

## Research Article

# Using the Contingent Grouping Method to Value Forest Attributes

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This paper presents the first application of a recently proposed stated preference valuation method called contingent grouping. The method is an alternative to other choice modeling methods such as contingent choice or contingent ranking. It was applied to an afforestation program in the northeast of Spain. The attributes included (and the marginal values estimated per individual) were allowing picnicking in the new forests (€2.47), sequestering 1000 tons of CO<sub>2</sub> (€0.04), delaying the loss of land productivity by 100 years, due to erosion in the new forests area (€0.783), and allowing four-wheel driving (€6.5), which is perceived as a welfare loss.

## 1. Introduction

Forest ecosystems generate a wide variety of goods and services not only for the forest owners but also for society at large. They provide a number of public goods, like enjoyment from recreational opportunities, nontimber products (e.g., mushrooms, berries, or aromatic herbs), carbon sequestration, erosion prevention and biodiversity preservation, among others. In order to make sound decisions for the whole society, forest planning and management ought to take into account the value of forests for both the landowner and the other affected persons. The field of economics helps in this process by being able to estimate the value, in monetary units, of the forest at stake. Their estimation could constitute a significant source of information for further forest policy design and the development of financial instruments.

Forest valuation is often undertaken from choice modeling techniques. They involve surveying people and asking them to state their preferences among a set of alternatives characterized by attributes fixed at different levels [1]. These preferences may be stated, for example, selecting the most preferred alternative from a choice set (named choice experiment; see, e.g., Louviere et al. [2]) or ranking the alternatives included in the choice set (named contingent

ranking; see, e.g., Chapman and Staelin [3]) according to their preferences. The different choice modeling variants, like the aforementioned contingent choice and contingent ranking, are able to obtain separate social values for different forest goods and services.

Recently, Brey et al. [4] proposed a variant named contingent grouping (CG). It requests individuals to classify alternatives included in a choice set as “better than” or “worse than” a status quo or reference situation. The purpose of this paper is to illustrate an application of CG in order to determine how Catalan people choose among potential afforestation programs described by six attributes. The marginal economic values of several forest functions are estimated using a survey with a CG elicitation format undertaken in Catalonia, a region in the northeast of Spain. Following Hensher and Greene [5] and Hensher et al. [6], the WTP values are presented in three different ways: a point estimates, the confidence interval, and the whole distribution. The latter can help to better understand the results obtained.

The structure of this paper is as follows. Section 2 introduces the CG method. Section 3 describes the application. Section 4 reports and discusses the results. Finally, Section 5 summarizes the main conclusions.

## 2. Methodology

Within the different valuation methods at hand, stated preference methods are most often used when valuing changes in forests or forest-related goods and services. The contingent valuation method (CVM) tends to be applied when a holistic approach is required, whereas attribute-based valuation methods (ABVM) can isolate the value of different forest attributes.

Typically, CVM analyzes the individual tradeoff between the provision of a good and a payment. The elicitation question can take different formats [7]. For instance, in the closed-ended dichotomous choice variant [8, 9], people may be asked whether they would accept the provision of a nonmarket good at a given price (usually called bid) that varies among subsamples. The allowable answer is therefore closed and dichotomous: yes or no, although a fraction of the population may not know or may not the answer. From the yes or no responses to the different bid amounts, the researcher estimates a response probability function, out of which the mean or median of the individual maximum willingness to pay (WTP) is computed as economic value. Some CVM applications to forests are, for example, [10–16].

An ABVM contains a set, or several sets, of alternatives (choice set) defined by options with different attribute levels, varying across the sample. Usually, the choice sets include a status quo or “business-as-usual” (BAU) option. Individuals express their preferences for the alternatives making some kind of choices, like picking the most preferred—called choice experiment or contingent choice (CC), or ranking the alternatives of the choice set from best to worse, or vice versa, labeled contingent ranking (CR). If one of the attributes is the money that a person would have to pay to secure the change, it is possible to generate estimates of the marginal value of changes in each attribute. In a sense, these methods are able to provide more information than CVM, but at the expense of a more demanding statistical treatment, and maybe a higher burden on the individuals.

CC seems to be relatively easier for respondents to answer than CR, since it resembles the kind of choices that individuals face in actual markets. From a statistical point of view, though, CC provides less information per choice set and individual than CR [1]. The increased complexity of CR may lead some individuals to rank arbitrarily or to engage in strategies of ranking different from utility maximization, which could lead to unreliable welfare measures [17–19]. CC exercises have been applied to forest ecosystems [11, 20–23]. Examples of CR applications in the field of forest economics can be found [24, 25].

