'Individual' versus 'Household' in Recreational Demand Models

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Abstract. This study proposes a novel approach to estimating a recreational demand model that accounts for intra-household resource allocation. The technique is based on an analogy borrowed from the literature of collective household behavior and, in particular, on Browning, Chiappori and Lewbel (2006)'s model. We formulate a collective recreational demand model that takes into account the role of each member's preferences for consumption choices and that depends on how disposable income is divided within the household. This model identifies the Consumer Surplus for each household member and the allocation of resources within a household by a consumption technology function, which summarizes all of the technological economies of scale and scope that result from living together, and by using information about the consumption of individuals living alone as if they were living in a household. Finally, we show that husbands and wives have significantly different recreational demands. This implies that observations for husbands and wives may not be treated as identical as in the traditional recreational demand model (unless one spouse is the dictator) and that the collective setting is a plausible next step to take in the analysis of recreational demand models.

1.   Introduction

Cost-benefit analysis has to be often applied when a change in policy affects the availability or the quality of environmental resources. It has been recognised that the value of these goods is not explicitly determined through market transactions and it is difficult to establish a monetary value for their access because of the absence of markets.

Economists have answered this challenge by developing alternative methods of valuing non-market goods. The Travel Cost Method (TCM) by Clawson and Knetsch (1966) aggregates visitors to a recreational site into their zones of origin and it explains the change in visitors rates from each zone by the travel cost, the income, the socio-demographic characteristics of visitors and the characteristics of the alternative sites. More research has provided extensions to the original Travel Cost Method. Research shows efficiency gains in estimating recreational demand models using the observations of individuals themselves rather than traditional zone averages (e.g. Brown and Nawas, 1973; Willis and Garrod, 1991).

We argue that these models treat the term 'household' and 'individual' as synonyms. A household is defined by Becker (1965) as a 'small factory.' It consists of individuals motivated sometimes by self-interest, other times by altruism and often by both, or as if they agree on the best way to combine capital

goods, time and home production activities. Traditional recreational models focused on defining a household as having the same utility level as a single individual, implying that intra-household resource allocation is irrelevant, or that it can be addressed within a dictatorial decision process.

In particular, the traditional Travel Cost Method is limiting in that it can reveal consumer preferences for non-market goods by only capturing family behavior. It assumes that a household acts as an elementary decision making unit. This approach is referred to as 'unitary.' However, a household consisting of several members does not necessarily behave as a single agent and individuals have utility, not households (Browning, Chiappori and Lewbel, 2006).

In the recreational framework, consider, for example, the case of a married couple going to visit a natural park together and the case of an individual living alone who goes to visit the natural area. The main question to ask should be, 'how much is an individual living alone willing to pay to attain the same indifference curve over goods as an individual attains, for those goods, as a member of the household?'

The utility of this study can be derived from the observation that within households choices are affected by the presence of other household members. In addition, usually only the household's total purchases are observed in recreational surveys and not their distribution and use among members. Thus we have to identify the individual's preferences and since the distribution of

resources within the household is not usually recorded, it has to be identified from the aggregate household demand. In order to identify the individual preferences we can use either information on exclusive goods consumption by individuals living in the same households (Chiappori 1988's approach), or information about the consumption of individuals living alone as if they were living in the family (Browning, Chiappori and Lewbel, 2006's approach). Note that from this point we will refer to them as BCL.

Still, a comprehensive study of a collective model applied to recreational demand models does not exist. This study proposes a novel approach to estimating a collective recreational demand model that accounts for intra-household resource allocation. The technique is based on an analogy borrowed from the literature of collective household behavior and, in particular, on the BCL' model. Thanks to the BCL model, combining data from households and from people living alone and by a consumption technology function, we can completely identify the sharing rule that expresses the bargaining power between household members and the Consumer Surplus (CS) for each household member. The consumption technology function summarizes all of the technological economies of scale and scope that result from living together.

Finally, we test for differences in recreational demands between husbands and wives by using cross sectional data from a recreational survey. We find that husbands and wives have significantly different recreational demands. This

implies that observations for husbands and wives may not be treated as identical as in the traditional recreational demand model (unless one spouse is the dictator). We also found that in absolute value the Consumer Surplus estimate derived from the traditional model appears to overestimate the Consumer Surplus of husbands and underestimate the Consumer Surplus of wives, and that wives have significantly higher Consumer Surplus than husbands for access at the West Garda Regional Forest.

The paper is organized as follows: Section 2 presents an overview of the literature on individual versus household in non-market valuation and the collective nature of household decisions. Section 3 outlines the BCL model's basic structure; it presents the traditional recreational demand model and it derives our extension of the BCL model to the recreational demand model. Section 4 provides some evidence of significant differences in recreational demand and Consumer Surplus between husbands and wives. The last section summarizes and discusses the welfare implications of the framework for collective household model with suggestions for future research.

2. Literature Review

It is by now accepted that the distinction between individual and household in recreational models matters. In the context of Contingent Valuation, Quiggin (1998) considers whether the Willingness-To-Pay (WTP) for the benefit

generated by a public good should be elicited on an individual or a household level. He finds that there may be some differences between individual and household WTP when household members are mutually altruistic. Munro (2005) shows that the household and the individual WTP are equal if and only if the household pools income.

Other authors (e.g. Haab and McConnell, 2002; Bockstael and McConnell, 2006) recognize that they ignore the distinction between household and individual in their work. In particular Bockstael and McConnell (2006) note that 'the distinction between the individual and the household is a difficult one for which there is, to date, no adequate treatment. In the original paper on household production, Becker treated the household as the decision making unit, suggesting that intra-household allocations of consumption and production activities would be made 'optimally' (p.512). In the forty years since that paper, little progress has been made in explaining this intra-household allocation process or in reconciling the distinction between the household as decision maker and the individual members as consumers. We continue to use the terms individual and household interchangeably, but recognize that embedded in their distinction are potentially important considerations' (p. 8, Chapter 4).

Smith (1988) compares five methods for estimating travel cost recreation demand models with microdata and argues that a component of research strategy should involve 'systematic effort at understanding how individuals make their

recreation choices and whether these are adequately described by any of these models' (p.35).

