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Finding the Social Value of Forests Through Stated Preference Methods. A Mediterranean Forest Valuation Exercise

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Abstract. There are several methods to estimate the social value of forests or forest attributes, the most widely used being the stated preference methods. This paper illustrates the use of such methods to estimate some recreational functions of Mediterranean forests, as well as CO_2 sequestration and soil erosion prevention. It also compares the results from a contingent ranking and a choice experiment method application.
Key word: forest valuation; environmental valuation; contingent ranking; choice experiment; conjoint analysis; forestation

Sumário. A declaração de preferências corresponde ao método mais comum para estimar o valor social das florestas ou dos seus atributos. Este artigo ilustra o uso deste método para estimar o valor de algumas funções recreativas das florestas mediterrâneas, assim como do sequestro de CO_2 e da prevenção da erosão do solo. Analisa também os resultados de aproximações de ordenação contingente no âmbito de métodos que envolvem a declaração de preferências.
Palavras-chave: valorização da floresta; avaliação ambiental; ordenação contingente; análises conjunto; florestação

Résumé. La déclaration des préférences correspond à la méthode la plus utilisée pour estimer la valeur sociale des forêts ou de ses attributs. Cet article illustre l'utilisation de telles méthodes pour estimer les fonctions récréatives des forêts méditerranéennes, aussi bien que la séquestration de CO_2 et la prévention de l'érosion du sol. Il analyse également les résultats des approches de l'ordonnance contingente à la portée des méthodes qui impliquent la déclaration des préférences.
Mots clés: évaluation forestière; évaluation environnementale; ordonnance contingente; ensemble d'analyses; reboisement

Introduction

Forests can be seen as complex economic goods, offering several functions to the investors and even to the rest of the population. Some of the functions forests provide are the formation and conservation of soils, the

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sequestration of CO_2, the provision of oxygen, the regulation of the water cycle, the creation of landscape, the conservation of biodiversity, and the provision of recreational facilities. One of the challenges in forest economics is to estimate the value of the different forest attributes as well as the value of a given forest as a whole. For both several valuation methods exist.

Some valuation methods are based on information from market behavior, for which they are called revealed preference methods. The two most widely used methods of this family are the hedonic price method and the travel cost method.

In hedonic pricing one finds the implicit price of a good characteristic by regressing the price of the good against its characteristics. It has its precedent in the work of HASS (1922), who tried to explain the price of farmland according to some characteristics (soil productivity, accessibility to a market town, value of buildings). It is a suitable method to estimate forest characteristics, for instance (LEE, 1997; MAHAN *et al.*, 2000; Le GOFFE, 2000).

The idea behind the travel cost method is that the proportion of visitors to a site would diminish as the cost to get there increases. Therefore, a demand curve between the quantity of visits to the park and the travel cost involved in the visit could be estimated. Once the curve is derived, the consumer surplus can be calculated as the welfare measure of being able to enjoy the good compared to not being able to do so (HOTELLING, 1949). This method is especially suitable to estimate the recreational value of a given forest area (WILLIS and GARROD, 1991; ENGLIN and MENDELSOHN, 1991).

The other family of valuation methods is called stated preference because they are based on surveys where people are asked to make a statement related to a payment to get some good (or avoid some bad), or a compensation to give up some good (or accept some bad). The most used one is the contingent valuation method, which values a given good or a given attribute of a good. The main variants to value several attributes in a single application are the contingent rating method, contingent ranking, contingent choice, and pairwise choice also called choice experiment or conjoint analysis (ADAMOWICZ *et al.*, 1998a; HANLEY *et al.*, 2001).

Although other variants exist, in a typical contingent valuation method a survey to a sample of the relevant population proposes the provision of a non-market good and a commitment to a payment to get the good provided. The respondent answers whether she would or would not be willing to commit to the payment. The proposed payments vary across subsamples, which gives enough variation to estimate a logit model or alike and derive the mean or median value (maximum willingness to pay) for the good (MITCHELL and CARSON, 1989). A key feature of the contingent valuation method is that only the proposed payments vary across respondents, whereas the amount of the good to be provided remains fixed.

