4. Travel cost estimation conditional on leisure consumption*

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4.1 INTRODUCTION

This chapter applies the travel cost method (TCM) in order to estimate the recreational demand of a visitor to the West Garda Regional Forest in Italy conditional on her leisure consumption. We consider the number of trips to the natural area as an approximation of the consumed quantity of the environmental good, while the expenditure on the visit as an approximation of the price for the good. No previous studies have applied travel cost method to the West Garda Regional Forest.

We explore two issues in empirical demand analysis: the estimation of a single demand equation, and the estimation of a complete demand system with the incorporation of demographic characteristics. We propose 'translating' as a general method for incorporating demographic variables into complete systems of demand equations (Pollak and Wales, 1978). The estimation of only single demand equations may give us a wrong picture because interactions between demands for commodities are ignored. In addition, some of the properties, or restrictions of a well-behaved utility function, as imposed by economic theory can not be tested if they appear as cross-equation restrictions (such as Slutsky symmetry or adding-up restrictions).

In this case we have to consider that the individual can visit different natural areas in one year. Bockstael et al. (1987) present the problem of choice in two steps: the first one is of macro-allocation and it consists of choosing the number of trips in one year; the second step is of micro-allocation since the choice is about where to go in one specific trip. Provencher and Bishop (1997) apply a dynamic model in which the individual chooses every day if and where to make a trip.

Complete demand systems have two principal advantages over existing valuation models in the literature. First, by incorporating the budget constraint into the analysis, the complete system approach forces recognition of the fact that an increase in expenditure on one consumption category must be balanced by decreases in the expenditure on others. Second, the complete system approach permits the separation of demographic effects from own and cross-price effects as well as income effects. Unless such a separation is made, there is no presumption that demographic effects estimated from one price situation will be relevant in another.

In the first stage of our complete demand system the individual decides, given her income, how much to allocate to food, leisure and other goods. In the second stage the leisure consumption is allocated between trips to the West Garda Regional Forest, trips to other natural areas and expenditure on other leisure activities.

If we focus on the visitor's expenditure, we can identify at least three variables significantly affecting patterns of spending: income, prices and the socio-demographic characteristics of the visitor. A demand system which incorporates demographic variables helps to examine these effects at the same time. This chapter attempts to contribute towards that by using a complete demand system within the framework of the almost ideal demand system (AIDS) of Deaton and Muellbauer (1980) modified according to translating demographic transformation. The difficulty in estimating the recreational demand functions for this second stage is that many visitors are observed to have zero demand for trips for sites different from West Garda Regional Forest. The demand equations for the second stage are estimated taking into account this problem of censoring. Ordinary least square estimates become biased because of the censoring. In order to transform the data into a form that mitigates the problem of censoring, we will use the generalized Heckman procedure (Arias et al., 2003).

We also explore the behavioural implications, estimate the demand model and compute the resulting benefits (consumer surplus) of access to the forest. Income and price elasticities provide the information on the visitor's response to income and price changes.

The chapter is organized as follows. Section 2 outlines the approach with a single demand equation and the almost ideal demand system (AIDS) to estimate a complete demand system conditional on leisure consumption. In Section 3 we describe the empirical application to the West Garda Regional Forest in Italy and we present the study site and the data. In Section 4 we report and discuss the results. Section 5 concludes the study. In the Appendix we present two feasible methods of estimation for recreational demand systems of equations with censored variables: the generalized Heckman procedure and the simulated maximum likelihood method (SML).

4.2 ECONOMETRIC MODELS FOR THE TRAVEL COST METHOD CONDITIONAL ON LEISURE CONSUMPTION

We propose the following estimation procedure in two steps. In a first step, we estimate the single demand equation for the visitor to the West Garda Regional Forest and her willingness to pay for a visit to the natural area by estimating the consumer surplus. In a second step, we estimate the complete demand system conditional on leisure consumptions using the almost ideal demand system (AIDS) of Deaton and Muellbauer (1980) and the Heckman procedure, in order to take into account the problem of censored variables, such as the number of trips to alternative sites.

4.2.1 Single Demand Equation Model and Consumer Surplus Estimation

The basic premise of the travel cost method is that the time and travel cost expenses that people incur to visit a site represent the 'price' of access to the site. Thus, people's willingness to pay to visit the site can be estimated based on the number of trips that they make at different levels of expense on travel. The basic idea of the travel cost method (TCM) is that visitors will choose the annual number of trips to a recreational site based on the cost of travelling to the site. The number of trips will be inversely related to the travel costs. Once information on the travel costs and trips taken during one year to a recreational site is obtained from visitors, a demand curve can be estimated.

The general form for the recreational demand for the natural area is:

$$N_i = \alpha(d_i, q_i) + \sum_{j=1}^{J} \gamma_j \ln p_j + \beta \ln y_i + u_i, \tag{4.1}$$

where:

- N_i is the annual number of visits to the natural area by individual $i = \{1, \ldots, K\}$;
- $\alpha = \alpha_0 + \Sigma_{\delta=1}^{\Delta} \alpha_\delta d_\delta + \Sigma_{\theta=1}^{Q} \alpha_\theta q_\theta$ is a linear function reflecting the 'translating' effects of:
  a) the socio-demographic variables $d_\delta = \{d_1, d_2, \ldots, d_\Delta\}$ such as education, sex, occupation, number of family members, number of children under 12, logarithm of the annual expenditure on leisure, logarithm of the willingness to pay a fee in order to preserve the natural area for the present and future generations;
  b) the qualitative variables of the natural area $q_\theta = \{q_1, q_2, \ldots, q_Q\}$ such as the quality of the natural area considering the

characteristics and functions that the respondent could enjoy, level of crowding, place where the survey was conducted;

- $\ln p_1$ is the logarithm of the travel cost per car to visit the area object of study;
- $\ln p_j = \{\ln p_2, \ldots, \ln p_j\}$ is the logarithm of the annual travel cost by car to visit alternative sites j different respect the natural area object of study;
- $\ln y_i$ is the logarithm of the individual i's monthly net income from the previous year;
- u_i is the stochastic term representing both measurement errors and information about the visitor unobservable to the researcher.