A new variant of the ABVM family for modeling preferences for goods, where goods are described in terms of their attributes and levels, is the contingent grouping method (CG) [4, 26]. This variant requests individuals to classify alternatives included in the choice set as “better than” or “worse than” a status quo or reference alternative. This elicitation method provides welfare measures conforming to standard consumer theory. Contingent grouping improves upon CC by generally collecting more information without the cognitive demands of CR [4]. In a way it can be regarded

as an appealing alternative to CC and CR, when balancing the amount of statistical information and burden on respondents.

The CG method can be introduced as follows. Consider an individual  $i$ ,  $i \in \{1, \dots, N\}$ , facing a set of five alternatives, as will be used in the empirical application. Denote these alternatives as  $a$ ,  $b$ ,  $c$ ,  $d$ , and  $q$ , where  $q$  represents the status quo or BAU alternative. The utility provided by an alternative  $j \in \{a, b, c, d, q\}$  can be expressed with a deterministic and a stochastic part, as in

$$U_{ij} = \beta_i' x_{ij} + \varepsilon_{ij}, \quad (1)$$

where  $x_{ij}$  is a vector of observable variables describing the alternative  $j$  for individual  $i$ ,  $\beta_i$  is a vector of unobserved coefficients representing the tastes of individual  $i$ , and  $\varepsilon_{ij}$  is an unobserved stochastic component independent of  $x_{ij}$  and  $\beta_i$ .

Next, consider that the individual is requested to classify the alternatives as “better than” or “worse than” the status quo alternative. Under the assumption of rational behavior, the individual will group the different alternatives according to whether they provide more or less utility than  $q$ . Therefore, there are 16 possible complete grouping results (see Table 1). In other words, assuming that the probability for an individual to select an alternative  $j$  from the choice set is given by the probability that its utility is greater than the sum of the utilities of all the other alternatives included in the choice set and that the utilities of these alternatives are independent (i.e., we have independent RUM models [27]), information about the individual preferences underlying the sixteen different groupings can be obtained as shown in Table 1.

Depending on the BAU position in the choice set in terms of the utility provided to the individual, the information obtained differs. Thus, a BAU dummy variable is to be included in the utility function model to obtain consistent estimates. This variable informs of where option  $q$  stands in relation to the other alternatives in the preferences of the individual. Using conditional logit models to estimate these probabilities, Brey et al. [4] showed by numerical simulation that CG generally provides better welfare measure estimates than CC but worse than CR.

## 3. Application

The case study application took place in Catalonia, a region in the northeast of Spain. About 40% is occupied by forests. Having a Mediterranean climate in most of the region, Aleppo Pine (*Pinus halepensis*) is the dominant species; coniferous trees account for 73% of the total forest area. Deciduous trees occupy 14% of the forest land, being Holm oaks (*Quercus ilex*) the most abundant species. Three quarters of the forest are in private hands, whereas the rest is publicly own, mostly municipal [28]. However, commercial forests are only marginal, with 2% of the agrarian production in Catalonia [29]. The main reason is the low profitability of its timber. Nevertheless, forests provide the Catalan society with many goods and services that seem to increase due to the economic development in the last decades [30].

TABLE 1: Grouping and information about the individual's preferences.

Groupings*	Information about the individual's preferences**
(i) $a, b, c, d > q$	(i') $P(U_a   U_a, U_q)P(U_b   U_b, U_q)P(U_c   U_c, U_q)P(U_d   U_d, U_q)$
(ii) $a, b, c > q > d$	(ii') $P(U_a   U_a, U_d, U_q)P(U_b   U_b, U_d, U_q)P(U_c   U_c, U_d, U_q)P(U_q   U_d, U_q)$
(iii) $a, b, d > q > c$	(iii') $P(U_a   U_a, U_c, U_q)P(U_b   U_b, U_c, U_q)P(U_d   U_c, U_d, U_q)P(U_q   U_c, U_q)$
(iv) $a, c, d > q > b$	(iv') $P(U_a   U_a, U_b, U_q)P(U_c   U_b, U_c, U_q)P(U_d   U_b, U_d, U_q)P(U_q   U_b, U_q)$
(v) $b, c, d > q > a$	(v') $P(U_b   U_a, U_b, U_q)P(U_c   U_a, U_c, U_q)P(U_d   U_a, U_d, U_q)P(U_q   U_a, U_q)$
(vi) $a, b > q > c, d$	(vi') $P(U_a   U_a, U_c, U_d, U_q)P(U_b   U_b, U_c, U_d, U_q)P(U_q   U_c, U_d, U_q)$
(vii) $a, c > q > b, d$	(vii') $P(U_a   U_a, U_b, U_d, U_q)P(U_c   U_b, U_c, U_d, U_q)P(U_q   U_b, U_d, U_q)$
(viii) $a, d > q > b, c$	(viii') $P(U_a   U_a, U_b, U_c, U_q)P(U_d   U_b, U_c, U_d, U_q)P(U_q   U_b, U_c, U_q)$
(ix) $b, c > q > a, d$	(ix') $P(U_b   U_a, U_b, U_d, U_q)P(U_c   U_a, U_c, U_d, U_q)P(U_q   U_a, U_d, U_q)$
(x) $b, d > q > a, c$	(x') $P(U_b   U_a, U_b, U_c, U_q)P(U_d   U_a, U_c, U_d, U_q)P(U_q   U_a, U_c, U_q)$
(xi) $c, d > q > a, b$	(xi') $P(U_c   U_a, U_b, U_c, U_q)P(U_d   U_a, U_b, U_d, U_q)P(U_q   U_a, U_b, U_q)$
(xii) $a > q > b, c, d$	(xii') $P(U_a   U_a, U_b, U_c, U_d, U_q)P(U_q   U_b, U_c, U_d, U_q)$
(xiii) $b > q > a, c, d$	(xiii') $P(U_b   U_a, U_b, U_c, U_d, U_q)P(U_q   U_a, U_c, U_d, U_q)$
(xiv) $c > q > a, b, d$	(xiv') $P(U_c   U_a, U_b, U_c, U_d, U_q)P(U_q   U_a, U_b, U_d, U_q)$
(xv) $d > q > a, b, c$	(xv') $P(U_d   U_a, U_b, U_c, U_d, U_q)P(U_q   U_a, U_b, U_c, U_q)$
(xvi) $q > a, b, c, d$	(xvi') $P(U_q   U_a, U_b, U_c, U_d, U_q)$

