower and domestic consumption all compete with recreational fishing and boating use.

Travel cost models (TCM) have long been used and are well accepted in resource economics to quantify recreation demand and values (U.S. Water Resources Council, 1983). The various forms of TCM are predicated on the concept that consumers respond to changes in the travel costs that are necessary to visit a site in a like manner to changes in site access fees. Hence, a researcher may use individual or zonal variation in travel costs to develop an empirical model of site demand and derive economic surplus for site users.

The two most frequently used TCM approaches are the zonal or aggregate approach and the individual approach. The zonal model was the first to be developed and is still widely used. It is based on establishing a relationship between participation rates at a

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site from various geographic origin zones and the costs incurred in travel from the origin zone to the given site. The relationship is conditioned by socio-economic variables characterizing the population in each zone and by indices accounting for substitution activities or prices. Recent applications include Richards *et al.* (1990), Bergstrom and Cordell (1991) and Hellerstein (1991).

The individual model is based on individual or micro data for annual trips, trip costs and other socio-economic variables. From these, one directly estimates a price–quantity relationship for a typical individual. Recent examples include Wilman and Pauls (1987), Creel and Loomis (1990) and Ozuna *et al.* (1993). Economic theory shows individual models to be superior to zonal models (Fletcher *et al.*, 1990). However, in cases where households or individuals take only one or at most a few trips per year, individual models may not be estimable. In these cases, zonal models are a common substitute (Ward and Loomis, 1986).

A number of researchers have investigated properties of TCM for developing net economic surplus estimates. Choice of functional form used in estimation has been shown to affect both the expected value and variance of consumer surplus estimates (Ziemer *et al.*, 1980; Adamowicz *et al.*, 1989; Hellerstein, 1991; Ozuna *et al.*, 1993). Others have examined the role of substitute sites in benefit estimates (Caulkins *et al.*, 1986; Ward and Loomis, 1986; Wilman and Pauls, 1987). The issues of how to incorporate and value travel and on-site time in TCM have received a good deal of attention and are still unresolved (Smith *et al.*, 1983; Bockstael *et al.*, 1987; Hof and Rosenthal, 1987; Wilman and Pauls, 1987; McConnell, 1992). In particular, the choice of how to value travel time has been shown to have large impacts on surplus estimates (Wilman and Pauls, 1987; McKeen *et al.*, 1995).

One aspect of TCM that has received fairly little attention is the specification of the pecuniary price of a recreation trip. As its name implies, TCM presumes that costs incurred while travelling to a recreation site are one of the primary components of recreation trip price. Site entrance fees are often considered the other main component (Fletcher *et al.*, 1990). In most zonal and some individual TCM studies, pecuniary travel costs have been equated with transportation costs, and have been assumed to be a linear function of distance and a cost per mile constant (Caulkins *et al.*, 1986; Smith, 1988; Creel and Loomis, 1990; Bergstrom and Cordell, 1991; Hellerstein, 1991; McConnell, 1992).

Among these studies, there has not been general agreement on the appropriate cost per mile. Several have assumed transportation costs at less than ten cents per mile (Smith, 1983; Hof and Rosenthal, 1987; Hellerstein, 1991). However, the rates used by McConnell (1992), \$0·168/mile, and by Creel and Loomis (1990), \$0·22/mile, were substantially higher. For some other studies, it is not possible to determine exactly what cost per mile was used (Caulkins *et al.*, 1986; Bergstrom and Cordell, 1991).

Similarly, studies that have used reported out-of-pocket costs have not shown consensus on which expenditures to include. In their review of the TCM literature, Ward and Loomis (1986) noted that it is not obvious which cost to include, and suggested that a key determinant of whether or not to include certain expenses depends on how well those expenses serve as entry fee proxies. In a study of Lake Michigan anglers, Kealy and Bishop (1986) chose to include travel costs, as well as spending for fishing tackle, equipment and boat rentals, trip-related food and lodging. Larson (1993) used a cost per mile to approximate travel expenditures, and also included all food and lodging expenses made while travelling.