This recreational demand model uses count data such as the number of trips to the natural area. Smith (1988) and Shaw (1988) address the sample selection problem with a count variable using the Poisson distribution.

The basic premise of the travel cost method is that the time and travel cost expenses that people incur to visit a site represent the 'price' of access to the site. Thus, people's willingness to pay to visit the site can be estimated based on the number of trips that they make and how much they pay to travel. This is analogous to estimating people's willingness to pay for a marketed good based on the quantity demanded at different prices. The willingness to pay, or consumer surplus, is estimated by calculating the areas below the demand curve and between the actual cost of travelling to the natural area and the maximum cost, above which the number of visits to the natural area is zero.

The consumer surplus (CS) measure of access to good x for consumer i is given by

$$CS_i = \int_{p_0}^{\tilde{p}} x_i(p, y)\, dp, \tag{4.2}$$

where $x(p, y)$ is the Marshallian demand function for individual i, p_0 is the current price and $x(\tilde{p}) = 0$ (Bockstael et al., 1990). Figure 4.1 shows that the consumer surplus is measured as the area to the left of the Marshallian demand curve and between the two prices p_0 and $\tilde{p}$. The consumer surplus is a monetary measure of the willingness to pay of the visitor for a trip to the natural area.

4.2.2 A Complete Demand System Conditional on Leisure Consumption

The analysis of visitor choices takes into account decisions between consumption and leisure, as well the allocation of expenditure over commodities. The study of the disaggregated categories of expenditures

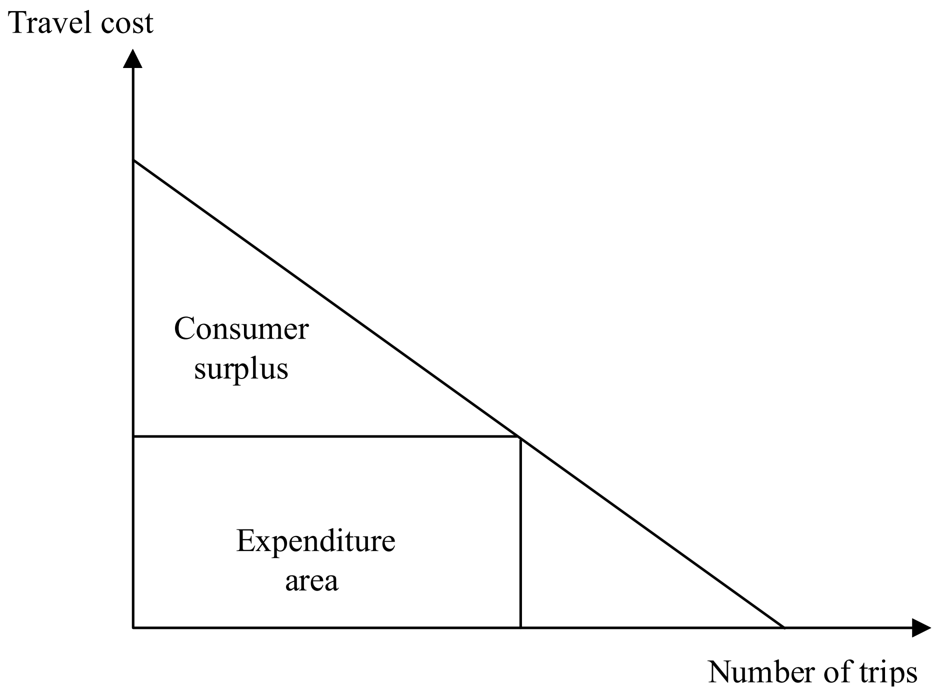

Figure 4.1 Consumer surplus

implies several complementary and substitutability relationships. One solution to this problem is to analyse visitor patterns by the two-stage budgeting procedure (Shenggen et al., 1995).

This procedure assumes that the visitors' utility maximization decision can be decomposed into two separate steps. In the first step, the total income is allocated among broad groups of goods. In the second step, visitors decide how to distribute group expenditure on individual commodities. In this way consumption is partitioned into subsets that include commodities that are closer substitutes or complements among them.

Weak separability is a prerequisite for two-stage budgeting and both a necessary and sufficient condition for estimating the second stage. According to this idea, the marginal rate of substitution among goods belonging to the same group is independent of any other good outside the group. Since it reduces the original problem to a sequence of decisions, the advantage of this approach is that each step requires only information on prices and expenditure at that specific decision level.

Given a weakly separable utility function in a partition of commodities into N groups ($N > 2$), price aggregation is possible if and only if the direct utility function is strongly separable into generalized Gorman polar forms, homothetically separable forms or a combination of the two (Gorman, 1958). We choose a strongly separable utility function, with each group function corresponding to a specific group of commodities and taking the generalized Gorman polar form.