\*“>” reads “preferred to.”

\*\*For example,  $P(q | a, b, c, d, q)$  denotes the probability of selecting the alternative  $q$  from the choice set composed by the alternatives  $a, b, c, d$ , and  $q$ .

Fire is probably the principal disturbance of the Catalan forest. It plays a relevant role in determining the landscape structure and plant community composition, but also in the amount of carbon sequestration and soil erosion.

An afforestation program was proposed in the valuation exercise, increasing the forest surface from 40% to 50% of Catalonia. The expansion would come at the expense of marginal agricultural land. The proposal was in line with the government's policy. Social and economic changes that occur within developed societies lead up to a situation in which large pieces of agricultural land are being left abandoned as many rural areas become depopulated. Afforestation may be an attractive way of managing fallow lands. Numerous European countries implement subsidized afforestation programs, which provide land owners with financial support for afforestation and management of the planted forest [31, 32].

**3.1. CG Design.** The program contemplated five different nonmonetary attributes, allowing for picnics in the new forests, four-wheel drive access, picking mushrooms, different amounts of CO<sub>2</sub> sequestration, and deferring erosion over time and a required payment. The attributes and levels are summarized in Table 2. The selection of these attributes and levels come from a combination of expert opinions, focus groups, and pilot tests.

A total of 512 combinations were obtained out of the levels and attributes ( $2^3 \times 4^3$ ). A fractional factorial design was then applied to obtain 16 alternatives that were included in four choice sets of four alternatives each.

**3.2. Questionnaire.** The first part of the questionnaire described the most relevant aspects of the current forest situation in Catalonia and the afforestation program, with its likely effects. The central part contained the description of the market institution and the value elicitation questions. Each individual was faced with one of the predetermined choice sets and was asked to classify the alternatives as better or worse than the BAU option. The final part of the questionnaire collected several debriefing questions and the request of personal and economic data from the individuals.

The questionnaire went through different focus group sessions and two pilot tests. Focus group participants found the program to be very credible and its description in the questionnaire is understandable for the general public. More than 90% of surveyed people perceived the afforestation program as an overall positive or very positive initiative. Figure 1 reproduces the map included in the questionnaire showing the forested areas before and after the proposed afforestation.

**3.3. Data Collection.** The questionnaire was administered face-to-face in personal home interviews. A stratified random sample of 800 individuals was selected in Catalonia, from which 732 valid responses were obtained. The strata used were age, gender, and size of the town of residence. The interviews involved 25 randomly selected locations and administered to the population of 18 years of age or older proportionally to the population of each location. In each location, the questionnaires were distributed using random survey routes,

TABLE 2: Attributes and levels used in the choice sets.