In the rest of the stated preference methods considered here, both the payment and the amount of the good (or goods) change between subsamples. This feature is what allows these methods to estimate marginal values (the value of one extra unit) of the good. If several goods or characteristics of a good vary, several marginal willingness to pay

values can be estimated (HANLEY *et al.*, 1998a; HANLEY *et al.*, 1998b; MORRISON *et al.*, 2002). For that, respondents are faced with different alternatives (say afforestation programs) at different costs. In the contingent rating method each respondent gives a score from a predetermined scale to each alternative according to her preferences. In the contingent ranking variant respondents rank the alternatives. Similarly, in the contingent choice method or choice experiment the most preferred alternative is singled out by the respondent. Finally, the pairwise choice variant is like the contingent choice case, but only the status quo and two alternatives are presented to the different subsamples. The contingent ranking and pairwise choice methods will be presented in more detail in the next section.

All methods have advantages and disadvantages when compared with each other. Even the different stated preference methods capable of estimating marginal values of several attributes have pros and cons when compared to each other (for a full discussion see, for instance, MORRISON *et al.*, 1996; HANLEY *et al.*, 2001).

This paper focuses on a comparison of marginal willingness to pay estimations using two stated preference methods: the contingent ranking and the pairwise choice (or choice experiment). It involves an empirical application to Mediterranean forests where the values of some forest functions are estimated: recreational activities, CO_2 sequestration, and soil erosion prevention when increasing in a given amount the surface of forests in Catalonia.

This study differs from other comparisons (MACKENZIE, 1993; BOXALL *et al.*, 1996, ADAMOWICZ *et al.*, 1998b; HANLEY *et al.*, 1998b) in obtaining the contingent ranking and the choice experiment results from separate samples. The other novelty is that the comparison comes from an application to forest attributes.

Next section briefly revises the literature on contingent ranking and choice experiment methods. Section "Model specification" develops the linkage between the theoretical economic model and the statistical model to be applied in the value estimation. The next section explains the design of the application. It is followed by a section presenting the results. Finally, the comparison of results are discussed and some conclusions drawn.

Comparison of methods

Choice experiment is a stated preference valuation method where the respondent has to choose the preferred alternative among several, including the status quo situation (MAGAT *et al.*, 1988; ADAMOWICZ *et al.*, 1994; BOXALL *et al.*, 1996; ADAMOWICZ *et al.*, 1998b; HANLEY *et al.*, 1998b; ROLFE *et al.*, 2000; MORRISON *et al.*, 2002). In the contingent ranking, people are asked to rank different alternatives, including the status quo (BEGGS *et al.*, 1981; DESVOUGES *et al.*, 1983; LAUREAU and RAE, 1989; GARROD and WILLIS, 1997; GARROD and WILLIS, 1998; MOURAUTO and FOSTER, 1999; ATKINSON *et al.*, 2000).

Each alternative contains a combination of attributes (or sometimes goods). Most applications include from 3 to 6 attributes. One of the attributes is a monetary amount the person would have to pay or would receive in compensation. Each attribute appears

with a given level in the alternative. For instance, say only two attributes are relevant: the surface to be forested and the amount of money one would pay for the forestation program. The status quo alternative could have the levels 0 of extra surface of forest and 0 euros of payment, while an alternative could reflect 1000 ha of new forest and a payment of 3 euros per year. The levels vary from one alternative to another according to an experimental design (for a review of such a design, see BENNETT and BLAMEY, 2001).

Although there are many applications of stated preference methods (Carson, forthcoming), very few compare the results obtained when different methods are applied to the same good. Most of them focus on the comparison between contingent valuation and some other stated preference or revealed preference methods. Examples of studies that compare the results from the contingent valuation and contingent ranking methods are DESVOUGES *et al*. (1983), RIERA (1995), and MOURATO and FOSTER (1999), WHILE MAGAT *et al*. (1988), BOXALL *et al*. (1996), ADAMOWICZ *et al.* (1998b), HANLEY *et al*. (1998a), and HANLEY *et al.* (1998b) compare contingent valuation results with choice experiment values.