The almost ideal demand system (AIDS) developed by Deaton and Muellbauer is used for the two stages estimation. We estimate the AIDS because it has numerous advantages: it gives an arbitrary first-order approximation to any demand system; it satisfies the axioms of choice; it can be aggregated over consumers without imposing parallel Engel curves (like the linear expenditure system); it has a functional form which is consistent with known household-budget data; it is simple to estimate, largely avoiding the need for non-linear estimation; and it can be used to test the restrictions of homogeneity and symmetry through linear restrictions on fixed parameters (Deaton and Muellbauer, 1980).

The share equation for the AIDS model is:

$$\omega_{i,I} = \alpha_{i,I} + \frac{1}{2}\sum_{j\in I} \gamma_{ij} \log p_{j,I} + \beta_{i,I} \log \frac{E_i}{P_I} + e_{i,I} \tag{4.3}$$

where $\omega_{i,I}$ is the budget share of good i in commodity group I; $e_{i,I}$ is the disturbance term; $p_{j,I}$ is the price of commodity j in group I; E_i is the ith group's total expenditure and P_I is the I-th group price index:

$$\log P_I = \alpha_{0,I} + \sum_{i,I} \alpha_{i,I} \log p_{i,I} + \frac{1}{2}\sum_{i,I}\sum_{j,I} \gamma_{ij,I} \log p_{i,I} \log p_{j,I}, \tag{4.4}$$

with the following restrictions:

homogeneity:

$$\sum_{j,I} \gamma_{ij,I} = 0;$$

adding-up:

$$\sum_{i,I} \alpha_{i,I} = 1; \quad \sum_{i,I} \beta_{i,I} = 0; \quad \sum_{i,I} \gamma_{ij,I} = 0;$$

symmetry:

$$\gamma_{ij,I} = \gamma_{ji,I}$$

The assumption of weak separability between commodities in the different commodity groups implies that the effects of the price change in one commodity group are captured through the group expenditure. Note that in the second stage the I-th group is represented by the leisure expenditure and the i-th commodity is represented by different configurations of leisure expenditure. In this way we define the complete demand system conditional on leisure consumption.

Following Blanciforti et al. (1986) conditional uncompensated price elasticities of commodity i with respect to commodity j's price, in the same group, are

$$\eta_{ij,I} = \delta_{ij,I} + \frac{\gamma_{ij,I}}{\omega_{i,I}} - \frac{\beta_{i,I}\alpha_{i,I}}{\omega_{i,I}} - \frac{\beta_{i,I}}{\omega_{i,I}} \sum_{j\epsilon I} \gamma_{ij,I} \ln p_{i,I},$$

where:

$$\delta_{ij,I} = -1 \text{ } if\, i = J, \;\; \delta_{ij,I} = 0 \text{ otherwise.}$$

We define the conditional expenditure elasticity as:

$$\varepsilon_{i,I} = 1 + \left(\frac{\beta_{i,I}}{\omega_{i,I}}\right)$$

and the compensated elasticity by the Slutsky matrix:

$$\varepsilon^{c}_{ij,I} = \frac{\gamma_{ij,I}}{\omega_{i,I}} - \delta_{ij,I} + \omega_{i,I}$$

Note that there is a close relation between the effects of changes in demographic variables and the effects of changes in total expenditure. A change in any demographic variables (for example, family size) causes a reallocation of expenditure among the consumption categories.

In this chapter demographic effects are introduced into the system of demand equations by the translating method. The model follows the Barten–Gorman approach in that it translates the budget line through the fixed cost element (translating) but it does not consider the scale effect of the Barten–Gorman model that makes it highly nonlinear.

The AIDS budget share with translating effect becomes:

$$\omega_{i,I} = \alpha_{i,I} + \sum_{k\epsilon I} \delta_{k,I} \log d_{k,I} + \frac{1}{2} \sum_{j\epsilon I} \gamma_{ij,I} \log p_{j,I} + \beta_{i,I} \log\left(\frac{E_i}{P_I * \Delta_I}\right) + e_{i,I}, \tag{4.5}$$

where $\omega_{i,I}$ is the budget share of good i in commodity group I; $p_{j,I}$ is the price of commodity j in group I; $e_{i,I}$ is the disturbance term; E_i is the ith group's total expenditure and P_I is the Ith group price index defined in equation (4.4); $d_{k,I}$ is the kth socio-demographic variable for group I; and

$\Delta_I = \Sigma_{k\in I}\delta_{ik,I}d_k \log p_{j,I}$ reflects translating effects of the socio-demographic variables $d_{k,I}$.

Note that the complete demand system is characterized by corner solutions. The expenditure for visits to other sites is zero for a part of the sample. If only nonzero visit observations are used in the parameter estimation, ordinary least square procedures would yield inconsistent estimates from selectivity bias. The generalized Heckman procedure described in the Appendix is employed in this study to circumvent the problem.

4.3 STUDY SITE AND DATA GATHERING

The sample is drawn from the survey conducted by the Department of Economics of the University of Verona in Italy, on the west side of Garda Lake, in June–October 1997. This survey was part of an integrated analysis on the multi-functionality of the West Garda Regional Forest in order to define cooperative policies between institutions, local operators and visitors. The survey took the form of on-site[1] interviews of adult visitors (mean age of 39 years).

This area was picked because it was felt that there would be many single-destination, single-purpose trips, which are a necessary assumption of the travel cost method (TCM) (Freeman, 1993). It was also felt that owing to Garda Lake's popularity with tourists from throughout the country and abroad there would be sufficient variation in distance travelled, time and trip cost.

In order to estimate the complete demand system, several questions were included in the survey to analyse the annual expenditure of the family. The first relevant question for this purpose asked the respondent her mean monthly expenditure on food and leisure including the visit to the West Garda Regional Forest. Questions that solicited information for the second stage of the complete demand system asked the respondent to recall the number of annual trips made to West Garda Regional Forest and the number of trips to other natural areas during the year, to allow screening of the sample between those visitors on single-destination and multiple-destination trips.