Attribute	Description	Levels
Picnic	Picnicking allowed in the new forests (BAU* = No)	Yes
		No
Drive	Driving by car allowed through the new forests would be allowed (BAU = No)	Yes
		No
Mushrooms	Picking mushrooms allowed in the new forests (BAU = No)	Yes
		No
CO <sub>2</sub>	CO <sub>2</sub> sequestered annually by the new forests. Equivalent to the pollution produced annually by a city of... (BAU = 0)	300.000 people
		400.000 people
		500.000 people
		600.000 people
Erosion	(If not afforested, land would become unproductive...)** (BAU = 100)	After 100 years
		After 300 years
		After 500 years
		After 700 years
Payment	The afforestation cost per person and year (BAU = 0)	6 euros
		12 euros
		18 euros
		24 euros

\*BAU: business-as-usual alternative. \*\*If afforested, erosion would be prevented indefinitely.

with the sample being stratified to include ten respondents selected in terms of gender and age. No significant problems were appreciated in applying the survey. The response rate (91.5%) has been considerably high, suggesting that the cognitive burden of the grouping task may be not too strong.

#### 4. Results and Discussion

The parameters were estimated by maximizing the log-likelihood function  $\sum_{i=1}^N w_i \ln P_i$ , where  $P_i$  denotes the  $i'$ - $xvi'$  expression for the corresponding event associated to individual  $i$ ,  $w_i$  are the weights associated to the individual, and  $N$  is the number of sampled individuals. Weights were included in the log-likelihood function to give the same importance to each individual. Expressions  $i'$ - $xvi'$  were estimated using random parameter logit models [5, 33]. Thus, CG is formulated here as a random parameter logit model with one or repeated choices with stable tastes from the sampled individuals.

The estimated coefficients are shown in Table 3. The estimations reported here were programmed in NLOGIT 3 [34], version of August 2005. The program code can be supplied by the authors.

The random variables were determined combining two approaches. One was the classical procedure based on estimating different models and using the likelihood ratio tests to select from them. The other procedure was based on

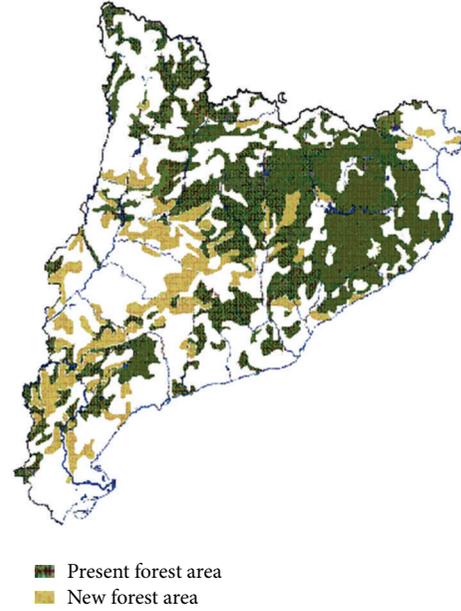


FIGURE 1: Forest areas in Catalonia earlier and the proposed expansions.

the inclusion of artificial variables, as suggested by McFadden and Train [35]. The application of both approaches determined variables CO<sub>2</sub> and Payment as random. The estimated spreads for these variables were different from zero at 5% significance level. Out of a number of different distributions tested, the triangular showed the best fit. A triangular density function has the shape of a triangle [36]. One of the main advantages of this distribution is that it has relatively short tails, avoiding the strong influence of outliers on the mean estimation [5]. On the other hand, it may provide difficult-to-explain sign changes for some variables. This could be the case, for example, with variable Payment, where the coefficient is always expected to be negative. To avoid this problem, Hensher and Greene [5] propose making the standard deviation or spread of this distribution a function of its mean, thus ensuring that the distribution provides only positive or negative values. However, it was not necessary to introduce this constraint since the estimated values of the spread for the random parameters were significantly lower than their mean.

All the estimated coefficients, except for Mushrooms, are significant at 10% significance level, and all but Mushrooms and Picnic are significant at 5%. The model contains multiplicative interactions of the status quo dummy variable with some dummies representing different age intervals, since respondents seemed to be more or less prone to select the “business as usual” alternative depending on their age. These dummy variables Age<sub>1</sub>, Age<sub>2</sub>, and Age<sub>3</sub> are set to 1 for individuals between 30 and 44 years of age, 45 and 64, or more than 60-year-old, respectively. The interval age between 18 and 29-year-old is then considered as the reference interval. The results indicate that the probability of choosing the status quo, everything else held constant, increases with the age of the respondents.

TABLE 3: Model estimations.

Nonrandom parameters	Coefficient	<i>t</i> -statistic
Picnic	0.238	1.924
Drive	-0.626	-4.965
Mushrooms	-0.190	-1.325
Erosion	-0.075	-2.633
SQ	-1.972	-5.812
SQ*Age <sub>1</sub>	3.416	9.764
SQ*Age <sub>2</sub>	3.637	11.129
SQ*Age <sub>3</sub>	4.112	10.322
Random parameters: mean		
CO <sub>2</sub>	0.263	2.929
Payment	-0.117	-5.663
Random parameters: spread		
CO <sub>2</sub>	$3.436 \times 10^{-4}$	3.380
Payment	$1.016 \times 10^{-4}$	3.602
Observations	732	
log-likelihood	-628.105	
log-likelihood at 0	-821.4110	

The model was estimated using the Halton sequences with 500 replications. In the results reported in this paper, the variables CO<sub>2</sub> and Erosion were divided by 10<sup>5</sup> and 10<sup>2</sup>, respectively, to facilitate estimation.

