FOREST VALUE INFERENCE USING CONTINGENT VALUATION AND CHOICE EXPERIMENTS

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Abstract

A way to avoid unnecessary costs in estimating the social value of forests is to base such estimations in other values already obtained. This practice has advantages and disadvantages. Among the latter, the reliability of the obtained value is probably the one of most concern. This paper tests the reliability of a specific value inference exercise for forests, finding positive results when contingent valuation and choice experiments are used.

Key words: Value inference; Choice experiment; Contingent valuation; Forest externalities; Social value; Total economic value.

Introduction

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 rest of effected persons. The field of economics helps in this process by being able to estimate the value, in monetary units, of the forest at stake. While the value for the owner –or *private value*– is expressed in terms of market prices, tools to estimate the forest value to the whole society –often called *social value* or *total economic value*– have been developed in the last few decades. The most used one is the contingent valuation method (CVM), with an increasing popularity of other stated preference methods, like choice experiments (CE).

Unfortunately, these methods are considerably time-consuming and rather expensive to undertake, especially if they are to be applied to a large number of forests. A foreseeable consequence of increasing costs is a decrease in the likelihood to undertake those valuation studies. To some extend, this has been mitigated in areas like transportation or health by "borrowing" or "transferring" some already obtained values to estimate the value of a relatively similar good (Ben-Akiva, and Bolduc, 1987; Koppelman *et al*. 1985; Galbraith and Hensher, 1982). However, relatively less attention has been paid to this approach in environmental economics, and even less in forest economics (Xu and Adamowicz, 1997; Azqueta and Touza-Montero, 2000; Rosenberger and Loomis, 2001; Haener *et al.*, 2001). The strongest concern in these fields has probably been the reliability of the procedure, whether the new values obtained from existing ones are similar or significantly different than the value that would be obtained from an *ad hoc* exercise (Loomis, 1992; Bergland *et al.*, 1995; Kirchhoff *et al*., 1997; Morrison and Bennett, 2000; Morrison *et al.,* 2002).

This paper proposes a way to infer values from existing ones and conducts a test of predictability of forest social value inference using two different methods, CVM and CE. This is related to benefit transfer tests, although it is different in the sense that there is no transfer between sites but between goods and attributes in the same site. To our knowledge, no similar tests have been conducted combining CVM and CE. Next section introduces the concept of value inference and the test to be conducted. In section three a brief overview of the methods used and their underpinning theory is presented, followed by the details of the exercises designed to apply the inference test. Section four presents the joint preference analysis. Before conclusions, the results of the test are presented.

Value Inference and Benefit Transfer

The closest literature to the study presented here is the benefit transfer (BT) one. Following Desvouges *et al*. (1992), benefit or value transfer is the use of the monetary value of a good obtained in a given context (often called *study site*), to estimate the value of a similar good under a different context (*policy site*). For instance, the value of a forest can be estimated from the known value of another similar forest placed elsewhere. Sometimes, however, it is the good itself that varies in one way or another. This would be the case of estimating the value of a forest with a given composition from a forest in the same area but with a different composition or management program. This case is what is called here "value inference" to distinguish it from value or benefit transfer.

Obtaining values from transfer exercises has pros and cons. On the negative side, transferred values are subject to different measurement errors (Bergstrom and De Civita, 1999). This could be specially the case when the study and policy sites differ very much in some characteristics. Potential statistically significant discrepancies between transferred values and values obtained directly have raised concerns about the reliability of transferring benefits (Brouwer, 2000). On the positive side, if reliable, transferability (inference) would be a cost-effective way to estimate the social value of forests. Applying previous research findings might be an attractive alternative to expensive and time consuming original research.

Transferring is standard practice for some practitioners, especially in cost-benefit analysis (Bergstrom and De Civita, 1999), and it has been suggested that benefit transfer approaches will become even more widespread (Desvouges *et al*., 1992; OECD, 1993). One reason for this practice is that since the 1990s more rigorous approaches to benefit transfer have been proposed with the use of better protocols, cautions, and common practice recommendations (Desvouges *et al.*, 1992; Boyle and Bergstrom, 1992; Smith, 1992; Kask and Shogren, 1994; Brouwer, 2000; EFTEC, 2000; Rosenberger and Loomis, 2000; Ruijgrok, 2001).