In this paper, we used zonal TCM to assess the per trip economic surplus of outfitted

whitewater rafting day use on the Chattooga River, which forms the northernmost portion of Georgia's border with South Carolina. We explored the sensitivity of consumer surplus estimates to differences in the specification of the money costs per trip. In particular, nine different price specifications were used. Three specifications were based on three different cost per mile rates, plus outfitter fees. For the other six, we aggregated individual trip expenses data to obtain zonal averages for reported per trip expenditures. Different price specifications resulted from unique combinations of three sets of expenditures and two methods for imputing prices for zones that produced no trips to the Chattooga. Each of the nine price specifications was examined using three different functional forms.

2. Data and methods

Data were collected in cooperation with America Outdoors, a national outfitter and guide industry organization. A random sample of households who used commercial outfitter services on the Chattooga River during the summer of 1993 were surveyed by mail. Information collected included annual use of the Chattooga and other rivers, detailed expenditure patterns for the trip, group size, home location and various demographics.

Of the 392 responses, 331 were useable. Outfitters on the Chattooga offer either day or overnight trips. Fewer than 5% of the responses were for overnight trips. We felt that since overnight trips are qualitatively different from day trips for both outfitters and clients, the two trip types should not be pooled. However, our sample did not have enough observations to model overnight trips, so these cases were deleted from the study. Because our empirical study was primarily for illustrative purposes, we wanted to examine as homogeneous a population of users as possible. For this reason, we eliminated responses from large organized groups such as church or Scouting groups (3%), from persons whose primary trip destination was not for a rafting trip on the Chattooga (25%), and from those travelling over 500 miles to the river (3%). Our final subsample consisted of 214 observations.

Preliminary examination of the data showed that over 70% of the respondents reported taking only one trip to the Chattooga in the past year. Because individual TCM can be difficult to estimate in these cases (Ward and Loomis, 1986; Richards *et al.*, 1990), we opted for a zonal model. As in all zonal TCM studies, definition of zones is somewhat arbitrary. Our zones were comprised of groups of counties and were defined by two criteria. The first division grouped counties according to 25-mile concentric rings around the Chattooga. County locations were determined by their geographic centroids. Only counties within 500 straight-line miles were included. Counties in each ring were then subdivided into three categories according to a ten-point rural–urban classification (Butler, 1990). Counties with one of the four most urban classifications were considered URBAN; counties with one of the three most rural classifications were RURAL. This distinction was made to ensure a higher homogeneity level of zonal populations according to social environment. Differences between urban and rural dwellers for participation in resource-based recreation have been noted in the past (for example, Hendee, 1969; Owens, 1984). In total, 60 zones were used for model estimation.

Our dependent variable was the annual number of outfitted trips taken from each zone. Annual trips taken by a household equalled the product of household trips and number of household members participating in each trip. This measure of quantity was

chosen over the number of household trips because it is the quantity of interest both to outfitters and to agencies that manage use of the Chattooga and other recreational rivers. This is true when users are charged on a per-head basis for guide services and when agencies measure use by some function of visits.

We examined nine different price specifications. Three were based on implicit travel cost per mile, using values of \$0·15, \$0·25 and \$0·35. For these, the number of round-trip travel miles was multiplied by the appropriate rate and then the average outfitter fees paid per sampled individual from that distance zone were added. From our sample, per person outfitter fees ranged from about \$50–85 for day trips on the Chattooga, while zonal averages for outfitter fees ranged from \$56·18–73·91. Overall, the average per person outfitter fee was about \$65.

The other price definitions were based on reported per person expenditures. The most basic included only reported travel expenses (eg. gasoline, car rental, air fares and lodging), plus outfitter and equipment rental fees. A second specification additionally included spending for secondary activities, souvenirs and film purchases. The last specification further added purchases of food and beverages at either stores or restaurants.