**4.1. Marginal WTP Estimates.** Following Hensher and Greene [5] and Hensher et al. [6], the mean WTP, the confidence interval, and its entire distribution were estimated. The simplest approach estimates coefficients as fixed points. Assuming a linear utility model, the WTP is estimated as the negative of the ratio between the mean coefficients of the corresponding attribute and the coefficient of the Payment attribute. Figure 2 shows the WTP estimates.

To estimate the sampling variance, the Krinsky-Robb procedure was adopted [37]. This procedure uses random draws from the estimated asymptotic normal distribution of parameter estimates to calculate different WTP estimates. Figure 2 shows WTP point estimate and the 95% confidence intervals calculated with 1000 replications.

The estimation of the whole marginal WTP distribution is also based on the Krinsky-Robb procedure. For each replication, marginal WTP values were obtained considering the triangular distribution of the random variables according to the following expressions:

$$\frac{\beta_S}{\beta_{\text{COST-MEAN}} + \beta_{\text{COST-SPREAD}}t_1}, \quad (2)$$

for attributes Picnic, Drive, Mushrooms, and Erosion ( $S = \{\text{Picnic, Drive, Mushrooms, Erosion}\}$ ), and

$$\frac{\beta_{\text{CO}_2\text{-MEAN}} + \beta_{\text{CO}_2\text{-SPREAD}}t_2}{\beta_{\text{COST-MEAN}} + \beta_{\text{COST-SPREAD}}t_3}, \quad (3)$$

for attribute CO<sub>2</sub>, where  $t_1$ ,  $t_2$ , and  $t_3$  denote random variables following a triangular distribution with centre at zero and spread of one.

The values obtained from the previous expressions can be used to apply some nonparametric density estimators, allowing the description of the distribution of the marginal WTP. This is done without assuming any underlying analytical distribution. Two different estimators of the density function will be reported here: a histogram, which constitutes the simplest representation, and the kernel density estimator, which can be seen as a generalization and improvement over histograms [38]. Figure 2 shows the histograms and the Kernel density estimates constructed from 5000 simulated observations of the marginal WTP, for the five attributes.

The values of 2.47, -1.978, and -6.505 of Picnic, Mushrooms, and Drive, respectively, correspond to the maximum amount of euros (at 2005 values) that on average an individual would pay annually for a discrete change, from not being allowed to picnic, pick mushrooms, or drive cars in the new forests, to being allowed to do those recreational activities. The marginal CO<sub>2</sub> WTP of 2.735 euros reflects the value that a new forest provides to society by sequestering a quantity equivalent to the emissions of CO<sub>2</sub> that, on average, a Catalan city of 100.000 inhabitants generates annually in production and consumption activities, that is, approximately equivalent to 68000 tone of CO<sub>2</sub> per year [39]. Moreover, in the case of the CO<sub>2</sub> sequestered annually by the new forests, the distribution of the marginal WTP has presented a long tail indicating that a considerable part of the population is willing to pay amounts significantly larger than the estimated mean. Finally, 0.78 euros is the marginal WTP for delaying the loss of land productivity for a hundred years, or in other words, not avoiding erosion for that 100 year period would imply a land productivity cost of 0.783 euros per person and year.

Respondents valued positively the availability of new forests where picnicking is allowed, whereas they seem to be more indifferent toward the possibility of picking mushrooms. The nonsignificance of the Mushrooms coefficient might be due to the fact that picking mushrooms is a leisure activity requiring some specialized knowledge, and thus the number of people involved in this activity being more reduced than in other leisure activities in the forests.

The marginal WTP of Drive indicates that people tend to assess negatively this attribute. Furthermore, the estimated density function never reaches positive values, with a relatively long tail to the left. Thus, the four-wheel driving would not be part of the benefits that individuals perceive from a forest area. Allowing driving may be interpreted by individuals as a source of pollution, confronting with some of the environmental values associated to forests. Four-wheel driving may bring to forests one thing that many respondents might be trying to escape from.

Results also suggest that people tend to assess positively the environmental attributes considered, reinforcing the importance of forest environmental services to society.