In the framework of revealed preferences, the only papers that we could find specifically addressing these issues are McConnell (1999), Smith and Van Houtven (1998, 2004) and Dosman and Adamowicz (2006).

McConnell (1999) states that the fact that many studies do not distinguish between individual and household makes the empirical estimates ambiguous. Further, 'economists need to think carefully about the individual versus the household in designing surveys and in measuring welfare' (p. 466). He attempts to address this issue by developing a recreational model based on two individuals (spouses) sharing income, household production and earning different wages. The limit in this approach is that the basic structure of the model is the unitary model that assumes income pooling, that a household has a single utility function and that there is not bargaining and intra-household allocation of resources between household members.

Dosman and Adamowicz (2006) examine the choice of two spouses for a vacation site. They investigate intra-household bargaining using stated and revealed preference data. They overcome the problem that individual preferences for the site are not observed by using stated preference methods. They ask each partner to make choices in a stated preference experiment and they use these choices to develop estimates of the spouses' preference parameters. Then they

construct a bargaining model where the household utility is defined as the weighted average utility of partners' preferences. Since the household decision about the vacation site is observed, they estimate the bargaining parameter as the value that provides the best fit between the actual household choice and the weighted utility. They find that the probability that the household will choose the husband's favorite vacation site is decreasing as the husband's income is increasing. While the wife's power for the vacation site decision is increasing as the partner's income is increasing. An explanation of this result is that the opportunity cost of time for the husband is higher and he spends less time in planning the vacation.

Smith and Van Houtven (1998, 2004) focus on the collective model by Chiappori (1988, 1992). They extend Chiappori's model for recovering Hicksian welfare measures. They describe how it affects non-market valuation of price and quality changes but they do not provide any empirical application.

Chiappori (1988) proposes the first collective model, which is a static labor supply model. This model assumes that the objective function of the household is the weighted sum of the utility functions for each member's preferences. The weights represent the bargaining power of the household members in the intrahousehold allocation process. The rule that determines the sharing of total expenditure on private goods within the household is defined as 'sharing rule'. The bargaining power is affected by exogenous variables, such as wages and

non-labor income, and by other variables called 'distribution factors' (Browning et al., 1994), which influence the decision process without affecting either the utility function or the budget constraint. Examples of distribution factors are tax laws that differ according to marital status and divorce law. Changes in these variables may effect outside opportunities of the household members and may have consequences in their bargaining power within the household. An increase in an individual's non-labor income may shift bargaining power from one individual to the other and this affects the allocation of household consumption and labor supply (see Vermeulen, 2002 and Browning, Chiappori and Lechene, 2006 for a detailed overview of collective models).

In Chiappori's model and consequently in Smith and Van Houtven (1998, 2004)'s approach the sharing rule is identified up to a constant and it is estimated by using information on two exclusive goods privately consumed. Smith and Van Houtven consider the case of a two-member household where each individual consumes two private goods and in addition each person consumes one of these goods exclusively, for example sport fishing and swimming in the ocean. Finally, both members consume a third private good. They analyze the case where one member engages in a specific recreational activity affected by a change in environmental quality, and the other member does not. The authors do not investigate the case where both household members are affected by the change in

environmental quality. They point out that it is still possible to recover individual preferences but that the problem is more complicated.

Browning, Chiappori and Lewbel (2006) propose an alternative approach that does not use consumption of exclusive goods but household's consumption aggregate data of singles and couples. BCL show how to completely identify joint consumption and the allocation of resources within a household by a consumption technology function and the sharing rule. 'The idea of the consumption technology function is that features of household consumption such as economies of scale or scope, joint use of resources, etc., can be defined as a technology that describes the set of options for the joint consumption of goods that are available to household members' (BCL, p.5). BCL's framework is similar to Becker (1965) model, except that instead of using market goods to produce commodities that contribute to utility, the household produces the equivalent of a greater quantity of market goods via sharing (BCL).

BCL assume that individual's preferences for goods do not change when they marry but they emphasize that this assumption does not mean that once married individuals consume the same bundles as singles because of the economies of scales and scope in consumption in a couple. This assumption also does not exclude that individuals can get utility from marriage. What it implies is that the indifference curves of single men or women living alone are the same as the indifference curves associated with the utility functions of the individuals in a

couple (BCL). If this assumption holds, then the demand functions of household members can be estimated directly by observing the consumption behavior of single men and women. However, BCL also show how to overcome the assumption that tastes do not change. First, they identify the demand functions for singles, then they parameterize how preferences change because of marriage and finally, they use couple's data to estimate the parameters of the change in preferences, the consumption technology and the sharing rule.

3.   Models

3.1   The Benchmark Model: Browning, Chiappori and Lewbel (2006)'s Model

In this section we present BCL (2006)'s model of household behavior as the benchmark model that we use to develop a collective recreational demand model. BCL consider two cases: when the individual is living alone ('single') and when the individual is a household member ('couple'). This allows them to use the demand data of people living alone to identify individual preferences and to use household data to identify the consumption technology and the sharing rule.

When the individual i is living alone the optimisation problem is

$$Max\ U^i(\mathbf{z^i})\ \text{subject to}\ y^i = \mathbf{pz}^i \qquad (1)$$

where the utility function U^i is monotonically increasing, continuously twice differentiable and strictly quasi-concave; y^i is the exogenous income of individual i; $\mathbf{p}$ is the vector of prices of the goods $\mathbf{z}^i$. The solution is the vector of Marshallian demands $\mathbf{z^i_m}(\mathbf{p} / y^i)$. The corresponding indirect utility function is defined as

$$V^i(\mathbf{p} / y^i) = U^i(\mathbf{z^i_m} (\mathbf{p} / y^i)) \qquad (2)$$

Then, BCL consider the case where individual i is member of a household that consists of a couple living together ($i = f$ or m). The couple's utility maximization problem is

$$Max\ U[U^f(\mathbf{x^f}),\ U^m(\mathbf{x^m}),\ \mathbf{p} / y]\ subject\ to\ \mathbf{x} = (\mathbf{x^f} + \mathbf{x^m}),\ \mathbf{z} = F(\mathbf{x}),\ \mathbf{p'z} \leq y$$