In order to have a double check on the declared costs, visitors were asked to specify their place of residence, the distance between the natural area and their residence, the journey time and for those who were on vacation, the distance from the forest to the vacation lodging.

Moreover, the following data were collected for each individual: means of transportation used, number of passengers per means of transportation, how many were the family members and how many shared the expense of the trip; if stops were made at other places before going to the natural area; how many days the trip lasted; individual and family transportation expenditure to go to the forest; individual and family expenditure in food, lodging and activities during the trip. This information was used to construct three travel cost variables:[2] cost per payer (*sppag_rt* – mean value 49.37 euros), cost per car, equal to the cost per payer times the number of paying passengers (*spmac_rt* – mean value 60.12 euros per 2.84 paying passengers), cost per family (*spfam_rt* – in mean 5.5 euros per 3.19 members).

In order to estimate the expenditure on alternative sites the visitor was asked about the distance from their residence, number of visits to each site, the quality of the area and the purpose of the trip.[3]

Moreover note that the head of household will spend more if her family members travel with her. The mean travel distance of a visitor travelling alone is about 185 km, while it is about 250 km if at least one member of the family participates in the trip. Thus, we can separate the sharing of expenditure into two categories:

- *Case 1.* The individual pays their own travel cost themselves, independent of the fact that someone else travels with them.
- *Case 2.* The individual travels only if somebody else shares the travel cost.

The data show that the number of payers is equal to the number of passengers for 35 per cent of the sample (case 1); the remaining 65 per cent is composed by visitors who pay for friends or for family members travelling together (case 2).

4.4 RESULTS

In this section we present first the results of the single demand equation approach and then the results of the AIDS model applied to a complete demand system conditional on leisure consumption. They are examined in detail in the following sections.

4.4.1 Single Recreational Demand Equation Model and Consumer Surplus Estimation

The recreational demand equation was estimated using the Poisson distribution. The variables used in the estimation of the recreational demand equation are described in Tables 4.1 and 4.2. The dependent variable is the annual number of visits to the natural area (*nvai*), which has a mean of

Table 4.1 Definition of the variables in the single equation model

Variable	Definition
nvai	Annual number of visits to the natural area
ln_*clsr*	Log (annual interval income) in euros
ln_*sp*2	Log (annual leisure expenditure) in euros
spm	Travel cost per car in euros
ln_*sp*1*mc*	Log (annual travel cost per car for visits to 1st alternative site) in euros
ln_*sp*2*mc*	Log (annual travel cost per car for visits to 2nd alternative site) in euros
istrz	Education
eta	Age
*brclv*1	Type of job
nmfl	Number of family members
ln_*vltxi*	Log (willingness to pay a tax to preserve the natural area) in euros
area	Place where the survey was conducted
qtai	Quality of the natural area
affl	Level of crowding

Table 4.2 Descriptive statistics for selected variables in the single equation model

Variable	Mean	Std. Dev.	Min.	Max.
nvai	6.823	11.913	1	90
spm	60.101	109.104	1.033	898.635
qtai	7.378	1.255	4	10
affl	4.630	1.672	1	10
ln_*clsr*	9.904	0.519	9.068	11.034
ln_*sp*2	7.515	0.682	5.225	9.127
istrz	12.687	4.084	5	21
eta	39.355	14.321	14	85
area	2.717	1.494	1	6
*brclv*1	3.119	0.771	1	4
nmfl	3.186	1.317	1	8
ln_*sp*1*mc*	1.831	2.311	0	6.023
ln_*sp*2*mc*	0.405	1.936	0	6.166
ln_*vltxi*	1.027	1.908	0	6.142

Note: 361 observations.

Table 4.3 *Poisson estimates of the single demand equation model*

Variable	Coeff.	Std. Dev.	*t*-stat.
constant	3.140	0.512	6.132
ln_*clsr*	0.230	0.050	4.592
ln_*sp*2	0.309	0.034	9.118
spm	−0.007	0.001	−8.127
ln_*sp*1*mc*	−0.034	0.011	−3.123
ln_*sp*2*mc*	−0.023	0.013	−1.784
istrz	−0.023	0.006	−3.873
eta	0.004	0.002	2.566
*brclv*1	−0.220	0.027	−8.170
nmfl	−0.047	0.018	−2.641
ln_*vltxi*	0.053	0.011	4.895
area	0.089	0.013	6.938
qtai	−0.111	0.017	−6.658
affl	0.019	0.012	1.508

Note: 361 observations.

about six trips per year. The independent variables are the logarithm of the visitor's monthly net income of previous year (ln_*clsr*), the logarithm of the annual leisure expenditure (ln_*sp*2), the annual travel cost per car to visit the West Garda Regional Forest (*spm*), the logarithm of the annual travel cost per car to visit the first alternative site (ln_*sp*1*mc*) and the second alternative site (ln_*sp*2*mc*), education (*istrz*), age (*eta*), occupation (*brclv*1), number of family members (*nfml*), logarithm of willingness to pay a tax in order to preserve the natural area for the present and future generations (ln_*vltxi*); quality of the natural area (*qtai*), level of crowding (*affl*) and the place where the survey was conducted (*area*).

The estimated parameters in equation (4.1) are given in Table 4.3. The signs and significance of variable coefficients suggest interesting conclusions.