## 5. Conclusions

This paper has illustrated the use of a recently proposed stated preference variant, the contingent grouping (CG) method, to analyze the way in which individuals regard some attributes

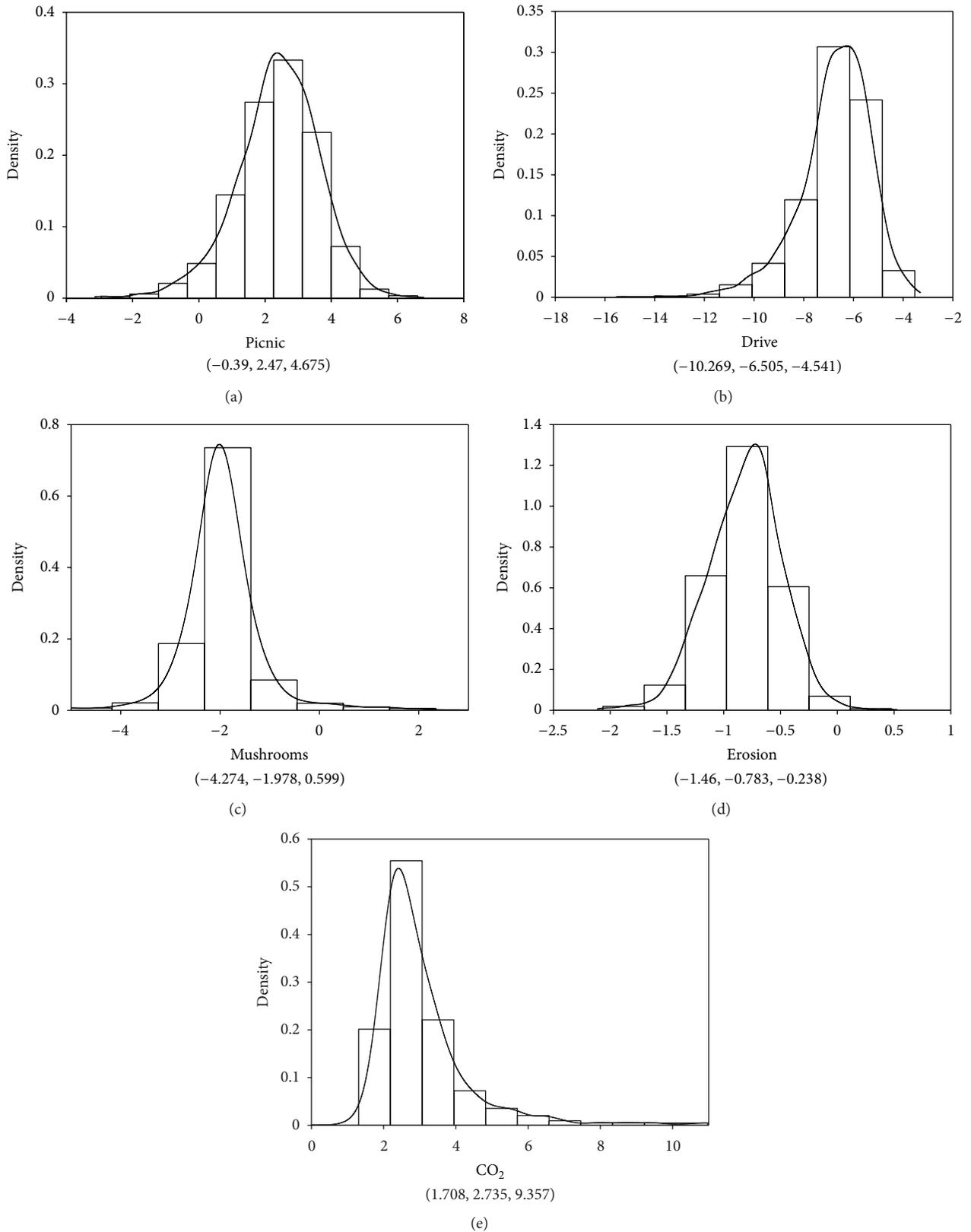


FIGURE 2: Point estimate, confidence intervals, Kernel's density functions, and histograms of the marginal willingness to pay (WTP) estimates for the five attributes (in € of 2005). NB: The first and last values in brackets represent the 95% confidence interval limits, and the values in the middle represent the corresponding point estimates.

representing both recreational and environmental functions of forests in Catalonia, Spain. CG requests individuals to classify alternatives as “better than” or “worse than” a status quo or reference alternative. This elicitation format has only recently been proposed and its feasibility in the empirical ground has to be tested. The results obtained seem to be in line with expectations regarding the sign for the attributes and no particular problems were detected in the CG application, when exposed to respondents. The response rate (91.5%) has been considerably high, suggesting that the cognitive burden of the grouping task may be not too strong.