$$(3)$$

where $\mathbf{z}$ is the vector of inputs that the couple purchases; $\mathbf{x,}$ $\mathbf{x^f}$ and $\mathbf{x^m}$ are the quantities of the goods $\mathbf{z}$ respectively consumed by the household and privately by each household member; $\mathbf{p}$ is the vector of market prices; y is the household total income and F is the consumption technology function. The transformation from $\mathbf{z}$ to $\mathbf{x}$ embodied by the function F is intended to summarize all of the technological economies of scale and scope that result from living together. Consider the example of BCL (p. 10): 'Let good j be automobile use, measured by distance travelled (or some consumed good that is proportional to distance, perhaps gasoline). If x_j^f and x_j^m are the distances travelled by car by each

household member, then the total distance the car travels is $z_j = (x_j^f + x_j^m) / (1 + r)$ where r is the fraction of distance that the couple rides together. This yields a consumption technology function for automobile use of $z = x / (1 + r)$.'

Note that this framework is similar to a Becker (1965) type household production model but with the following main difference: the production function combines the inputs and generates the output, while the consumption technology function transforms the output **x**, that is what the individuals consume, into the inputs **z** that are purchased by the individuals. Thus $F(x)$ can be interpreted as an inverse production function[1].

Further, note that U is a twice differentiable utility function that can be interpreted as 'a social welfare function for the household', in which each household member has different bargaining power. In BCL the bargaining function U depends on the relative incomes of the household members, and each household member's utility U^i also depends on demographic characteristics. Following Chiappori (1988, 1992), the utility function U can be written as the weighted sum of the utility functions for each member's preferences

$$U[U^f(\mathbf{x^f}), U^m(\mathbf{x^m}), \mathbf{p} / y] = \mu(\mathbf{p} / y) U^f(\mathbf{x^f}) + U^m(\mathbf{x^m}), \qquad (4)$$

where the weight μ represents the bargaining power of the household members in the intrahousehold allocation process. Individual m receives a weight of one and individual f a weight of μ in determining the intrahousehold decisions. The larger

μ is the larger the bargaining power of member f and therefore the larger the quantities $\mathbf{x^f}$ consumed by member f with respect to the quantities consumed by member m. As BCL note, one limit using μ is that it will depend 'on the arbitrary cardinalizations of functions U^f and U^m'. The interesting contribution of BCL that distinguishes their work from Chiappori (1988, 1992) is the introduction of 'the sharing rule' φ, which 'does not depend upon any cardinalization.' The sharing rule describes the allocation of resources among household members. BCL specify the sharing rule as a function of distributional variables $\mathbf{d}$ that affect the bargaining power, such as the wife's share of total gross income, the difference in age between husband and wife, or the log household total expenditure deflated by a Stone price index. Note that instead the approach followed by Chiappori (1988, 1992) identifies the sharing rule up to a constant.

The BCL's model for φ follows the logistic form

$$\varphi = exp(\mathbf{d'\gamma}) / [1 + exp(\mathbf{d'\gamma})] \qquad \text{with } 0 \leq \varphi \leq 1 \qquad (5)$$

where $\mathbf{d}$ is a vector of distributional variables and ϕ is a vector of parameters.

The household's behavior is equivalent to allocating the fraction of shadow income $\varphi^f = \varphi$ to member f, and the fraction of shadow income $\varphi^m = (1 - \varphi)$ to member m.

Each member i maximizes their own utility function $U^i(\mathbf{x^i})$ subject to the budget constraint $\phi^i = \pi'\mathbf{x}^i$. The maximization problem for each household member is

$$\text{Max } U^i(\mathbf{x^i}) \text{ subject to } \phi^i = \pi'\mathbf{x^i} \qquad (6)$$

where π is the shadow price vector for the individual i's private good $\mathbf{x^i}$ and η^i is the individual i's shadow income. BCL show that by homogeneity the price vector π can be normalized such that $\pi'\mathbf{x} = 1$, $\varphi = \varphi^f = \pi'\mathbf{x^f}$ and $\varphi^m = (1 - \varphi)$. The sharing rule is the fraction of the household's shadow income that is allocated to member f. Note that the household purchases the vector $\mathbf{z} = F(\mathbf{x^f} + \mathbf{x^m})$.

For simplicity BCL assume a Barten type technology function[2], defined as $\mathbf{z} = \mathbf{Rx}$, equivalent to the linear technology $\mathbf{z} = \mathbf{Rx} + \mathbf{a}$ when the matrix $\mathbf{R}$ is diagonal and $\mathbf{a}$ is a vector of zeros. In this case the constraint $\mathbf{p'z} = y$ becomes $\mathbf{p}'(\mathbf{Rx}) = y$. Since $\pi'\mathbf{x} = 1$, the shadow prices for this technology are

$$\pi = \mathbf{R'p}/y, \qquad (7)$$

where the couple faces market price $\mathbf{p}$ and total income y.

The second welfare theorem implies that the individual, facing price π and income η^i, will choose the bundle $\mathbf{x^i}$. The solution to the utility maximization problem is a set of Marshallian demands equal to

$$\mathbf{x_m^i}(\pi(\mathbf{p}/y)/\varphi(\mathbf{p}/y)) = \mathbf{x_m}^i\left(\frac{\mathbf{R'p}}{y}\frac{1}{\varphi(\mathbf{p}/y)}\right), \qquad (8)$$

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which yields the indirect utility function $V^i\,(\pi\,/\,\varphi).$ [3]

Then, since $\pi = \mathbf{R'p}\,/\,y$, the household actually purchases the vector $\mathbf{z}$ that becomes

$$\mathbf{z} \;=\; \mathbf{Rx_m}^{f}\!\left(\frac{\mathbf{R'p}}{y}\,\frac{1}{\varphi(\mathbf{p}/y)}\right)+\mathbf{Rx_m}^{m}\!\left(\frac{\mathbf{R'p}}{y}\,\frac{1}{1-\varphi(\mathbf{p}/y)}\right) \qquad (9)$$

The relationship between the weight μ and the sharing rule φ can be written as

$$\mu = -\frac{\left(\partial V^{f}\left(\pi/\varphi\right)/\partial\varphi\right)}{\left(\partial V^{m}\left(\pi/1-\varphi\right)/\partial\varphi\right)} \qquad (10)$$

where V^i is the indirect utility function of member i (see BCL p. 13 for a formal proof).