For zones that had positive numbers of trips to the river, prices were computed as the mean of per person expenditures from the sample, weighted by the annual number of trips that individuals took to the Chattooga River. Two separate methods were employed to impute prices for the 20 zones from which there were no applied individuals. The first method took the weighted average of expenditures across all individuals from that distance zone, without regard to the rural–urban continuum code.

The second method used a regression analysis to develop coefficients to construct prices for zones with no respondents. For each price specification, zonal price was regressed on one-way distance and binary variables for whether the zone was primarily rural or primarily urban, using OLS. Results indicated the presence of heteroskedasticity with variances increasing with distance from the river. Consequently, we fitted the following weighted least squares model:

$$\frac{\text{COST}}{\text{DIST}} = \frac{B_1}{\text{DIST}} + \beta_2 + \beta_3\left(\frac{\text{RURAL}}{\text{DIST}}\right) + \beta_4\left(\frac{\text{URBAN}}{\text{DIST}}\right) \tag{1}$$

where DIST is the one way distance to the river, and URBAN and RURAL are the binary variables indicating that the zone is urban or rural in character, respectively. Results of this regression are presented in Table 1.

It should be noted that we did not include any aspect of time costs in our price definitions. Various researchers have included either travel and/or onsite time in a number of different ways, and with a wide variety of valuations. As yet the literature reveals no consensus. In our case, all of the day trips had similar amounts of onsite time and, for most zones, travel time costs are likely to be small compared to outfitter fees and pecuniary travel costs. Finally, as the major objective of this paper is to demonstrate the effects of pecuniary cost specifications on economic surplus estimates, we opted for the most conservative approach regarding the opportunity costs of time.

Three empirical specifications were estimated for each of the six price definitions. The first uses a Tobit model,

$$\begin{aligned} \text{TRIPS}_i &= X_i'\beta + e_i \quad \text{if } X_i'\beta + e_i > 0 \\ &= 0 \qquad\qquad \text{if } X_i'\beta + e_i \leqslant 0 \end{aligned} \tag{2}$$

TABLE 1. Results of weighted least squares regression for per person trip expenses for zones with respondents ($N=40$)

	Price definition		
	Transportation + outfitter + lodging	Transportation + lodge + outfitter + activities	Transportation + lodging + outfitter + activities + food
1/DIST	78·4578	83·9082	147·3697
	(9·75)	(9·18)	(9·75)
DIST/DIST	0·2069	0·2385	0·2666
	(2·77)	(2·84)	(1·92)
RURAL/DIST	11·2057	11·6784	−28·5774
	(1·07)	(0·99)	(−1·47)
URBAN/DIST	−6·4491	−6·7381	−57·7175
	(−0·62)	(−0·79)	(−3·00)
Model F	70·95	64·20	47·91
Adjusted R^2	0·843	0·829	0·783

where the dependent variable is total annual trips from zone i to the site, X_i' is a vector of regressors, β is a parameter vector, and e_i is a random error term assumed independent and identically distributed. The second specification is also a Tobit model, using trips per capita from the zone as the dependent variable.

The last specification is the conventional semilog model,

$$\ln\,(\mathrm{TRIPS}_i+1)=X_i'\beta+e_i \tag{3}$$

wherein one trip was added to each zone to ensure computability.

In all cases, the regressor set included continuous variables for price specification (PRICE), an index of availability of water-based recreation resources (SUBOPP) which served as a proxy for a substitute site price, mean household income in thousands of dollars (INCOME) and the RURAL indicator. Preliminary examinations indicated that the URBAN variable was not significantly related to zonal trip demand. The Tobit model for total trips per zone and the semilog model also contained a continuous zonal population variable, measured in thousands of people (POP). Values for the demographic variables were obtained from 1990 Census data.