Most of the comments above can be applied to value inference. It shares the basic advantages and disadvantages of BT and different implementation approaches are possible, similar to BT. The rest of this section is devoted to illustrate the way value inference could work in a forest valuation context and to introduce the test to be undertaken in the case study application.

In the proposed application, two forests are considered, FOREST A and FOREST B, placed in the same region, but with different characteristics (attributes). The idea of the test is to see whether the value of FOREST B can be predicted (inferred) from the value of FOREST A using the marginal values of the attributes that vary from one forest to the other estimated with a choice experiment.

A bit more formally, assume that the correct welfare measure from a rational individual reflecting her value (maximum willingness to pay) for the provision of a good is the compensating variation (*CV*), which is the amount of money that deducted to her income (*y*) leaves her indifferent between getting the good by paying this amount, and not getting the good and paying nothing. Therefore, for a public good *z* and all attributes *j* of this good,

[1] $$v(p, y, z^0(z_j)) = v(p, y\text{-}CV, z^1(z_j))$$

where v is the indirect utility level of the individual, p is the vector of prices of private goods, z^0 is the level of the public good before the proposed change, z^1 is the new level of the good, and z_j denotes the j relevant attributes of good z.

The values CV_j assigned to each relevant attribute $j = 1, \ldots, J$, of good z, can be reflected in terms of an indirect welfare function as

[2] $$v(p, y, z^0(z_1, \ldots, z_J)) = v(p, y\text{-}CV(CV_1, \ldots, CV_J), z^1(z_1, \ldots, z_J))$$

The general expression [2] takes the form

$$v(p, y, z^0{}_1+\ldots+z^0{}_J) = v(p, y\text{-}CV_1 \text{-}\ldots\text{-}CV_J, z^1{}_1+\ldots+z^1{}_J)$$

when independence between attributes (no higher order cross effects) is assumed and the utility function is linear and additive with respect to the attributes.

Similar to [1], the indirect utility for FOREST A and FOREST B can be expressed respectively as

$$v(p, y, z^0(z_j)) = v(p, y\text{-}CV^A, z^A(z_j))$$
$$v(p, y, z^0(z_j)) = v(p, y\text{-}CV^B, z^B(z_j)),$$

where z^0 denotes the status quo situation (marginal agricultural use of the land, in the case study below), z^A and z^B denote the goods FOREST A and FOREST B, and compensating variations

CV^A and CV^B reflect the maximum willingness to pay (WTP) of the individual to obtain each good.

In the application below, CV^A for FOREST A and CV^B for FOREST B are estimated by CVM. In addition, CV^B is also estimated from inference by adding to CV^A the corresponding value of attributes variation between both forests (CV_J). The value of these attributes is estimated by CE. To distinguish between both CV^B, the one corresponding to the mean of the maximum willingness to pay calculated from CVM will be denoted μ_{CVM}^B, while the one obtained by value inference will be denoted as μ_{VI}^B.

The null and alternative hypothesis for the predictability (or convergence between *ad hoc* and inferred values) test can then be expressed as

[3] $$H_0: \mu_{CVM}^B = \mu_{VI}^B$$
$$H_1: \mu_{CVM}^B \neq \mu_{VI}^B$$

If the null hypothesis cannot be rejected at a given confidence level, the reliability of obtaining values from value inference could not be discarded, when estimated by the methods used in the empirical exercise.

Afforestation in Catalonia and the research design

Choice experiment method

Choice experiment, also called *contingent choice*, is a stated preference valuation method that is becoming progressively more popular. Other stated preference methods are contingent ranking and contingent rating o paired comparisons –see Louviere *et al.* (2000) or Hanley *et al.* (2001) for an overall description of stated preference methods. The choice experiment approach consists in a set of options, usually called *alternatives*, containing common attributes of a good with different values, often called *levels*, for each attribute. One of the attributes is the money a person would have to pay, or get in compensation, for the overall good as described by its attributes. It could also be applied to a bundle of goods, and the "attributes" would be the different goods of the bundle. Through a questionnaire, a sample of the population is faced with a number of alternatives, out of which a person has to choose the most preferred one. The alternatives presented to respondents ought to include always the status quo situation. The information of individual choices is then used to econometrically estimate the marginal value of each attribute (Hanley *et al.*, 1998a; Hanley *et al*., 1998b; Morrison *et al.*, 1998; Rolfe et al., 2002).