Note that one advantage of BCL model respect Chiappori (1988, 1992)'s model is that using data from households and from singles living alone, the sharing rule is completly identified. BCL empirically estimate simultaneously a joint system consisting of a vector of budget shares for singles and a vector of budget shares for couples. They can do so because all the parameters in the singles model appear in the couples model. They use the demand data of people living alone to identify individual preferences, thereby leaving the job of identifying the consumption technology and the sharing rule to household data.

3.2   Traditional Recreational Demand Model

In the traditional literature of recreational demand the terms 'individual' and 'household' are used interchangeably. Traditional analysis models the household as it was a single individual. The allocation of the resources among its members is ignored.

Following Bockstael and McConnell (2006), individuals maximize utility U which is a function of the number of trips (n) taken to a site[4], environmental quality at the site (q) and a composite commodity (b). The number of trips is produced using inputs **s** such as gasoline, food and lodging. First, note that the number of trips is a weak complement with the environmental quality: q does not affect the individual's utility if she does not go to the site ($n = 0$); second, note that some of the goods that compose the vector **s** are exclusive for the individual (for example sunscreen lotion for women and fishing equipment for men) and others are consumed and shared between members of the trip (for example gasoline and food), but for the moment, following the traditional literature, we assume that each individual that shares these goods consumes the same amount of them.

Then, consider the time constraint that limits the amount of time that can be spent on leisure activities. As Bockstael and McConnell (2006) emphasize, not considering the time cost term in the demand function would produce a biased

estimated cost coefficient that leads to an underestimate of the Consumer Surplus for access to the site. Then, the individual's optimisation problem is

Max U(n, b; q) subject to $y + wL \geq \mathbf{ps} + b$, $T \geq L + t\,n$ and $g(n, \mathbf{s}) = 0$ (11)

where y is exogenous non-wage income, w is the after-tax wage rate, L is the total number of hours spent working, p is the vector of prices of the inputs **s**, T is the total available time to the individual, t is the time cost of access to the recreational site, b is the price of the composite commodity normalized to 1 and $g(n, \mathbf{s})$ is the household production technology. As Bockstael and McConnell note, $g(n, \mathbf{s})$ implies a cost function that is the solution of the cost minimization problem

$$C(n, p) = min_s \{\mathbf{ps} \mid g(n, \mathbf{s}) = 0\} \qquad (12)$$

and if the cost function is linear in n than the marginal cost per trip equals the average cost per trip $c(\mathbf{p})$. The maximization problem becomes

Max U(n, b; q) subject to $y + wL \geq c(\mathbf{p})n + b$ and $T \geq L + t\,n$.   (13)

Since we assume that the individual can choose how to allocate his time between work (L) and leisure (t) the two constraints can be combined into one:

Max U(n, b; q) subject to $[y + wT - n(c(\mathbf{p}) + wt) - b] \geq 0$,   (14)

which leads to the Marshallian demand $n_m(c, q, w, T, y)$.

In the traditional Travel Cost Method the value of the site, which can be interpreted as the Willingness-To-Pay of the individual to access to the site, is

derived by calculating the individual's Consumer Surplus (CS). The individual's Consumer Surplus is the area behind the Marshallian demand for trips to the site

$$CS = \int_{c_0}^{\varsigma} n_m(c, q_0, w, T, y)\, dc \, , \tag{15}$$

where c_0 is the observed level of constant marginal cost to produce trips n and ς is the choke price of the trip: $n_m(\varsigma) = 0$.

Further, to be useful for policy purposes, the estimated Consumer Surplus can be aggregated across the population of recreational users. The total economic value of the site can be estimated as the sum of the Consumer Surplus of each individual going to the site:

$$CS = \sum_{i}^{K} \int_{c_{0,i}}^{\varsigma_i} n_{im}(c_i, q_0, w_i, T, y_i)\, dc \tag{16}$$

where K is the total number of site users.

3.3   Collective Recreational Demand Model

In this section, we develop a collective recreational demand model applying the collective model of household behaviour of BCL (2006) to the traditional recreational demand model described in the previous section.

Since we are considering individuals living together their individual choice is conditioned by the presence of the other members. This is a more complicated

case than BCL's case. We have to consider not only the consumption technology function but also the household production function. The consumption technology function transforms what the individuals privately consume (for example number of trips taken to a site by member m and f) into the inputs that the couple is observed purchasing (for example number of trips taken to a site by the household). The household production function combines inputs, such as food and gasoline, to generate the output 'trips'.

Another issue is related to the time cost of the recreational trip. 'Time' raises two problems[5]. First, it is easier to pool money than to pool time in a household. For instance, the husband could spend his wife's money if he wants, but it is much harder for him to spend his wife's time to go to a recreational site[6]. Second, the time costs are not shared in the same way as money costs. Suppose a couple takes some joint recreational trips. The money costs are shared, for example the couple benefits from the same gasoline purchase. However the time costs are not shared in the same way. If both husband and wife take the trip, then both husband and wife's time costs must be charged. This problem makes the recreational demand model different from the BCL's model.

First, we analyze the case of individuals living alone, and then the case of individuals living together. In fact, BCL use the demand data of people living alone to identify the Marshallian demand functions $\mathbf{x}^i_m$ arising from the utility

functions U^i, and the household data to estimate the household's demand functions **z,** the consumption technology F and the sharing rule φ.[7]

3.3.1 *Individuals Living Alone*

We apply the traditional recreational demand model described in Section 3.2 because we consider individuals living alone, thus, there is not intra-household allocation of resources and no shared travel costs or problems with pooling time.

The utility optimisation problem of individual i is similar to that of the traditional recreational demand model, however there are two differences. The first difference is in the notation. Each variable and the utility function of individual i are characterized by the superscript i: if $i = f$ we refer to a woman; if $i = m$ to a man. The second difference consists of replacing the implicit production function $g(n^i,\ \mathbf{s^i}) = 0$ with $n^i = B(\mathbf{s^i})$, where B is the transformation (production) function from inputs into the production of trips.