Following Hellerstein (1992, equation 4), the expected CS for zone i from the Tobit models is given by

$$E[CS_i]=\int_{P_{\mathrm{obs}}}^{P_c}(\Phi * X_i\beta+\sigma\varphi)\mathrm{d}P \tag{4}$$

where Φ and φ are the standard normal distribution and density functions, respectively, evaluated at $(X\beta/\sigma)$, P_{obs} is observed travel cost, P_{c} is a maximum (choke) price, and σ

is the standard deviation of the error term. Expected consumer surplus per trip over the entire sample is given by

$$\frac{E[CS]}{\text{TRIP}} = \frac{\sum_i E[CS_i]}{\sum_i \text{TRIPS}_i} \tag{5}$$

For the semilog model, consumer surplus per trip equals $1/-\beta_p$ where β_p is the price coefficient.

3. Results

Estimation results for the MLE Tobit total trips model are reported in Table 2. Heteroskedasticity has been reported to be an occasional problem associated with using trips as the dependent variable in zonal models when population is not equal across zones. Using a Breusch–Pagan test (Judge *et al.*, 1988), we tested for increasing error variance with zone population. We were unable to reject the hypothesis of homoskedasticity for any of these models.

As expected, higher levels of population and income were associated with increased zonal trip production. Somewhat surprisingly, rural zones supplied significantly more trips than did non-rural zones, when population and other regressors were constant. That is, accounting for variation in levels of population across zones while controlling for other variables such as income does not completely capture the differences in resource-based recreation demand between urban, suburban and rural zones.

Both within and across the three types of price definitions, there are noticeable differences in the estimated price coefficients. In general, distance-based prices yielded the most negative coefficients and lowest surplus estimates. Cost-based prices with missing prices imputed by zonal averages yielded insignificant price coefficients, and hence large surplus estimates. For the WLS-imputed prices, adding food expenditures increased the average trip cost by about \$33 but reduced the price coefficient by over 40%.

Within each price type, price definitions with the lowest (greatest) mean yielded price coefficients with the greatest (smallest) absolute value. Differences in price coefficients translate directly into differences in estimates of consumer surplus (*CS*). Within each price type, surplus estimates from the largest price definition were more than twice as large as *CS* estimates from the smallest price definition. Average per trip surpluses for the distance-based prices ranged between about \$21 and \$50. Per-trip surpluses for cost-based prices ranged from about \$45 to \$90 when missing prices were imputed with WLS regression, and between \$60 and \$140 when missing prices were imputed with zonal averages.

For the Tobit trips per capita model, both income and rural character were positively associated with trips per person (Table 3). The importance of the RURAL variable to characterizing whitewater demand is accentuated by noting that the variable's t-ratios have larger absolute values in this model than in the Tobit model of total trips per zone. Again, price coefficients for cost-based prices were insignificant when missing prices were imputed by distance zone averages. Distance-based price coefficients had larger t-values and absolute values compared to the cost-based prices. Again within each type of price, higher price definitions led to more positive price coefficients.

TABLE 2. Zonal Tobit regressions (dependent variable = total trips, $N = 60$)

Variable (t-value)	Distance-based prices: cost/mile + outfitter fee			Cost-based prices: imputed by average by distance zone			Cost-based prices: be weighted squares regression from observed zones		
	\$0·15/mile	\$0·25/mile	\$0·35/mile	Outfitter, trans. and lodging	Outfitter, trans., lodging and activities	Outfitter, trans., lodging activities and food	Outfitter, trans. and lodging	Outfitter, trans., lodging and activities	Outfitter, trans., lodging, activities and food
Constant	−544·99	−948·72	−1126·9	−1841·3	−1903·9	−2011·6	−1566·9	−1668·3	−1602·8
	(0·50)	(−0·87)	(−1·04)	(−1·59)	(−1·58)	(−1·66)	(−1·32)	(−1·41)	(−1·33)
Population	0·3727	0·3666	0·3620	0·1368	0·1300	0·0933	0·1851	0·1764	0·1375
(1000s)	(3·61)	(3·59)	(3·57)	(1·43)	(1·38)	(1·03)	(1·97)	(1·90)	(1·56)
Income (\$1000)	76·826	80·076	81·768	120·50	122·57	136·67	110·24	113·20	111·39
	(2·09)	(2·19)	(2·24)	(2·98)	(3·04)	(3·10)	(2·78)	(2·85)	(2·75)
Rural	526·21	536·26	542·51	829·83	824·29	840·93	601·69	786·93	740·55
	(1·77)	(1·81)	(1·83)	(2·56)	(2·53)	(2·55)	(2·52)	(2·46)	(2·26)
Subst. opps	0·344	0·4807	0·2127	−35.97	−36·25	−43·55	−24·98	−24·50	−30·675
	(0·01)	(0·02)	(0·01)	(−1·43)	(−1·43)	(−1·69)	(−1·00)	(−0·97)	(−1·23)
Price	−12·412	−7·429	−5·266	−3·2648	−2·7908	−0·8841	−5·8405	−5·1411	−2·9005
	(−4·11)	(−4·12)	(−4·12)	(−1·31)	(−1·25)	(−0·57)	(−2·28)	(−2·23)	(−1·89)
Tobit σ	592·42	592·20	592·75	675·67	677·68	684·84	659·55	662·93	670·29
$E[CS/\text{Trip}]$	21·32	35·04	48·99	58·99	62·30	140·62	44·87	48·23	90·33
Mean price/trip across zones	143·44	195·94	248·44	128·21	139·83	176·10	132·91	145·26	188·19