As expected, the number of visits to the natural area decreases if the travel cost per car (ln_*spm*) and the number of family members (*nfml*) increase (all these variables have a negative sign and are significant at the 5 per cent level); if income (ln_*clsr*), age (*eta*) and the expenditure in leisure (ln_*sp*2) increase then the number of trips increases. These variables have positive and significant coefficient at less than 1 per cent level of significance.

It is interesting to note that the level of crowding of the area (*affl*) is the less significant coefficient (10 per cent level) and has a positive sign. This could mean that visits to the natural area are not significantly affected by

Table 4.4 Willingness to pay (WTP) for a one day visit by single equation demand model (in euros)

WTP per trip and per car (*g*)	71.41
Average number of passengers (*h*)	2.84
WTP per trip and per passenger ($i = g/h$)	25.14
Average number of days of one trip (*l*)	5.78
WTP per passenger and per one day of visit ($m = i/l$)	4.35

the level of crowding because the forest is located in a tourist area on the lake where people come for reasons other then visiting the forest (sailing, swimming, visiting historic centres), so that crowding is not a real problem for the forest. The positive sign could be due to the fact that if a lot of people go to the forest this could mean that it is a valuable place to be visited.

The variables involving travel costs to alternative sites have a negative and significant coefficient. If expenditure on other sites increases then the number of visits to the West Garda Lake decreases. It is interesting to note that the travel cost for the second site (ln_*sp*2*mc*, significant at less than 1 per cent) affects the number of trips to the West Garda Regional Forest less than the travel cost for the first site (ln_*sp*1*mc*, significant at the 10 per cent level).

Another remarkable result is that the number of trips increases if the environmental concern of visitors increases. The coefficient of the variable willingness to pay a tax to preserve the area for the present and future generation is positive and significant at every significant level. Instead the negative and significant coefficients of the variables quality of the area (*qtai*), education (*istrz*) and type of work (*brclv*1) are the opposite of our expectations.

The estimates of consumer surplus experienced by the visitors are listed in Table 4.4. By equation (4.2) we found a consumer surplus per car and per trip of 71.41 euros. Dividing this amount by the average number of passengers and the average number of days per trip we found that the average willingness to pay per one day of visit at the West Garda Regional Forest is about 4 euros. As an indicator of the willingness to pay, the consumer surplus is defined as the difference between the amount an individual would be willing to pay for a good with a constant per-unit price and with a given income, versus the amount actually paid.

4.4.2 Travel Cost Estimate Conditional on Leisure Consumption

According to the idea of complete demand system conditional on leisure consumption in two-stage budgeting, visitors of the West Garda Regional

Forest proceed to allocate total income (ln_*redda*) among the broad groups food (*w*1), leisure (*w*2) and other goods (*w*3). In a second step, visitors decide how to distribute the expenditure for leisure (ln_*sp*2) in trips to West Garda Regional Forest (*w*4), trips to other sites (*w*5) and other leisure (*w*6).

The shares of each good are specified as a system of equations according to the almost ideal demand system (AIDS) described in equation (4.6). The descriptive statistics for the selected variables are presented in Tables 4.5 and 4.6. The shares of the first stage are the ratio between the expenditure of each group and the total annual income. The shares of the second stage are the ratio between the commodity expenditure and the total expenditure on leisure. The independent variables included in the AIDS model are the prices of the commodities of each stage,[4] the demographic variables age and education and, respectively for the first and second stage, the logarithm of annual income and the logarithm of annual leisure expenditure.

Maximum likelihood estimates for the AIDS were obtained using the maximum likelihood routine in the computer package Gauss. Table 4.7 shows the estimated means of the expenditures shares for each good in the first and second stage. The estimated share equations were found to be consistent with the underlying theory.[5]

As indicated in previous sections, effects on the intra-household distribution of expenditures can come through three channels: changes in income, price and demographic variables. They are presented by the budget/income elasticities, the compensated elasticities and the elasticities with respect to the demographic variables. Table 4.8 presents the elasticities for the first stage where the demographic variables are age and education.

It is of interest to examine the cross-price effects. From the Slutsky equation of consumer theory, it is known that compensated cross-price effects must be symmetric in order for the demand functions to be consistent with the utility maximization hypothesis. Note that the elasticity with respect to food price is positive (0.01) and so contrary to our expectation. The elasticities with respect to the price of leisure and other goods are negative, at -0.029 for leisure and -0.052 for other goods.

In line with the economic theory, the income elasticities are positive: 0.153 for the food expenditure, 3.967 for leisure expenditure and 0.614 for the expenditure in other goods.

Note that the complete demand system is characterized by corner solutions in the second stage. The expenditure on visits to other sites is zero for part of the sample. If only nonzero visit observations are used in the parameter estimation, ordinary least square procedures would yield inconsistent estimates from selectivity bias. The generalized Heckman procedure described in the Appendix is applied in this study to circumvent the