It is made explicit that the exogenous income (y^i), the number of trips to a recreational site (n^i), the composite commodity (b^i), the time costs of access to the recreational site (t^i), the after-tax wage rate w^i, the total number of hours spent working (L^i) and the vector of inputs used ($\mathbf{s^i}$) refer to the site's user i and not to the household as a single decision making unit.

Following the methodology presented in Section 3.2, we can derive the individual recreational demands for the recreational site, $n^f_m(c^f,\ q,\ w^f,\ T,\ y^f)$ and

$n^m_{\ m}(c^m, q, w^m, T, y^m)$, where c^i is the constant cost per trip derived assuming marginal cost equal to average cost, and thus, we can obtain the usual welfare measures of the traditional recreational demand literature (compensating variation and Consumer Surplus). Note that in this case, these measures refer to the welfare of an individual that lives alone.

3.3.2 Individuals Living Together

Now, consider the case of two individuals living together, ($i = m$ and f), who can take trips separately as well as jointly.[8]

As we pointed out at the beginning of Section 3.3, in this case travel costs will be shared if the two individuals take a trip jointly while the time costs are not shared. We deal with this problem expanding BCL's model by including time constraints on each individual in the household's maximization problem. We evaluate time at different wage rates because we assume that the household members have different jobs. Further, as in the traditional recreational demand model, the household production technology is such that trips are produced using inputs **s** (for example gasoline and lodging), and we assume that the travel cost function is linear in the number of trips. This implies that the marginal travel cost per trip equals the average travel cost per trip $c(\mathbf{p})$.

The household's optimisation problem becomes

$$Max\ U[U^f(n^f,\ b;\ q),\ U^m(n^m,\ b;\ q)] = \mu\ U^f(n^f,\ b;\ q) + U^m(n^m,\ b;\ q), \qquad (17)$$

subject to

$$N = n^f + n^m, \qquad (18)$$

$$Z = F(N), \qquad (19)$$

$$y + w^f L^f + w^m L^m \geq c(\mathbf{p})Z + b, \qquad (20)$$

$$T \geq L^f + t^f n^f \qquad (21)$$

$$T \geq L^m + t^m n^m \qquad (22)$$

where the weight μ represents the bargaining power of the household members in the intra-household allocation process: individual m receives a weight of one, and individual f receives a weight of μ in determining the intra-household decisions; U is a twice differentiable utility function 'interpreted as a social welfare function for the household'; U^i is the utility of member i;[9] $\mathbf{p}$ is the vector of prices for the inputs $\mathbf{s}$; y the household total income; b is the price of the composite commodity normalized to 1; t^f and t^m are the time costs of each household member; L^f and L^m are the total number of hours spent working by individuals f and m; w^f and w^m are the after-tax wage rate of each household member; Z is the number of trips the couple is taking to a site accounting for the fact that some trips are taken jointly; n^f and n^m are the number of trips taken by each household member; N is the total number of trips taken by both household

members; *F* is the consumption technology function that summarizes the economies of scale that arise from traveling together and sharing.[10]

We allow the two time constraints for the two household members to be collapsed in the budget constraint.

The household's optimisation problem becomes

$$Max\ U[U^f(n^f, b; q),\ U^m(n^m, b; q)] = \mu\ U^f(n^f, b; q) + U^m(n^m, b; q), \tag{23}$$

subject to

$$N = n^f + n^m,$$

$$Z = F(N),$$

$$y + (w^f + w^m)T \geq c(\mathbf{p})Z + (w^f t^f n^f + w^m t^m n^m) + b. \tag{24}$$

Note that empirically we observe the total household income and not the individual income. The household's behaviour is equivalent to allocating the fraction of shadow (not observed) income $\phi^f = \varphi$ to member *f*, and the fraction $\phi^m = 1 - \varphi$ to member *m*, where φ is defined in Equation (5). Each household member *i* maximizes their own utility function U^i subject to the budget constraint $\phi^i = \boldsymbol{\pi}^i n^i$, where $\boldsymbol{\pi}^i$ is the shadow price vector for the own number of trips n^i and ϕ^i is the individual *i*'s shadow income.

The household purchases trips $Z = F(n^f + n^m)$ and for simplicity BCL assume a Barten type technology function, defined as $Z = RN$, where $N = n^f + n^m$.[11]

The budget constraint (27) becomes

$$n^f[c(\mathbf{p})R + w^f t^f] + n^m[c(\mathbf{p})R + w^m t^m] + b = y + T(w^f + w^m) \text{ (25)},$$

which yields to the shadow prices of individual i's trips

$$\pi_m^m = \frac{c(\mathbf{p})R + w^m t^m}{y + T(w^f + w^m)} \qquad (26)$$

and

$$\pi_m^f = \frac{c(\mathbf{p})R + w^m t^m}{y + T(w^f + w^m)}, \qquad (27)$$

where the couple faces constant cost per trip $c(\mathbf{p})$ and total income y. Note that the shadow prices of individual i's trips depend on the time costs of both individuals, not only on the time cost of individual i.

By the second welfare theorem, the solution to the utility maximization problem is a set of Marshallian demands equal to $n_m^i (\pi^i / \varphi^i)$ and the indirect utility function is $V^i (\pi^i / \varphi^i)$, which depend on the shadow prices and the sharing rule. This implies that the recreational demand of individual i depends not only on individual i's time cost but also on the time cost of the other household member.

Then Z becomes

$$Z = Rn_m^m \left(\frac{c(\mathbf{p}) + w^m t^m}{y + T(w^f + w^m)} \frac{1}{\varphi} \right) + \\ Rn_m^f \left(\frac{c(\mathbf{p}) + w^f t^f}{y + T(w^f + w^m)} \frac{1}{1 - \varphi} \right) \qquad (28)$$

26

Note that the knowledge of the sharing rule φ permits the derivation of individual indirect utility and cost functions that can be used to perform both interpersonal and inter-household comparisons.

Finally, following the traditional recreational literature and applying Equation (15) we can calculate the Consumer Surplus for each household member and for the household, taking into account the intra-household allocation of resources and that each individual has their own preferences.