Initially, marketing was one of the main fields of application of choice experiments, but other areas, such as transportation, geography, and the environment, among others, incorporated the method (Louviere, 1991). Most of the papers on choice experiments in environmental economics are relatively recent (Opaluch *et al.*, 1993; Adamowicz *et al*., 1994; Eom, 1994; Adamowicz *et al.*, 1996; Rolfe and Bennett, 1996; Boxall *et al.*, 1996; Bergland, 1997; Adamowicz *et al.*, 1998; Hanley *et al*., 1998a; Hanley *et al*., 1998b; Boxal and Macnab, 2000; Rolfe *et al.*, 2002).

The number of papers dealing with BT and choice experiments is rather modest. The closest applications to the one presented here are those of Morrison *et al.* (1998) and Morrison and Bennett (2000). These authors estimated the marginal WTP for some attributes of Australian wetlands, using the choice experiment method in three subsamples, and tested the equality among those marginal WTP values. They concluded that choice experiments estimate similar marginal values when applied to goods with different levels of their attributes.

The valuation exercise presented in this paper involves the estimation of the impact of alternative afforestation programs on non-market forest values. The afforestation program concerned was in Catalonia, a region in the Northeast of Spain, which has 1.3 million ha of forests, or about 40 per cent of its total area. Although the composition of the forest varies from the coastal areas to the Pyrenees and the inland plains, most are composed of Mediterranean species. The pine is the dominant species covering 50 per cent of the forested area, followed by the holm oak with some 10 per cent (Ministerio de Medio Ambiente, 1996). The majority (77 per cent) of forests is privately owned.

The program being proposed involves an increase in forest coverage from the current 40 per cent of the Catalonian area to 50 per cent. The additional 10 per cent of forest area would be at the expense of marginal agricultural land. Each questionnaire contained a sequence of four election sets with three alternatives. The alternatives varied from questionnaire to questionnaire, as will be explained below. One of the three alternatives was always the status quo situation, i.e. no afforestation and no payment required. The other two reflected 10% afforestation with different attribute levels.

The first step in implementing the CE exercise was the determination of the attributes to be used to describe each afforestation alternative. Discussions with experts working in forestry research, focus groups and repeated interviews with samples of the Catalan population, were conducted to determine the non-market attributes associated with the forest. The attributes chosen for the analysis were some recreational activities –such as picnicking, picking mushrooms, and driving motor vehicles on forest ways–, CO_2 sequestration, erosion prevention, and the payment contribution. Payment values were originally expressed in Spanish pesetas, although in this paper they are reported in euros. The attributes and their levels are shown in Table 1.

Table 1. Attributes and levels used in the choice experiment

Attribute	Description	Levels
Picnic	Picnicking allowed in the new forests	Yes No
Drive	Driving by car through the new forests would be allowed	Yes No
Mushrooms	Picking mushrooms allowed in the new forests	Yes No
CO_2	CO_2 sequestered annually by the new forests. Equivalent to the pollution produced annually by a city of...	300.000 people 400.000 people 500.000 people 600.000 people
Erosion	Erosion decrease (If not afforested, land would become unproductive....)*	After 100 years After 300 years After 500 years After 700 years
Cost##	The afforestation cost per person and year	6 euros 12 euros 18 euros 24 euros

Note:
#SQ: Status Quo
Payment values were originally expressed in Spanish pesetas, although in this paper they are reported in euros
* If afforested, erosion would be prevented indefinitely.

The final design selected 64 pairs of alternative afforestation compositions out of a universe of $(2^3 \times 4^3) \times (2^3 \times 4^3)$ possible combinations, following a fractional factorial design (Louviere, 1988). The 64 pairs were then blocked into 16 versions of 4 choice sets of two alternatives plus the status quo. In this way, there were a total of 16 questionnaire versions, each one assigned randomly to a subsample out of a larger sample of 1200 individuals representative in terms of location, age and gender of the Catalan population over 18 years old. Appendix A displays one of the resulting choice sets.

Contingent valuation method

A second valuation exercise was undertaken, to find the maximum willingness to pay for two given new forest compositions: FOREST A and FOREST B. The new forests had the same extension than in the previous exercise, i.e. covering an additional 10% of Catalonia, substituting marginal agricultural land. The method used was the Contingent Valuation Method, which was applied in a similar way than the choice experiments, but without varying the physical attributes of the forest, only the monetary payments. CVM is a stated preference method where respondents are asked for their maximum willingness to pay (or minimum willingness to accept in compensation) to get or avoid a given increase or decrease in environmental quality (see, for instance, Mitchell and Carson, 1989). CVM has been used to estimate the value of a wide variety of environmental resources. However, its use has been subject to criticism in terms of its ability to deliver reliable and accurate estimates of the willingness to pay and the correct design of CVM surveys (Diamond and Hausman, 1994).