TABLE 3. Zonal Tobit regressions (dependent variable = total trips per capita, $N = 60$)

Variable (t-value)	Distance-based prices: cost/mile + outfitter fee			Cost-based prices: imputed by average by distance zone			Cost-based prices: be weighted squares regression from observed zones		
	\$0·15/mile	\$0·25/mile	\$0·35/mile	Outfitter, trans. and lodging	Outfitter, trans., lodging and activities	Outfitter, trans., lodging activities and food	Outfitter, trans. and lodging	Outfitter, trans., lodging and activities	Outfitter, trans., lodging, activities and food
Constant	−6·9026	−8·5952	−9·3153	−9·1148	−9·3897	−9·2909	−8·6489	−9·0634	−7·7716
	(−1·05)	(−1·30)	(−1·40)	(−1·23)	(−1·27)	(−1·25)	(−1·19)	(−1·24)	(−1·05)
Income	0·4960	0·5054	0·5091	0·4768	0·4812	0·4598	0·4785	0·4854	0·4256
	(2·43)	(2·47)	(2·48)	(2·09)	(2·10)	(2·01)	(2·42)	(2·15)	(1·88)
Rural	4·0554	4·0940	4·1130	4·9087	4·8573	4·7898	4·9016	4·8018	4·3730
	(2·21)	(2·22)	(2·22)	(2·39)	(2·35)	(2·31)	(2·42)	(2·36)	(2·12)
Subst. Opps	0·0391	0·0402	0·0401	−0·0701	−0·0686	−0·0822	−0·064	−0·0195	−0·0323
	(0·30)	(0·30)	(0·30)	(−0·48)	(−0·47)	(−0·55)	(−0·18)	(−0·13)	(−0·22)
Price	−0·0536	−0·0320	−0·0227	−0·0197	−0·0171	−0·0090	−0·0313	−0·0280	−0·0183
	(−4·07)	(−4·00)	(−3·96)	(−1·46)	(−1·39)	(−1·01)	(−2·25)	(−2·20)	(−2·03)
Tobit σ	3·8000	3·821	3·832	4·319	4·335	4·3642	4·2293	4·2501	4·2794
$E[CS/\text{Trip}]$	31·66	50·84	70·46	51·82	55·69	104·64	39·97	43·74	58·21

Differences in *CS* estimates across price definitions were somewhat less than in the Tobit trips model.

The same general patterns were repeated yet again in the results for the semilog models (Table 4). Income and rural character were positively and significantly related to trip production. Coefficients on the distance-based prices were larger in absolute value, and the range of surplus estimates smaller compared to cost-based prices. Within each price type, smaller price definitions yielded smaller *CS* estimates. Surpluses for the distance-based prices ranged from \$27·55–63·29, and for the expense-based prices with WLS-imputed missing prices, from \$41·32–69·44. The zonal average expense-based prices had non-significant price coefficients.