4. Some Empirical Analysis

4.1 Study Site and Data Gathering

The sample is drawn from an onsite survey conducted by the Department of Economics of the University of Verona on the West side of Garda Lake in the Northeast of Italy from June to 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.[12]

This area was picked because the trips taken would mostly be single-destination, single-purpose trips, which is a necessary assumption of the Travel Cost Method (Freeman, 1993). It was also felt that, due 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.

Each respondent was asked to recall the number of annual trips made to the West Garda Regional Forest and the number of trips to other natural areas during the year. In order to double check the declared costs, visitors were asked to specify their place of residence, the distance travelled between the natural area and their residence, the journey time and for those who were on vacation, the distance from the forest to their vacation lodging.

Moreover, the following data were collected for each individual: means of transportation used, number of passengers per means of transportation, how many 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 free time activities during the trip; occupation and weekly number of hours of work. We used this information to construct the variable 'travel cost', which comprehends the opportunity cost of time spent traveling to the natural area.[13]

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

This survey also has an advantage in allowing us to know if the visitors are married, and then if the visitor is the husband or the wife.[14]

The visitor was also asked how she allocated her time during the visit between naturalistic (for example going sightseeing), harvesting (for example harvesting flowers, mushrooms, hunting and fishing) and recreational activities (for example mountain biking, horse riding, hiking, picnicking, visiting historic places), and how she would have wished to spend her time between these activities. Figure 1 shows the percentage of on site time spent in different activities for husbands and wives. Husbands bike and visit more than wives do, but they hike and sightsee less than wives do.

Figure 1 – Percentage of on site time spent in different activities

4.2   Empirical Model and Results

In this paper we do not estimate the collective recreational demand model developed in Section 3.3 but first, we test the null hypothesis that, after controlling for income and other socio-economic characteristics, the recreational demand of husbands is not statistically different from the recreational demand of wives. Testing for this hypothesis allows us to motivate future research in the estimation of the collective recreational demand model. If the recreational

demand of husbands and wives are the same then husband and wife responses may be treated identically, as in the traditional recreational demand model. Second, we test the null hypothesis of no difference in Consumer Surplus between husbands and wives, and third we test that the Consumer Surplus estimated using the traditional recreational demand model is not statistically different from the Consumer Surplus estimates of husbands and wives.[15]

In order to test these hypotheses we consider the sample of husbands and wives (225 observations) and we estimate an unrestricted Poisson model where we allow the parameters of the model to vary by gender. Table 1 defines the variables used in the Poisson model and Table 2 presents summary statistics for husbands and wives.

Table 1 - Definition of the variables in the Poisson model

Table 2 - Descriptive statistics for selected variables in the Poisson model

Let **X** be the vector of independent variables: the logarithm of the individual *i*'s monthly net income from the previous year (*ln_income*), the travel cost per car to visit the natural area (*tc*), the logarithm of the annual travel cost per car to

visit two alternative sites that are different from the West Garda Regional Forest (ln_tc1, ln_tc2), education (edu), and age (age).

We allow for differences in recreational demand between husbands and wives by interacting the **X** vector with the dummy variable for sex ($sex = 1$ if male, 0 if female).

The general form for the recreational demand for the natural area becomes

$$trips^* = E(trips_i) = \exp(\mathbf{X}'\boldsymbol{\alpha} + \mathbf{X}'\boldsymbol{\beta} \cdot sex) \qquad (29)$$

where $trips_i$ is the annual number of visits to the natural area by individual $i = \{1,...,K\}$ and $trips^*$ is the expected number of trips.

The α parameters correspond to the coefficients for the **X** variables for wives. The β parameters represent the difference between husbands and wives.

If the null hypothesis of no significant differences between husbands and wives is not rejected then the unrestricted model (model A in Table 3) becomes the same as the restricted traditional Poisson model (model B in Table 3). To test this hypothesis we specify the null as H_0: $\boldsymbol{\beta} = \mathbf{0}$ (i.e. 'husbands' = 'wives') and the alternative as H_1: at least one coefficient of the vector of parameters $\boldsymbol{\beta}$ is significantly different from zero.

Table 3 shows the parameter estimates for the unrestricted and restricted model. As expected the number of visits to the natural area decreases if the travel cost (tc) increases (tc has a negative sign and is significant at the 1% statistical

level) and if income increases then the number of trips increases (*ln_income* has a positive sign and is significant at the 1% statistical level). However that the coefficient on education (*edu*) is negative is opposite of our expectations.

Table 3 – Poisson estimates of restricted and unrestricted models

We use the unrestricted model to perform a Wald test of the null hypothesis $H_0: \boldsymbol{\beta} = \mathbf{0}$ of no differences between husbands and wives. We reject the null at the 1% significant level.[16] We also perform the likelihood ratio test using the unrestricted and restricted models and we again reject the null hypotheses of no difference in the recreational demand between husbands and wives at the 1% significant level.[17] Rejection of the null hypothesis suggests that observations for husbands and wives may not be treated as identical as in the traditional recreational demand model (unless one spouse is the dictator).

Finally, we want to test the null hypotheses of (i) no significant difference in the Consumer Surplus estimates of husbands and wives, and (ii) of no significant difference between the Consumer Surplus estimates of husbands and wives and the Consumer Surplus obtained using the traditional restricted model (i.e. model A).

The unrestricted Poisson model just described can be used to calculate the Consumer Surplus of husbands and wives by taking the area under the expected demand function (29). For the exponential demand function (29), the choke price, at which the demand of trips is zero, is infinite (Habb and McConnell, 2002, p. 167). Let us consider the simple demand specification $trips^* = exp(\delta_0 + \delta_1 tc)$, the Consumer Surplus for access to the forest is

$$CS = \int_{tc^0}^{\infty} \exp(\delta_0 + \delta_1 tc)dtc = -\frac{trips_0^*}{\delta_1} \quad \text{when} \quad \delta_1 < 0 \qquad (30)$$

where $trips_0^* = \exp(\delta_0 + \delta_1 tc_0)$ is the expected number of trips at the current travel cost tc_0 and δ_1 is the coefficient on tc_0. Then, the Consumer Surplus per trip can be calculated as $-1 / \delta_1$ (Creel and Loomis, 1990).