Table 4.5 Definition of the selected variables in the complete demand system

Variable	Definition
First Stage	
*sp*1	Annual food expenditure in euros
*sp*2	Annual leisure expenditure in euros
*sp*3	Annual expenditure on other goods in euros (= *redda* − (*sp*1 + *sp*2))
redda	Annual income in euros
*w*1	Food annual share (= *sp*1/*redda*)
*w*2	Leisure annual share (= *sp*2/*redda*)
*w*3	Other goods annual share (= *sp*3/*redda*)
ln*p_w*1	Log food price (= *log* (*sp*1)) in euros
ln*p_w*2	Log leisure price (= *log* (*sp*2)) in euros
ln*p_w*3	Log other goods price (= *log* (*sp*3)) in euros
ln_*redda*	Log (annual income) in euros
eta	Age
istrz	Education
Second Stage	
*sp*4	Annual West Garda Regional Forest visits expenditure in euros
*sp*5	Annual expenditure on other site visits in euros
*sp*6	Annual other leisure expenditure in euros (= *sp*2 − (*sp*4 + *sp*5))
nvai	Annual number of visits to the natural area
*nvai*2	Annual number of visits to other sites
*w*4	Leisure annual share to West Garda Regional Forest (= *sp*4/*sp*2)
*w*5	Leisure annual share to visit other sites (= *sp*5/*sp*2)
*w*6	Other leisure annual share (= *sp*6 / *sp*2)
ln*p_w*4	Log West Garda Regional Forest visits price (= log (*sp*4/*nvai*)) in euros
ln*p_w*5	Log other site visits price (= log (*sp*5)/(*nvai* + *nvai*2)) in euros
ln*p_w*6	Log other leisure price (= log (*sp*6)) in euros
ln_*sp*2	Log (annual leisure expenditure) in euros
eta	Age
istrz	Education
dum	Heckman dummy
*brclv*1	Occupation
*fgs*12	Children under 12
*cdzlv*1	Type of job
distr	Distance of residence from the natural area

Table 4.6 Descriptive statistics for selected variables in the complete demand system

Variable	Mean	Std. Dev.	Min.	Max.
First Stage				
*w*1	0.258	0.144	0.010	0.811
*w*2	0.117	0.085	0.005	0.682
*w*3	0.625	0.181	0.048	0.980
ln*p*_*w*1	8.382	0.579	5.225	10.710
ln*p*_*w*2	7.515	0.682	5.225	9.820
ln*p*_*w*3	9.3743	0.816	6.419	11.014
ln_*redda*	16.815	0.534	15.725	18.027
eta	39.355	14.321	14	85
istrz	12.687	4.084	5	21
Second Stage				
*w*4	0.088	0.143	0.002	0.896
*w*5	0.032	0.063	0.000	0.691
*w*6	0.880	0.163	0.091	0.997
ln*p*_*w*4	3.108	1.286	0.032	6.801
ln*p*_*w*5	2.952	1.199	−2.924	6.061
ln*p*_*w*6	7.355	0.813	3.279	9.792
ln_*sp*2	7.515	0.682	5.225	9.820
eta	39.355	14.321	14	85
istrz	12.687	4.084	5	21
dum	0.568	0.496	0	1
*brclv*1	3.119	0.771	1	4
*fgs*12	0.357	0.724	0	4
*cdzlv*1	2.194	1.664	1	6
distr	0.209	0.316	0.005	2.500

Note: 361 observations.

problem. In order to apply this procedure we create a dummy variable (*dum*) equal to zero when the expenditure for other sites is zero and equal to one otherwise.

Further insights can be gained into the nature of our estimated share equations and their underlying preference ordering by examining the share elasticities. Table 4.9 presents the elasticities for the second stage where we consider the compensated price elasticities, the leisure expenditure elasticities instead of the income elasticity and the elasticities in respect of the socio-demographic variables age and education.

As expected the signs are positive for the compensated elasticities and negative for the elasticites respect to the leisure expenditure. An increase

Table 4.7 Maximum likelihood (ML) and simulated maximum likelihood (SML) estimates of first stage and second stage shares

First Stage		
	Shares (ML)	
	Prediction	Actual
Food	0.242	0.258
Leisure	0.148	0.117
Other goods	0.609	0.625
	Shares (SML)	
	Prediction	Actual
Food	0.286	0.258
Leisure	0.123	0.117
Other goods	0.591	0.625

Second Stage		
	Shares (Heckman)	
	Prediction	Actual
Trips to West Garda Regional Forest	0.095	0.088
Trips to other sites	0.024	0.031
Other leisure activities	0.881	0.880
	Shares (SML)	
	Prediction	Actual
Trips to West Garda Regional Forest	0.126	0.088
Trips to other sites	0.258	0.031
Other leisure activities	0.616	0.880

Note: 361 observations.

of the leisure expenditure of 10 per cent corresponds to an increase of 55.2 per cent in the expenditure for trips to West Garda Regional Forest and of 52.48 per cent in the expenditure on other leisure activities. The Slutsky condition is satisfied since the compensated elasticity matrix has all the elements of the main diagonal negative.

Table 4.8 Elasticities for first stage of the complete demand system

	Compensated elasticities		
	Food	Leisure	Other goods
Food	0.010	−0.029	0.019
Std. Dev.	0.014	0.007	0.010
t-stat.	0.728	−3.972	1.822
Leisure	−0.048	−0.135	0.183
Std. Dev.	0.012	0.009	0.011
t-stat.	−4.076	−15.241	17.095
Other goods	0.008	0.045	−0.052
Std. Dev.	0.004	0.002	0.004
t-stat.	1.805	17.753	−12.212
	Income elasticities		
	Food	Leisure	Other goods
Annual Income	0.153	3.967	0.614
Std. Dev.	0.041	0.046	0.014
t-stat.	3.694	86.601	43.639
	Socio-demographic elasticities		
	Food	Leisure	Other goods
Age	0.004	0.001	−0.002
Std. Dev.	0.005	0.002	0.019
t-stat.	0.885	0.305	−0.110
Education	0.003	−0.017	0.003
Std. Dev.	0.005	0.018	0.007
t-stat.	0.517	−0.927	0.421

Note: 361 observations.

4.5 CONCLUSIONS

In this chapter we explored two issues in empirical recreational demand analysis: first, the estimation of a single recreational demand equation and the consumer surplus of a visitor to the West Garda Regional Forest in Italy; second, the estimation of complete demand systems of demand equations conditional on leisure consumption.