In this paper, the CG estimations have been formulated as a random parameter logit model with one or repeated choices with stable tastes from the sampled individuals. The WTP estimates have been presented in three different ways: point estimates, confidence intervals, and their entire estimated distribution. On average, in 2005 values, a Catalan over 18-year-old would pay 2.47 euros per year for being allowed to picnic in the new forests and 2.73 euros per year for the CO<sub>2</sub> sequestered annually by the new forests, which is equivalent to the emissions from a Catalan city of 100.000 inhabitants. The relatively large tail of the estimated distribution seems to indicate that a portion of the population has large WTP for this attribute. Respondents value negatively the possibility that driving through the new forests is allowed; this implying an individual cost of 6.5 euros per year. Likewise, they would be willing to pay 0.783 euros per year to delay one 100-year period of the loss of land productivity caused by erosion.

The results may be relevant for policy design in the afforestation practices in Catalonia. For example, the WTP estimates that could be used by forest planners in a social cost-benefit analysis to assess different variants of an afforestation program are the best to implement. Likewise, policy makes facing mushroom picking legislation ought to be aware of the social effects of such regulations. Management plans for public forests can benefit from the estimates if social welfare is taken into consideration. The results could also be used in forest damage assessments and the estimation of compensations.

CG does not seem to have notably different problems from other choice modeling variants. However, more applications would be needed to further test the applicability of CG.

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## References

- [1] N. Hanley, S. Mourato, and R. E. Wright, “Choice modelling approaches: a superior alternative for environmental valuation?” *Journal of Economic Surveys*, vol. 15, no. 3, pp. 435–462, 2001.
- [2] J. J. Louviere, D. A. Hensher, and J. D. Swait, *Stated Choice Method. Analysis and Application*, Cambridge University Press, Cambridge, UK, 2000.
- [3] R. G. Chapman and R. Staelin, “Exploiting rank ordered choice set data within the stochastic utility model,” *Journal of Marketing Research*, vol. 19, no. 3, pp. 288–301, 1982.
- [4] R. Brey, O. Bergland, and P. Riera, “A contingent grouping approach for stated preferences,” *Resource and Energy Economics*, vol. 33, no. 3, pp. 745–755, 2011.
- [5] D. A. Hensher and W. H. Greene, “The mixed logit model: the state of practice,” *Transportation*, vol. 30, no. 2, pp. 133–176, 2003.
- [6] D. A. Hensher, J. M. Rose, and W. H. Greene, *Applied Choice Analysis. A Primer*, Cambridge University Press, New York, NY, USA, 2005.
- [7] R. C. Mitchell and R. T. Carson, *Using Surveys to Value Public Goods: The Contingent Valuation Method*, Resource for the Future, Washington, DC, USA, 1989.
- [8] R. C. Bishop and T. A. Heberlein, “Measuring values of extramarket goods: are indirect measures biased?” *American Journal of Agricultural Economics*, vol. 61, no. 5, pp. 926–930, 1979.
- [9] W. M. Hanemann, “Welfare evaluations in contingent valuation experiments with discrete responses,” *American Journal of Agricultural Economics*, vol. 66, no. 3, pp. 332–341, 1984.
- [10] R. A. Kramer and D. E. Mercer, “Valuing a global environmental good: U.S. residents willingness to pay to protect tropical rain forests,” *Land Economics*, vol. 73, no. 2, pp. 196–210, 1997.
- [11] E. Lehtonen, J. Kuuluvainen, E. Pouta, M. Rekola, and C. Z. Li, “Non-market benefits of forest conservation in southern Finland,” *Environmental Science and Policy*, vol. 6, no. 3, pp. 195–204, 2003.
- [12] M. Lockwood, J. Loomis, and T. DeLacy, “A contingent valuation survey and benefit-cost analysis of forest preservation in East Gippsland, Australia,” *Journal of Environmental Management*, vol. 38, no. 3, pp. 233–243, 1993.
- [13] M. Lockwood, J. Loomis, and T. DeLacy, “The relative unimportance of a nonmarket willingness to pay for timber harvesting,” *Ecological Economics*, vol. 9, no. 2, pp. 145–152, 1994.
- [14] J. B. Loomis and A. Gonzalez-Caban, “A willingness-to-pay function for protecting acres of spotted owl habitat from fire,” *Ecological Economics*, vol. 25, no. 3, pp. 315–322, 1998.
- [15] M. Rekola and E. Pouta, “Public preferences for uncertain regeneration cuttings: a contingent valuation experiment involving Finnish private forests,” *Forest Policy and Economics*, vol. 7, no. 4, pp. 635–649, 2005.
- [16] R. Scarpa, S. M. Chilton, W. G. Hutchinson, and J. Buongiorno, “Valuing the recreational benefits from the creation of nature reserves in Irish forests,” *Ecological Economics*, vol. 33, no. 2, pp. 237–250, 2000.
- [17] M. Ben-Akiva, T. Morikawa, and F. Shiroishi, “Analysis of the reliability of preference ranking data,” *Journal of Business Research*, vol. 24, no. 2, pp. 149–164, 1991.
- [18] V. Foster and S. Mourato, “Testing for consistency in contingent ranking experiments,” *Journal of Environmental Economics and Management*, vol. 44, no. 2, pp. 309–328, 2002.
- [19] J. A. Hausman and P. A. Ruud, “Specifying and testing econometric models for rank-ordered data,” *Journal of Econometrics*, vol. 34, no. 1-2, pp. 83–104, 1987.
- [20] W. Adamowicz, J. Swait, P. Boxall, J. Louviere, and M. Williams, “Perceptions versus objective measures of environmental quality in combined revealed and stated preference models of