We obtain the mean Consumer Surplus per trip estimates for husbands and wives by substituting the estimated coefficients from the unrestricted model from Table 3.[18] These results, along with their standard errors estimated by bootstrapping for 1000 replications, are shown in Table 4.[19]

Table 4 – Mean Consumer Surplus (CS)

In absolute value, the Consumer Surplus estimate derived from the restricted traditional model appears to overestimate the Consumer Surplus of husbands and

underestimate the Consumer Surplus of wives. The difference is statistically significant at the 1% level.[20] We also reject the null hypothesis of no difference in Consumer Surplus between husbands and wives at the 1% level[21]: wives have significantly higher Consumer Surplus than husbands for access at the West Garda Regional Forest.

5. Conclusions and Discussion

The main contribution of this paper to the recreational models literature is conceptual: we demonstrate that a utility theoretic framework derived from the collective model proposed by Browning, Chiappori and Lewbel (2006) can be used to formulate a collective recreational demand model. This model allows the researcher to find the Consumer Surplus for each household member and for the household. It takes into account the intra-household allocation of resources and that each individual has their own preferences by using information about consumption of singles and couples and by a consumption technology function, which summarizes the economies of scale and scope that result from living together.

First, we considered the case of an individual living alone. In this case, we do not have intra-household resource allocation and the household expenditure in leisure and consumption goods is equal to that of the single individual. In order

to find the Consumer Surplus measure we can apply the traditional recreational demand model.

Then, we considered the case with intra-household allocation of resources. This situation refers, for example, to couples that go to visit a recreational site. If the quality of the site changes household members might be willing to pay for the change in the site's quality because it also affects the other member's recreational activities and not only their own. They can recognize that the degradation of the site can cause a reallocation of income in the household. This can affect the change in exogenous income necessary to return the individual to the utility level that he or she experienced before the change. This yields different values for the change in quality of the area, compared to the values derived by using the traditional recreational model.

The traditional recreational demand model assumes that a household acts as a single decision unit, even if it consists of different individuals. The traditional recreational model does not make any distinctions about the value of the site for different household members. The amount a household member would pay or be paid to be as well off with or without the quality change does not take into account the allocation of resources in the family, the differences in preferences or the differences in the opportunity cost of time of the household members. Individuals in a household can value a change in quality differently, depending on their opportunity cost of time, how the household income is allocated in the

household, how much they like a particular site and how they use it. The collective recreational demand model developed in this study allows the derivation of Consumer Surplus measure for each household member taking into account the intra-household allocation of resources and that each individual has their own preferences. We also showed that the recreational demand of individual i depends not only on individual i's time cost but also on the time cost of the other household members.

With the collective recreational demand model, the policy maker can use each household member's Consumer Surplus in order to know how to regulate the access of a recreational site, how much to compensate different individuals in case of degradation of a natural environment and how to target programs to individuals in certain recreational activities groups rather than to households.

We included children's welfare by assuming that there is one altruistic member that takes into account the household members' well-being. Following BCL, we assumed that the utility function of the woman and all the associated demand functions refer to the joint utility function of a woman and her children. It is not simple to relax this assumption, however. Children consume the same kind of goods as their parents. For example, the expenditure on food includes the wife's consumption, the husband's consumption and the child's consumption. Usually it is not possible to distinguish these components in the data.

We also focused on the behavior of a family and we did not account for the behavior of groups where individuals from different households choose to take a trip together. Relaxing this assumption will be the subject of forthcoming research applying the model by Chiappori and Ekeland (2006) about group behaviour.

At this point one could ask if the distinction between the traditional and the collective recreational demand model is merely an academic curiosity, or if differences in how resources are distributed within households reflect appreciable differences in the welfare measures.

In this paper, we made a first step in this direction. We tested the null hypothesis that, after controlling for income and other socio-economic characteristics, the recreational demand of husbands is not statistically different from the recreational demand of wives. If the recreational demand of husbands and wives are the same then husband and wife responses may be treated identically, as in the traditional recreational demand model. We rejected the null hypothesis at the 1% statistical level. There are statistical differences in the recreational demand functions of husbands and wives. This implies that observations for husbands and wives may not be treated as identical as in the traditional recreational demand model (unless one spouse is the dictator). We also found that, in absolute value, the Consumer Surplus estimate derived from the traditional model appears to overestimate the Consumer Surplus of husbands

and underestimate the Consumer Surplus of wives, and that wives have significantly higher Consumer Surplus than husbands for access at the West Garda Regional Forest.

Even if these findings are referring to spouses not living in the same household, they imply that the collective setting is a plausible next step to take in the analysis of recreational demand models.

It is left for future research the estimation of the collective model developed in this study in order to obtain the Consumer Surplus estimates of husband and wife from the same couple and the sharing rule. For an empirical application we need data about individuals living alone and together. This should allow us to use the demand data of people living alone to identify individual preferences, thereby leaving household data the job of identifying the consumption technology and the sharing rule. This will also be the subject of forthcoming research.

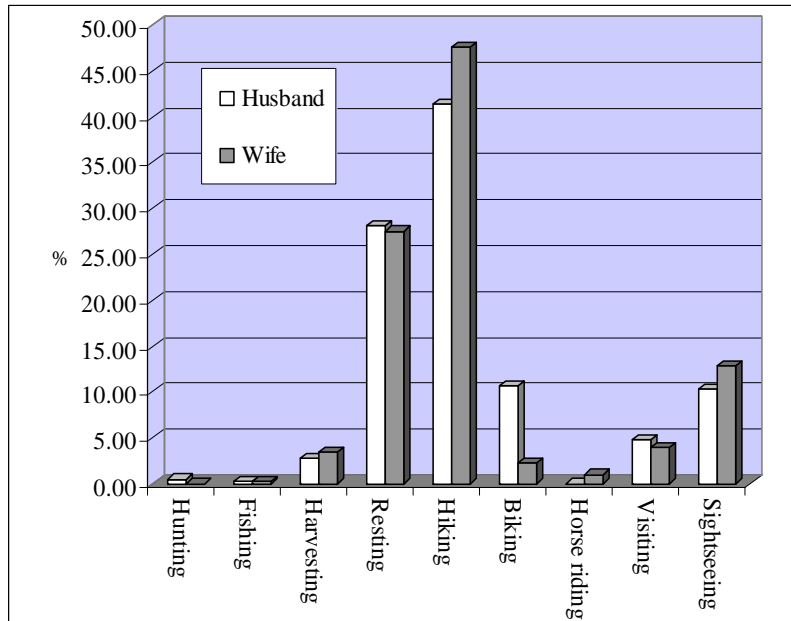Figure 1 – Percentage of on site time spent in different activities