We compared surplus estimates for distance-based and WLS-imputed cost-based prices across functional forms and found an interesting pattern. For distance-based prices, the largest *CS* estimates came from the Tobit trips/capita model, estimates from the semilog models were in the middle, and the Tobit trips model produced the smallest estimates. However, for cost-based prices, the pattern was exactly reversed. Tobit trips models produced the *largest CS* estimates while the lowest estimates came from the Tobit trips/capita model.

Finally, we examined the percentage changes in expected per trip surpluses across price definitions and functional forms (Table 5). For each type of price, the middle price definition served as a base (\$0·25/mile for distance-based; transportation, lodging and activities for cost-based). The first column shows the percentage difference in average trip price compared to the base price. The next three columns show the percentage difference in estimated *CS* per trip compared to the *CS* estimate obtained from the base price for each functional form. The base price was \$195·94 per trip for distance-based prices, and \$145·26 for cost-based prices.

For distance-based prices, a \$0·10 per mile rate change represents a 26·8% change in the average trip price for both price increases and decreases. Estimates of per trip surplus changed between 38–40% across functional forms. For cost-based prices, deleting activity-related expenses from the base price resulted in about a 8·5% decline in average price. Surplus estimates declined between 7% and 9%. Including food increased the average price by about 30% over the base price, but increased estimated per trip *CS* by 33–87%, depending on the functional form.

As should be expected, our results indicate that the responsiveness of *CS* estimates to increases or decreases in assumed cost per mile is fairly consistent. However, responsiveness of surplus estimates to changes in price definition is asymmetrical for cost-based prices. Further, the asymmetry can vary across functional forms and the direction of price change.

4. Discussion

Accounting for the rural or urban character of a zone appears to be an important factor in demand for whitewater rafting. Simply using zonal population level as a regressor may not be sufficient to capture the different nature of rural recreation demand. Past efforts that have not adequately characterized this aspect of defined zones may have derived biased estimates of consumer surplus. Future zonal travel cost efforts should include a similar variable to avoid mis-specification of demand models.

Our results highlight some important issues in defining prices for travel cost modelling, for both distance-based and cost-based prices. For distance-based prices, results from Table 1 indicate that actual pecuniary trip costs per mile are not constant across

TABLE 4. Zonal Semi-log regressions (dependent variable = log(Trips + 1), $N = 60$)

Variable (t-value)	Distance-based prices: cost/mile + outfitter fee			Cost-based prices: imputed by average by distance zone			Cost-based prices: be weighted squares regression from observed zones		
	\$0·15/mile	\$0·25/mile	\$0·35/mile	Outfitter, trans. and lodging	Outfitter, trans., lodging and activities	Outfitter, trans., lodging activities and food	Outfitter, trans. and lodging	Outfitter, trans., lodging and activities	Outfitter, trans., lodging, activities and food
Constant	−2·0102	−3·1111	−3·6058	−5·3728	−5·5081	−5·9018	−3·9247	−4·1905	−3·3894
	(−0·54)	(−0·86)	(−1·01)	(−1·33)	(−1·38)	(−1·46)	(−1·02)	(−1·11)	(−0·87)
Population	0·0011	0·0011	0·0011	0·0004	0·0004	0·0003	0·0007	0·0007	0·0005
	(3·21)	(3·25)	(3·26)	(1·27)	(1·29)	(0·99)	(2·17)	(2·19)	(1·84)
Income	0·3034	0·3095	0·3128	0·4243	0·4229	0·3172	0·4340	0·3718	0·3775
	(2·39)	(2·46)	(2·50)	(3·07)	(3·13)	(3·19)	(2·83)	(2·91)	(2·68)
Rural	1·2458	1·2523	1·2604	2·1778	2·1534	2·2049	2·0106	1·9264	1·5810
	(1·26)	(1·27)	(1·28)	(2·03)	(2·01)	(2·03)	(1·98)	(1·91)	(1·52)
Subst. Opps	0·0795	0·0825	0·0830	0·0404	0·0367	0·0560	0·0209	0·0295	0·0086
	(1·05)	(1·09)	(1·10)	(−0·51)	(−0·46)	(−0·70)	(0·27)	(0·38)	(0·12)
Price	−0·0363	−0·0221	−0·0158	−0·0094	−0·0089	−0·0033	−0·0242	−0·0225	−0·0144
	(−3·89)	(3·99)	(4·01)	(−1·14)	(−1·23)	(−0·62)	(2·80)	(2·94)	(2·82)
$E[CS/\text{Trip}]$	27·55	45·25	63·29	106·38	112·36	303·03	41·32	44·44	69·44