- environmental valuation,” *Journal of Environmental Economics and Management*, vol. 32, no. 1, pp. 65–84, 1997.
- [21] P. C. Boxall and B. MacNab, “Exploring the preferences of wildlife recreationists for features of boreal forest management: a choice experiment approach,” *Canadian Journal of Forest Research*, vol. 30, no. 12, pp. 1931–1941, 2000.
- [22] P. Horne, P. C. Boxall, and W. L. Adamowicz, “Multiple-use management of forest recreation sites: a spatially explicit choice experiment,” *Forest Ecology and Management*, vol. 207, no. 1–2, pp. 189–199, 2005.
- [23] J. Rolfe, J. Bennett, and J. Louviere, “Choice modelling and its potential application to tropical rainforest preservation,” *Ecological Economics*, vol. 35, no. 2, pp. 289–302, 2000.
- [24] G. D. Garrod and K. G. Willis, “The non-use benefits of enhancing forest biodiversity: a contingent ranking study,” *Ecological Economics*, vol. 21, no. 1, pp. 45–61, 1997.
- [25] J. Siikamaki and D. Layton, “Pooled models for contingent valuation and contingent raking data: valuing benefits from biodiversity conservation,” Working Paper, Department of Agricultural and Resource Economics, University of California, Davis, Calif, USA, 2001.
- [26] P. Riera, M. Giergiczy, J. Peñuelas, and P. A. Mahieu, “A choice modelling case study on climate change involving two-way interactions,” *Journal of Forest Economics*, vol. 18, no. 4, pp. 345–354, 2012.
- [27] R. D. Luce and P. Suppes, “Preference, utility and subjective probability,” in *Handbook of Mathematical Psychology*, R. D. Luce, R. R. Bush, and E. Galanter, Eds., J. Wiley and Sons, New York, NY, USA, 1965.
- [28] Departament d’Agricultura, *Ramaderia I Pesca, DARP*, Pla General de Política Forestal. Generalitat de Catalunya, Barcelona, Spain, 1994.
- [29] C. García, *Estimació de les macromagnituds agràries de les comarques de Catalunya, 1993*, Serveis de Publicacions, Universitat de Lleida, Lleida, Spain, 1997.
- [30] M. Merlo and E. Rojas, “Policy instruments for promoting positive externalities of Mediterranean forests,” in *Proceedings of the European Forest Institute, Annual Conference*, Chantreuse Ittingen, Switzerland, 1999.
- [31] Council Regulation (EC) No 2080/92 Community aid scheme for forestry measures in agriculture, 30 June 1992.
- [32] Council Regulation (EC) No 1257/1999 Support for rural development from the European Agricultural Guidance and Guarantee Fund (EAGGF) and amending and repealing certain Regulations, 17 May 1999.
- [33] K. Train, *Discrete Choice Methods with Simulation*, Cambridge University Press, New York, NY, USA, 2003.
- [34] W. H. Greene, *NLogit Version 3.0 Reference Guide*, Econometric Software, Plainview, NY, USA, 2002.
- [35] D. McFadden and K. Train, “Mixed MNL models for discrete response,” *Journal of Applied Econometrics*, vol. 15, no. 5, pp. 447–470, 2000.
- [36] M. Evans, N. Hastings, and B. Peacock, *Statistical Distributions*, John Wiley and Sons, New York, NY, USA, 3rd edition, 2000.
- [37] I. Krinsky and A. L. Robb, “On approximating the statistical properties of elasticities,” *The Review of Economics and Statistics*, vol. 68, no. 4, pp. 715–719, 1986.
- [38] B. W. Silverman, *Density Estimation for Statistics and Data Analysis*, Chapman and Hall, New York, NY, USA, 1986.
- [39] Departament de Medi Ambient, *Les emissions a l’atmosfera a Catalunya. Una aproximació quantitativa. Quaderns de Medi Ambient*, 5. Generalitat de Catalunya, Barcelona, Spain, 1996.



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