Following the guidelines of the NOAA blue ribbon panel (Arrow *et al.*, 1993), a binary dichotomous choice format was used where each forest was offered to individuals at a given price (bid). Thus, after describing the particular forest composition, the respondents were given the option of choosing to pay the bid (annual payment) and accepting the afforestation program, not paying the cost amount and not accepting the program ("status quo" option) or responding "I don't know". The monetary amounts were 6, 12, 18, 36, 48, and 72 euros, and one amount was assigned to each questionnaire version, making a total of six versions per type of afforestation. Table 2 shows the attribute levels of both forests. It is assumed, from the differences in physical attribute levels that FOREST B is preferred to FOREST A. Appendix B shows a card corresponding to the FOREST A CVM exercise.

Table 2. Attributes and levels used in the CVM exercises

Attribute	FOREST A	FOREST B
Picnic	Yes	Yes
Drive	Yes	Yes
Mushrooms	Yes	Yes
CO_2	400,000 people	600,000 people
Erosion	After 500 years	After 100 years
Cost	6 euros 12 euros 18 euros 36 euros 48 euros 72 euros	6 euros 12 euros 18 euros 36 euros 48 euros 72 euros

A total sample of 1000 people, representative in terms of location, age and gender of the Catalan population over 18 years old, was divided into two roughly equal sub-samples[1]. Each sub-sample

[1] The sample of 1000 respondents used in the CVM exercises was a sub-sample of the total sample used in the CE. Each respondent faced a questionnaire that contained a description of the positive and negative effects of the afforestation programme, the choice experiment questions, the dichotomous choice CVM question, a part devoted to debriefing, and a socio-demographic section.

was assigned a given afforestation project (FOREST A or FOREST B), and one of the six CVM questionnaire versions were randomly allocated to respondents within each sub-sample.

Sample

Interviews were conducted face-to-face in households, in the fall of 1999. The average valid response rate was 95 per cent across all subsamples for the CE application and 84 per cent for the CVM survey. The difference is explained by a higher number of protest answers in the CVM version. The most common motives for protesting were that the "government should pay", and the belief that the provision of the good would be ineffectual. Protest answers were excluded for the value estimation. The socio-demographics of the respondents can be seen in detail in Mogas *et al*. (2002).

Model specification

The CE structure and the referendum CVM structure can both be analyzed using a random utility model (RUM) (Thurstone, 1927; McFadden, 1974). Under the RUM framework, the election of one of the three scenarios in the choice experiment, or yes/no in the CVM experiment, represents a discrete choice from a set of alternatives reflecting an underlying utility function. The utility that and individual derives from an alternative *i* is represented as

$$U_i = v_i + \varepsilon_i$$

This conditional indirect utility function is comprised of a deterministic component (v_i) and a random error component (ε_i). An individual will choose alternative i if $U_i > U_j$ for all $j \neq i$. Thus, the probability of choosing alternative i is

$$\pi(i) = \text{Probability}(v_i + \varepsilon_i \geq v_j + \varepsilon_j), \quad \forall j \in C$$

where C is the choice set. If the random terms are assumed to be independently and identically distributed with an extreme value type I distribution, then the probability of choosing i takes the form

$$\pi(i) = \frac{e^{\omega v_i}}{\sum_{j \in C} e^{\omega v_i}}$$

where ω is a scale parameter, inversely proportional to the standard deviation of the error distribution, and conventionally normalized to one. In the dichotomous choice form of the CVM, this formulation can be estimated using the binary logit model (Hanemann, 1984), while in the CE approach this form represents the conditional logit model (McFadden, 1974).

Equivalence test of the models

Before proceeding with the test of the hypothesis for the predictability (or convergence of values) described above and the estimation of welfare measures, the preference equality across the three sets of data (CE and CVM for FOREST A, and CVM for FOREST B) is considered. Since the CE and CVM approaches share the random utility maximization theory, and the choices are being made over the same goods, it is possible to combine the three datasets for a joint estimation to identify the relative scale factors (Swait and Louviere, 1993; Adamowicz *et al.*, 1994; Adamowicz *et al.*, 1998; Rolfe *et al.*, 2002).