TABLE 5. Percentage differences in price definition and expected consumer surplus per trip

	% Price difference	$\frac{E[CS]-E[CS_{Base}]}{E[CS_{Base}]}$		
		TOBIT trips	Trips/capita	TOBIT semi-log
Distance-based prices (base = \$0·25/mile):				
0·15/mile	−26·8	−39·2	−37·7	−39·1
0·35/mile	26·8	39·8	38·6	39·9
Cost-based, WLS-imputed (base = transportation, lodging and activities)				
Transportation and lodging only	−8·5	−7·0	−8·6	−7·0
All costs	29·6	87·3	33·08	56·3

distance zones. Costs per mile are greater for shorter trips than for longer ones over the range of distances examined here. Part of the reason is that for longer trips, total trip costs including fixed costs such as outfitter fees are spread over more miles. This is important when entry or outfitter fees are a non-trivial portion of total trip costs. Future TCM studies which base prices on costs per mile may want to provide some justification for mileage rate selection and consider using variations in rates across distance zones.

Including activity-related expenses in a cost-based price definition made a relatively small difference in both the average trip price and the estimated price coefficient. However, including food-related expenses had a much greater effect. TCM literature is of only limited assistance in deciding which expenses are properly included. Ward and Loomis (1986) state only that prices should be such that "site consumers respond to variations in travel cost in a similar manner as they would respond to varying site fees." Minimal expenses would seem to include transportation, entry fees and travel-related lodging. Correct treatment of expenses for food, film, activities, clothing and souvenirs is unclear. Any purchases that the individual considers to be essential costs of the trip should be included in the trip price and in the price of available substitutes. Clearly, there is a need for theoretical development in defining prices for recreation trips.

Resolving price definition issues is especially important because of the relationship between price definition and *CS* estimates. First, choosing between distance-based and cost-based prices is important. Most of the surplus estimates presented here are fairly comparable across the two price types, although the range of estimates for distance based prices (\$21–70) is lower than the range for cost-based prices (\$40–90). However, a number of TCM studies have used a cost/mile rate well below our minimum of \$0·15/mile. This rate consistently produced the lowest surplus estimates of any presented here. Further reduction in the rate would have yielded yet lower estimates of per trip surplus. Regardless of which type of price one chooses to use, the definition of trip price is still a central issue. Our results indicate that the price elasticity of surplus estimates is frequently greater than unity over the range of price definitions we examined. In future TCM studies, sensitivity analyses across a reasonable set of mileage cost ranges or cost definitions would be useful.

Overall, our results support the findings of previous studies that have shown that travel cost consumer surplus estimates vary across estimated functional forms. However, we show that not only the magnitude, but also the direction of differences, depend on whether cost-based or distance-based prices are employed.

In summary, this research indicates that selection of travel cost prices is as important in estimating consumer surplus as is choice of functional form. There appears to be a good deal of room for improvement in understanding how to define or calculate trip prices. Choosing an incorrect definition can lead to a mis-specified price variable and biased surplus estimates. A related question is how well the common methods of calculating trip prices (either from expenses or costs per mile) actually mimic entry fees, particularly in applications where significant entry fees exist. These issues would appear to be of increasing import as TCM continues to be used and as public agencies obtain increased flexibility in assessing user fees.

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