Table 1 - Definition of the variables in the Poisson model

Variable	Definition
trips	Annual number of visits to the natural area
ln_income	Log(annual income/1000) in euros
tc	Travel cost per car in euros
ln_tc1	Log(annual travel cost per car for visits to 1st alternative site) in euros
ln_tc2	Log(annual travel cost per car for visits to 2nd alternative site) in euros
edu	Number of years of education
age	Age
sex	Sex (=1 if male; 0 if female)
Obs.	Number of Observations

Table 2 - Descriptive statistics for selected variables in the Poisson model

	Pooled sample		Husbands		Wives	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
trips	7.098	12.064	8.317	14.240	5.128	6.926
ln_income	3.091	0.495	3.115	0.497	3.052	0.492
tc	3.927	7.196	4.276	7.334	3.364	6.973
ln_tc1	2.137	2.048	2.126	2.051	2.154	2.054
ln_tc2	0.915	1.700	0.932	1.714	0.889	1.685
edu	12.342	4.241	12.647	4.283	11.849	4.149
age	44.418	11.330	45.237	11.704	43.093	10.630
Obs.	225		139		86	

Table 3 – Poisson estimates of restricted and unrestricted models

Variable	Model A (Restricted)			Model B (Unrestricted)		
	Coef.	Std. Err.		Coef.	Std. Err.	
	α parameters					
constant	0.751	0.213	***	0.933	0.218	***
ln_income	0.491	0.060	***	0.569	0.095	***
tc	-0.010	0.001	***	-0.003	0.001	***
ln_tc1	0.073	0.015	***	0.024	0.028	
ln_tc2	-0.014	0.016		0.089	0.031	***
edu	-0.017	0.007	**	-0.064	0.013	***
age	0.003	0.002		-0.007	0.004	
	β parameters					
ln_income*sex				-0.059	0.098	
tc*sex				-0.013	0.001	***
ln_tc1*sex				0.068	0.033	**
ln_tc2*sex				-0.143	0.037	***
edu*sex				0.056	0.015	***
age*sex				0.009	0.005	**
Log likelihood	-1464.111			-1362.4418		
Sample Size	225			225		

*** Significance at the 1% level; ** Significance at the 5% level;

* Significance at the 10% level.

Table 4 – Mean Consumer Surplus (CS)

Variable	Obs.	Mean	Std. Err.	Std. Dev.	95% Conf. Interval	
Traditional CS	225	6.280	0.196	2.945	5.893	6.667
Husbands' CS	139	4.503	0.223	2.634	4.061	4.945
Wives' CS	86	16.058	0.641	5.944	14.784	17.333

Notes

1.   As BCL note, we can have more complicated consumption technologies. For example, 'the fraction of time r that the couple shares the car could depend on the total usage, resulting in F being a nonlinear function of x_j. There could also be economies (or diseconomies) of scope as well as scale in the consumption technology, e.g., the shared travel time percentage r could be related to expenditures on vacations, resulting in $F(x)$ being a function of other elements of x in addition to x_j' (p. 11).

2.   Barten type technology function (1964) is a special case of Gorman's (1976) general linear technology model $z = Rx + a$, with R diagonal and a zero (see also Muellbauer, 1977; Perali, 2003).

3.   Note that $\pi(.)$ and $\varphi(.)$ are functions and p/y is their argument.

4.   For simplicity we consider trips on a single site.

5.   The author thanks Nancy Bockstael for having pointed out these problems.

6.   Note that pooling time is possible when household members reallocate household tasks. For example, the husband has more time for fishing if the wife cleans and cooks the fish.

7.   BCL's model assumes that marriage does not induce preference changes. They justify this assumption claiming that 'it may be reasonable to assume that, at least for some goods, the dollar effect of a change in tastes is small.' In the recreational case we could assume that preferences of singles are not

significantly different from those of married people if there are not children in the household.

8. We anticipate here that the behavior of a group is assumed equal to the behavior of a family, recognizing that important considerations are embedded in this distinction.

9. We assume that the utility functions of children are jointed with the utility of the household member f, living for future research the investigation of a model that relaxes this assumption.

10. The consumption technology may also capture some kinds of taste that result from traveling together rather than traveling alone.

11. R can be thought as a scale factor when trips are taken jointly.

12. For a detailed description of the survey see Tommasi and Veronesi (2006).

13. 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).

14. Note that only one respondent was interviewed in each household so 'husband' and 'wife' are not in the same couple.

15. It would have been also interesting to compare the recreational demand and the Consumer Surplus of single men and women with those of

husbands and wives with and without children but unfortunately the small sample size does not allow us this kind of estimation. We suggest implementing this comparison as future research.

16. The χ^2 statistic is 195.01 for H$_0$: $\boldsymbol{\beta} = \mathbf{0}$ (p-value 0.000). The critical value of the χ^2 statistic with 6 degrees of freedom is 16.81 at the 1% confidence level.

17. The χ^2 statistic is 203.34 (p-value 0.000). The critical value of the χ^2 statistic with 6 degrees of freedom is 16.81 at the 1% confidence level.

18. From Table 3 (model B) we have that wives' δ_l corresponds to α_{tc}, $= -0.003$, while husbands' $\delta_{l} = \alpha_{tc} + \beta_{tc} = -0.003 + (-0.013) = -0.016$.

19. Note that the CS figures in Table 4 have been divided by the number of passengers in the car and by the number of days of the visit at the site, so they refer to the CS per day of trip and per passenger.

20. p-value $= 0.000$.

21. p-value $= 0.000$.

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