This study on recreational demand has applied the travel cost technique to the West Garda Regional Forest for the first time. The visits to the natural

Table 4.9 Elasticities for second stage of the complete demand system by Heckman procedure

	Compensated elasticities		
	Trips to West Garda Regional Forest	Trips to other sites	Other leisure
Trips to West Garda Regional Forest	−0.342	0.095	0.247
Std. Dev.	0.022	0.037	0.035
t-stat.	−15.401	2.570	7.114
Trips to other sites	0.381	−0.360	−0.012
Std. Dev.	0.096	0.192	0.184
t-stat.	3.987	−1.926	−0.064
Other leisure	0.027	−0.000	−0.026
Std. Dev.	0.004	0.005	0.003
t-stat.	7.094	−0.066	−8.085
	Income elasticities		
	Trips to West Garda Regional Forest	Trips to other sites	Other leisure
Leisure Expenditure	5.520	5.248	0.398
Std. Dev.	0.205	1.537	0.018
t-stat.	26.865	3.415	22.425
	Socio-demographic elasticities		
	Trips to West Garda Regional Forest	Trips to other sites	Other leisure
Age	0.010	0.123	−0.004
Std. Dev.	0.019	0.003	0.351
t-stat.	0.531	47.491	−0.013
Education	0.025	0.232	−0.009
Std. Dev.	0.111	0.070	0.009
t-stat.	0.228	3.312	−1.048

Note: 361 observations.

area produce a high value of consumer surplus to the users, 25 euros per trip per person. The corresponding willingness to pay per day is about 4 euros.

This chapter has presented a recreational demand model that exploits the notion of separability to derive a two-stage demand system conditional on leisure consumption. Visitors to the West Garda Regional Forest proceed to allocate total income among the broad groups food, leisure and other goods. In a second step, visitors decide how to distribute the expenditure for leisure in trips to the West Garda Regional Forest, trips to other sites and other leisure activities.

The complete demand system has two principal advantages over existing valuation models in the literature. First, by incorporating the budget constraint into the analysis, the complete system approach forces recognition of the fact that an increase in expenditure on one consumption category (such as recreation, for our purposes) must be balanced by decreases in the expenditure on others. Second, the complete system approach permits the separation of demographic effects from own and cross-price effects as well as income effects. Unless such a separation is made, there is no presumption that demographic effects estimated from one price situation will be relevant in another.

The economic results are presented in the context of the almost ideal demand system (AIDS) of Deaton and Muellbauer (1980) modified into a Gorman form by translating the demographic effect of the socio-demographic variables. The resulting demand coefficient estimates suggest the empirical tractability of estimating a complete demand system for a visitor to a natural area combining information about the travel cost and a priori information from consumer theory about the expenditure on leisure by the visitor. The proposed approach may be especially useful in disaggregate demand analysis.

Estimation of demand functions provides us with the means to calculate income and price elasticities. The measurement of income and price elasticities is necessary input to the economically optimal design of many different policies. For example, efficient policy design for indirect taxation and subsidies requires knowledge of these elasticities for taxable commodities and services (Deaton, 1988).

An aspect of the AIDS which has made it attractive is its simplicity. In the empirical estimation of the Engel curves of some commodities, non-linearities appeared to be important. For instance, Banks et al. (1997) show that the Engel curves for clothing and alcohol in the UK are non-linear in the logarithm of expenditures. Since the AIDS demand curves are linear in the logarithm of expenditures, they are not appropriate for the estimation of these Engel curves. We suggest in the future estimating the expenditure share using the quadratic almost ideal demand (Banks et al., 1997).

Note finally that individuals, and not households, have utility. What is relevant is not the preferences of a given household, but rather the preferences of the individuals that compose it (Browning et al., 2003). Estimation of comparisons at the individual level following the earlier literature about the collective approach to household behaviour proposed by Browning et al. (2003) are left for future research.

APPENDIX: ECONOMETRIC METHODS FOR CENSORED VARIABLES

The difficulty in estimating recreational demand functions is that a proportion of the population in a given geographical region are likely to be non-participants in the alternative recreational areas. That is, they are observed to demand zero trips. We are interested in a problem in which many people demand zero trips for alternative sites.

There are many examples in economics of models that can be represented by systems of equations with several censored variables: systems of demand equations where some consumers choose not to buy several of the goods in the system (Wales and Woodland, 1983; Phaneuf, 1999; Perali and Chavas, 2000); systems of input demand and supply equations where firms choose not to produce several outputs or not to use several inputs in the system (Huffman, 1988); systems with censored prices (Arias and Cox, 2001) or models of labour supply (Heckman, 1974).

We present two methods of estimation for systems of equations with censored variables: the generalized Heckman procedure and the simulated maximum likelihood method (SML).

The generalized Heckman procedure is an extension to a system of equations of the two-step Heckman estimator (Heckman, 1974 and 1979), while the simulated maximum likelihood method (Hajivassiliou et al., 1996; Arias and Cox, 2001) uses multiple integrals that are computed with a simulated algorithm to reproduce the statistical process that generated the zero realizations.