To see whether the preferences reflected in the choice experiments and the contingent valuation exercises are the same, the equivalence test originally proposed by Swait and Louviere (1993) was conducted. The preference equality across data sources involves pooling the three data sources under the restriction that the common parameters across the models are equal, while controlling for the scale parameters. Although it is not possible to identify the three scale parameters, a relative scale parameter can be computed across separate data sets. The scale factor will account for differences in the variation of the unobserved effects, i.e. error variance heterogeneity (Swait and Louviere, 1993). The scale parameter for the CE dataset is set to 1, while the scale parameters for CVM (from FOREST A and FOREST B) are unconstrained. Therefore, two relative scale parameters with respect to the CE data scale could be estimated: the ratio of the scale parameter of the FOREST A dataset relative to the scale parameter of the CE data (ω_A) and the scale factor of FOREST B relative to the CE data (ω_B).

The hypothesis to be tested is H_0: $\beta = \beta^{CE} = \beta^{CVMA} = \beta^{CVMB}$, where β^{CE}, β^{CVMA}, β^{CVMB} are utility parameters for the common attributes between the three datasets. Under this hypothesis, the relative scale factors between models can be estimated by stacking the three datasets and conducting a one-dimensional search using a range of values for the scale parameters. The value of the scale parameter is found when the log-likelihood of the conditional logit model using the stacked data, is maximized. The joint model is presented in Table 3. The maximum log-likelihood value of the joint or "stacked" model was achieved when ω_A assumed a value of 1.45 and ω_B a value of 1.61.

Table 3. Joint model estimation (scaled)

Variable	Coefficient	Statistic	Value
Constant	1.146***	Scale parameters	
Picnic	0.073**	ω_A	1.45
Mushrooms	0.106***	ω_B	1.61
Drive	-0.166***		
CO_2	0.730E-06***		
Erosion	-0.264E-03***	Log. Likelihood	-5046.064
Cost	-0.0180E-01***	Pseudo-R^2 (McFadden, 1974)	0.15
Age	-0.010***		
Gender	-0.290***	χ^2	1737.72
Income	0.3195E-05**	Observations	5411
Visitation	0.374***		
Rural	0.607***		

***Significant at 1% level; **Significant at 5% level

Variable definitions:

Age = individual's age minus mean age of sample (45.64)
Gender = gender of the respondent (1 for male, 0 for female)
Income = income of the respondent in euros
Visitation = Use of the forest for recreation (1 if the respondent had used the forest during the last year, 0 otherwise)
Rural = village size (1 if <10,000 inhabitants, 0 if >10,000 inhabitants)

The Swait and Louviere (1993) test is used to determine whether the null hypothesis should be rejected. This test statistic is asymptotically chi-squared distributed with *k*-1 degrees of freedom, where *k* is the number of attributes that are forced to be the same across datasets. The estimated chi-squared statistic is 4.724 (5 d.f.), and the critical value of the χ^2 statistic at the 5% significance level is 11.07, implying that the null hypothesis of equality of parameters cannot be rejected. In other words, the hypothesis of preference equality between the three data sources can be retained.

Results

Choice experiment results

A conditional logit model was specified and estimated from the choice data using a maximum likelihood approach (McFadden, 1974). The results of the logit analysis of the stated preference data are presented in Table 4.

Table 4. conditional logit model estimation for the CE application

Variable	Coefficient	Statistic	Value
Constant	1.0446***	Log. Likelihood	-4515.908
Picnic	0.0809**	Pseudo-R^2 (McFadden, 1974)	0.10
Mushrooms	0.1079***		
Drive	-0.1649***	Pseudo-R^2 (Veall-Zimmermann, 1996)	0.27
CO_2	0.8110E-06***		
Erosion	-0.3030E-03***		
Cost	-0.0187***	χ^2	1005.60
Age	-0.0105***	Observations	4576
Gender	-0.3712***		
Income	0.840E-03***		
Visitation	0.4174***		
Rural	0.7385***		

Note: ***Significant at 1% level; **Significant at 5% level

Variable definitions:

Age = individual's age minus mean age of sample (45.64)
Gender = gender of the respondent (1 for male, 0 for female)
Income = income of the respondent in euros
Visitation = Use of the forest for recreation (1 if the respondent had used the forest during the last year, 0 otherwise)
Rural = village size (1 if <10,000 inhabitants, 0 if >10,000 inhabitants)

The signs of the parameters are consistent with usual expectations, and almost all attributes are statistically significant at 95% confidence level. The intercept term indicates that the respondents perceive as positive the afforestation program. Picnicking, picking mushrooms, and the CO_2 sequestered by the new forests are factors that positively affect utility, while respondents place a negative value to allowing the use of cars in forest ways and to increases in erosion if the afforestation would not be undertaken. The coefficient of the annual contribution is also negative, as expected, which indicates that it is perceived as a cost.

Focusing on the socio-demographic characteristics, being female, living in a rural area, having higher income, and using forest for recreation, increase significantly the probability of choosing the afforestation program alternatives. Also, ages between 25 and 65 tend to be more willing to pay for the program than younger or older population.

The fit of the model is rather low[2], although in line with some other CE applications (Adamowicz *et al.*,1998; Christie and Azevedo, 2002; Morrison *et al.* 2002; Rolfe *et al.*, 2002). It would be advisable, however, to replicate the value inference test with higher fit statistics.

The β coefficients from the conditional logit model were used to estimate the marginal WTP for each attribute, or implicit price. The marginal annual WTP for each attribute can be inferred by calculating the ratio $-\beta_i / \beta_{COST}$, where β_i is the regression coefficient of the physical attribute and β_{COST} represents the monetary attribute coefficient. The confidence intervals for the different marginal WTP estimations were obtained following the Krinsky and Robb (1986) bootstrapping

[2] Two Pseudo-R^2 s based on different construction criteria are used following the recommendations of Amemiya (1981)

procedure and the percentile method of Efron and Tibshirani (1993) with 1000 random extractions[3]. Table 5 shows the main results.

Table 5. Marginal annual WTP for the CE attributes (in euros of 1999)

Variable	Marginal WTP
Picnic	4.33[#] (0.039, 9.96)
Drive	-8.83 (-15.91, -4.18)
Mushrooms	5.78 (1.07, 12.00)
CO_2	4.345E-05 (2.18E-05, 7.66E-05)
Erosion	0.017 (0.0064, 0.032)

Note: [#] Non-significant coefficient in the conditional logit estimation.
In brackets, confidence intervals at 95%.

Marginal WTP indicate, for each attribute, the average amount of euros that a person would be prepared to pay annually, indefinitely, for an increase (or decrease) of one unit in the attribute level. A positive (negative) marginal value for an attribute denotes that the average person would be better off with an increase (decrease) in the level of the attribute. The values of PICNIC, MUSHROOMS, and DRIVE correspond to a discrete change, from being able to picnic, pick mushrooms, or drive cars in the new forests, to not being able to do those recreational activities. The marginal WTP for CO_2 reflects the value that a new forest provides to society by sequestering the CO_2 emissions that a citizen of Catalonia generates annually in production and

[3] It involves the simulation of an asymptotic distribution of the coefficients that are generated in a CE, from which confidence intervals can then be computed. The distribution is achieved by taking repeated random draws of the coefficient vectors from the multivariate normal distribution defined by the coefficient estimates and their associated covariance matrix. Implicit prices can then be calculated from each of the random draws of coefficients, and confidence intervals estimated by identifying the values at each tail of the distribution of implicit prices (Rolfe *et al.*, 2002)

consumption activities[4]. Similarly, the marginal WTP for EROSION is interpreted as the average maximum WTP for increasing one year the time horizon of land productivity due to the prevention of erosion with the land use change. The value is taken with a positive sign, although the sign is negative in Table 4 due to the way the question was framed.

Contingent valuation results

The coefficients of the two CVM exercises were estimated using a logit regression. Table 6 shows the model estimation results for FOREST A and FOREST B, with the dependent variable reflecting the answers to accept the proposed annual payment (bid).