Generalized Heckman Procedure

The generalized Heckman procedure consists of transforming the system of censored equations into a system of uncensored equations by using the appropriate correction. Following Arias et al. (2003), we consider the unconditional mean:

$$\begin{aligned} E[y_i|x_{it}] &= E[y_i|y_i > 0]\,\Phi\left(\frac{f_i(x_i, \beta_i)}{\sigma_i}\right) \\ &= f_i(x_i, \beta_i)\,\Phi\left(\frac{f_i(x_i, \beta_i)}{\sigma_i}\right) + \sigma_i\phi\left(\frac{f_i(x_i, \beta_i)}{\sigma_i}\right), \end{aligned}$$

where, ϕ and Φ are respectively the probability density function and the cumulative density function of a standard normal distribution, y_i is the endogenous variable corresponding to the i-th equation in the censored system, x_i is a vector of explanatory variables, β_i is a vector of parameters. Using the expression for the unconditional expected value of each endogenous variable we consider the following system of uncensored equations:

$$y_i = f_i(x_i, \beta_i)\,\Phi\left(\frac{f_i(x_i, \beta_i)}{\sigma_i}\right) + \sigma_i \phi\left(\frac{f_i(x_i, \beta_i)}{\sigma_i}\right) + \xi_i,$$

where $\xi_{it} = y_{it} - E[y_i | x_{it}]$. This system can be estimated by limited maximum likelihood assuming that:

$$\xi \sim MVN(0, \Omega)$$

where, ξ is a random vector whose i-th element is ξ_i. An important detail stressed by Arias et al. (2003) is that this is a straightforward maximum likelihood estimation since the latter system does not contain any censored equation. We use this approach to generate reasonable starting values for the method of simulated maximum likelihood.

Simulated Maximum Likelihood Method

Following Arias and Cox (2001) the likelihood function for an observation in which the n first endogenous variables out of m are censored is:

$$\begin{aligned} L_2 &= \int_{-\infty}^{c1} \ldots \int_{-\infty}^{cn} \mathrm{d}f(u_1, \ldots, u_m)\, du_1 \ldots du_n \\ &= df_1(u_{n+1}, \ldots, u_m) \int_{-\infty}^{c1} \ldots \int_{-\infty}^{cn} cf(u_1, \ldots, u_n | u_{n+1}, \ldots, u_m)\, du_1 \ldots du_n \end{aligned}$$

where df_1 is the marginal probability density function of the uncensored portion and cf is the probability density function of the censored variables conditional on the uncensored ones. This expression represents a portion of the likelihood function with an n-dimensional definite integral. Under the assumption of multivariate normality of the disturbances of the system, this integral does not have a close form solution. Therefore, estimating the system of equations by maximum likelihood requires an efficient method for evaluating the high dimensional definite integrals.

Simulated maximum likelihood consists of simulating rather than calculating these integrals using probability simulation methods, which are based on the fact that the integral of interest represents the probability of an event in a population (Lerman and Manski, 1981; Stern, 1992; Börsh-Saupan and Hajivassiliou, 1993; Hajivassiliou et al., 1996).

Table 4.10 Elasticities for second stage of the complete demand system by simulated maximum likelihood method (SML)

	Compensated elasticities		
	Trips to West Garda Regional Forest	Trips to other sites	Other leisure
Trips to West Garda Regional Forest	−0.347	0.082	0.265
Std. Dev.	0.023	0.019	0.018
t-stat.	−15.070	4.397	14.524
Trips to other sites	0.237	−0.523	0.285
Std. Dev.	0.052	0.056	0.045
t-stat.	4.561	−9.389	6.402
Other leisure	0.029	0.011	−0.030
Std. Dev.	0.002	0.002	0.002
t-stat.	12.293	4.874	−18.347
	Income elasticities		
	Trips to West Garda Regional Forest	Trips to other sites	Other leisure
Leisure expenditure	5.430	3.019	0.441
St. Dev.	0.180	0.350	0.009
t-stat.	28.622	8.616	45.003
	Socio-demographic elasticities		
	Trips to West Garda Regional Forest	Trips to other sites	Other leisure
Age	0.008	0.059	−0.003
Std. Dev.	0.020	0.002	0.168
t-stat.	0.423	30.846	−0.019
Education	−0.021	0.247	−0.003
Std. Dev.	0.040	0.074	0.007
t-stat.	−0.428	3.333	−1.033

Note: 361 observations.

We present the estimated elasticities for the second stage of the complete demand system conditional on leisure consumption using simulated maximum likelihood method (Hajivassiliou, 2000; Arias and Cox, 2001) in Table 4.10. Table 4.7 presents a comparison of the estimated shares of the first and second stage of the complete demand system applied to the travel cost estimate. We conclude that SML is the preferable approach to the censored variable problem.

NOTES

* The views presented here are those of the authors and do not necessarily represent the views or policies of the Economic Research Service or the United States Department of Agriculture.

1. Visitors were interviewed in the following places: Passo Spino (27.98 per cent of the respondents), Valvestino (17.17 per cent), Tignale (30 per cent), Tremosine (12.47 per cent), Tremalzo (4.16 per cent) and others ones (8 per cent). There were 400 respondents but after skimming the actual sample consists of 361 observations.
2. Every travel cost variable comprehends the opportunity cost of time spent travelling to the natural area. Several studies apply and compare different values to estimate the opportunity cost of time (for example, Cesario, 1976; McConnell and Strand, 1981; Johnson, 1983; Smith et al., 1983; Chavas et al., 1989; Bockstael et al., 1990; McKean et al., 1996). In this study we evaluate travel time at one-third of the wage rate (Cesario, 1976).
3. There may be some concern over how accurately the respondent can recall the information above. Champ and Bishop (1996) found recall bias is less likely to be a problem with questions on total expenditures but it is thought to be a common problem with questions on the number of trips.
4. We use the logarithm of the expenditure as an approximation of the price for each commodity.
5. Estimated parameters of the AIDS in equation (4.5) are available on request.

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