Table 6. Logit model estimation for Forests A and B

Variable	FOREST A Coefficient	FOREST B Coefficient
Constant	0.577 ***	0.802**
Cost	-0.033***	-0.018***
Gender	-0.215E-02	-0.458**
Income	4.261E-4***	4.128E-4**
Visitation	0.581***	0.482**
Rural	1.091***	0.405*
Maximum Log. Likelihood	-289.469	-238.325
% of correct predictions	68%	63%
χ^2	64.856	22.586
Number of valid observations	464	371

Note: ***Significant at 1% level; **Significant at 5% level

Variable definitions:

Age = individual's age minus mean age of sample (45.64)

Gender = gender of the respondent (1 for male, 0 for female)

Income = income of the respondent in euros

Visitation = Use of the forest for recreation (1 if the respondent had used the forest during the last year, 0 otherwise)

Rural = village size (1 if $<$10,000 inhabitants, 0 if $>$10,000 inhabitants)

[4] This estimation was based in the total of CO_2 emissions added to the atmosphere in Catalonia in 1995, equivalent to 6.8 tonnes per year (Departament de Medi Ambient de la Generalitat de Catalunya, 1996)

As expected, the sign of PRICE coefficient is negative and significant, which indicates that the probability for people to accept to pay the proposed amount decreases as the demanded payment increases. In both CVM models those who have more income, those who used the forest for recreation during the last year and those who live in a rural area, are more likely to pay. The chi-square statistic indicates that each model is significant at the 99% level.

Table 7 shows the estimation of the mean WTP based on the information from Table 6. Since the assumed distribution for WTP in the logit model is a symmetrical one, the mean and median WTP coincide and can be estimated from the ratio $-\alpha/\beta$, where β is the value of the coefficient of the cost variable in the estimated logit equation, and α is the sum of all other terms in the equation evaluated at the mean values of the explanatory variables (Hanemann, 1984; Hanemann and Kanninen, 1999). Table 7 reports the mean WTP for both forests, as well as the confidence intervals. The confidence intervals were calculated using the Krinsky and Robb (1986) bootstrapping procedure with 1000 extractions.

Table 7. Mean annual WTP for FOREST A and FOREST B (in euros of 1999)

Welfare specification	WTP FOREST A	WTP FOREST B	P-value (Poe *et al.*)
Mean CVM	37.5 (31.57, 45.97)	60.95 (47.28, 100.62)	0.00

Note: 95 per cent confidence intervals for 1000 extractions.

The mean WTP for FOREST B (WTP_B) is greater than the WTP for FOREST A (WTP_A), by a difference of about 23 euros. The sign of this result is consistent with expectations, since

FOREST B type was supposed to be more desirable than FOREST A because it sequesters more CO_2 and prevents erosion for a longer period of time (Table 2).

To see, however, if the difference is statistically significant, the one-tail non-parametric test proposed by Poe *et al.* (1997) was applied. This test was constructed following a Krinsky and Robb (1986) bootstrap procedure, with a thousand extractions. The 95% confidence intervals and the probability value for the test of equality among means are shown in Table 7. For a 95% confidence level, the null hypothesis of equal WTP for forests A and B is rejected.

Value Inference Test

The value inference test checks whether μ_{CVM}^{B} is significantly different than μ_{VI}^{B}. The value of μ_{CVM}^{B} in [3] is the WTP for FOREST B reported in Table 7 (60.95 euros per year and person, in 1999 values). The value of FOREST B inferred from FOREST A, $\mu_{VI,}^{B}$, is calculated from the WTP for FOREST A and the marginal values obtained through the CE of the two attributes that vary between forests (CO_2 and EROSION), as shown in Table 5 (52.70 euros).

For the inference test both the values for the increase in CO_2 sequestration of FOREST B compared to FOREST A –which is the annual equivalent of a city of 200,000 people–, and the improvement in erosion prevention –for an extra 400-year period–, were treated as if they responded to a linear function. This is a usual hypothesis in the literature and implies the assumption that marginal unitary values would be constant within the limited segments of level variation examined.

Table 8 shows the above-mentioned results and their confidence intervals using Krinsky and Robb (1986) bootstrap procedure with 1000 extractions. It also shows the results of the test for [3], based on the non-parametric indicator proposed by Poe *et al*. (1997), with 1000 bootstrapping extractions. In this particular contrast, [3] takes the form:

H_0: $\mu_{CVM}{}^{B} - \mu_{VI}{}^{B} = 0$
H_1: $\mu_{CVM}{}^{B} - \mu_{VI}{}^{B} \neq 0$.

Table 8. Predictability test for FOREST B (in euros of 1999)

Welfare specification	WTP FOREST B $\mu_{CVM}{}^{B}$	WTP FOREST B PREDICTED $\mu_{VI}{}^{B}$	P-value (Poe *et al.*)
Mean CVM	60.95 (47.28, 100.62)	52.70 (46.14, 64.29)	0.20

The result implies that the null hypothesis of equality between the transferred predicted value and the one obtained with an *ad hoc* estimation cannot be rejected at a 95% confidence level (the *p* value is above the 5% threshold level). These results suggest that the marginal WTP values obtained from a choice experiment may constitute an acceptable option for estimating the value of new forests where attributes of the good vary, instead of undertaking successive CVM studies to find the value of each forest.

Conclusions

In their decision-making, public administrations or private agents may often be interested in knowing the economic value of environmental assets, like forests. This value is most usually obtained by applying the contingent valuation method (CVM) or some other valuation method. If the process of estimating such values were less expensive and time consuming, environmental values would probably influence decisions more often, contributing to their rationality. A possible cost-effective way for obtaining non-market values for a number of environmental assets (like forests) would be through a procedure with similarities to benefit transfer, named here "value inference", i.e. relying on previously obtained values. In other words, if by value inference the analyst could obtain approximately the same value than with a CVM *ad hoc* study, the procedure would be an advisable cost-effective alternative.

This paper has proposed the combined use of CVM and choice experiments (CE) to obtain a base value and marginal attribute values respectively to be used in the inference exercise. Furthermore, it has presented an application between forests that vary in some attribute levels. The main conclusion has been that the null hypothesis of equality between the CVM value of a forest and the value predicted from inference cannot be rejected. The result suggests that, if it could be further replicated, the combination of CVM and CE (base and marginal values) would constitute a reliable alternative to valuing relatively similar environmental goods.

Future work could test whether assuming other than a linear relation between attribute level and value, or using discrete instead of marginal values of attributes, could improve the accuracy of the inference. Additionally, using CE only, without relaying in CVM, could also be considered.

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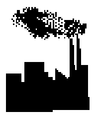
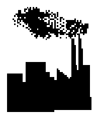
Appendix A

Example of a pair of afforestation alternatives used in the CE exercise

Of these two ways of afforesting 10% of the area of Catalonia **[SHOW CARD AND EXPLAIN THE MEANING OF THE LEVELS AND ATTRIBUTES]**

FOREST UTILITY	**AFFORESTATION A**	**AFFORESTATION B**
RECREATIONAL ACTIVITIES ALLOWED	 • DRIVING BY CARS IN DESIGNATED TRAILS	 • DRIVING BY CARS IN DESIGNATED TRAILS  • PICNICKING
GAS CO_2 SEQUESTERED PER YEAR (Pollution produced by....	 CITY OF **400.000** INHABITANTS	 CITY OF **500.000** INHABITANTS
NEW FOREST IN...	Soil eroded **A LITTLE** (Unproductive in 500 years)	Soil eroded **A LITTLE** (Unproductive in 500 years)

ECONOMIC COST

ANNUAL CONTRIBUTION	**18 euros/year**	**24 euros/year**

¿Would you choose A, B, or neither?**[ALLOW INDIFFERENCE]**

AFFORESTATON A...........1
AFFORESTATION B..........2
NEITHER.............................3
INDIFERENT.......................4
DOESN'T KNOW............... 8
DOESN'T ANSWER...........9

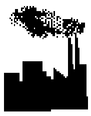
Appendix B.

Example of the question used in the CVM corresponding to the FOREST B

The afforestation that the administration is thinking about carrying out is the afforestation corresponding to the card **[SHOW CARD]** *,i.e., they would do a afforestation with these effects* **[EXPLAIN THE MEANING OF THE LEVELS AND ATTRIBUTES OF THE CARD]**

FOREST B

FOREST UTILITY

RECREATIONAL ACTIVITIES ALLOWED		• DRIVING BY CARS IN DESIGNATED TRAILS
		• PICNICKING
		• PICKING MUSHROOMS
GAS CO_2 SEQUESTERED PER YEAR (Pollution produced by....		CITY OF **400.000** INHABITANTS
NEW FOREST IN......		Soil eroded **A LITTLE** (Unproductive in 500 years)

ECONOMIC COST

ANNUAL CONTRIBUTION	**36 euros/year**

¿Would you accept this afforestation?

YES................... 1
NO........................... 2
DOESN'T KNOW..... 8
DOESN'T ANSWER.... 9