The comparison of results from stated preference methods other than the contingent valuation method is rather exceptional. In the closest study to the one presented here, MACKENZIE (1993), a contingent rating exercise on hunting was undertaken. Out of the results of this exercise, the answers to a contingent ranking and a choice experiment type of applications were simulated and the marginal willingness to pay for the attributes obtained. Therefore, the results were not obtained from three separate exercises, but from one of the methods, and derived for the other two. The conclusion was that the marginal willingness to pay estimates from the different methods was not significantly different, which differs from the conclusion of the exercise presented in the following sections of this paper using separate samples for each method application.

Model specification

Both choice experiment and contingent ranking are consistent with the Random Utility Maximization Model (RUM) (THURSTONE, 1927; MCFADDEN, 1973). Suppose individual i faces m alternatives. From the researcher's perspective, the utility this individual obtains from a particular alternative j (U_{ij}) can be decomposed into

$$U_{ij} = V_{ij} + \varepsilon_{ij},$$

where U_{ij} is person I's utility from choosing alternative j, V_{ij} is the observable part of the total utility (or deterministic component), which depends of the characteristics of the alternative and of the individual, and ε_{ij} is the non-observable part (or stochastic or random component) which represents unobservable influences on individual choices.

Choice experiment model

An individual will choose alternative j to any other alternative k if $U_{ij} > U_{ik}$ for all $k \neq j$. However, since the utility function in the model includes a stochastic component, the relevant model for the researcher for the choice above is formulated in probability terms. In this way the probability P_{ij} that any particular

respondent *i* prefers option *j* in the choice set to any alternative option *k*, can be expressed as the probability that the utility associated with option *j* exceeds that associated with any other option. Formally,

$$P_{ij} = \text{Prob}\{ V_{ij} + \varepsilon_{ij} > V_{ik} + \varepsilon_{ik};\ \forall\ k \in C \backslash \{j\} \},$$

where *C* is the set of all possible alternatives and $C\backslash\{j\}$ denotes the set of all alternatives but *j*.

Under the assumption that the error terms are distributed identically and independently with an extreme value type distribution (Gumbel distribution), the conditional logit model can be applied for the statistical estimation of the economic model above (McFADDEN, 1973):

$$P_{ij} = \frac{e^{\omega V_{ij}}}{\sum_{k=1}^{m} e^{\omega V_{ik}}}, \quad (3.1)$$

where ω denotes the scale parameter which is inversely proportional to the standard deviation of the error distribution. It is normal practice to normalize this parameter to 1 since it cannot be separately identified in most cases (BEN-AKIVA and LERMAN, 1985).

Contingent ranking model

If the axioms of Luce (LUCE, 1959) are met, the ranking data can be transformed into election data. In this way, the ordering of *m* alternatives is equivalent to a sequence of *m*-1 independent choice problems (CHAPMAN and STAELIN, 1982; FOSTER and MOURATO, 2000). If ε_{ij} are independently and identically distributed following a extreme value type distribution, and assuming a scale parameter equal to one, the probability for individual *i* to choose alternative 1 over alternative 2, alternative 2 over alternative 3, and so on, can be modeled as a *rank-order logit model* or *exploded logit model* (BEGGS *et al.*, 1981) which is the product of *m*-1 ordinary logit likelihood functions:

$$P_{i(1,2,\ldots,m)} = \prod_{j=1}^{m-1} \frac{e^{V_{ij}}}{\sum_{k=j}^{m} e^{V_{ik}}}$$

Application

The aim of the exercise presented here was to estimate the mean of the maximum willingness to pay (WTP) of a given population for changes in their welfare due to a variation in the quantity or quality of some attributes that forests provide. The variation takes place in Catalonia, a Spanish region with some 1,330,000 ha of forests, which accounts for roughly 40% of its total area. The afforestation program under valuation implies an increase from the current 40% to 50% of the Catalan land devoted to forest. The additional forest would be located in marginal agricultural land. This would imply some positive and negative changes. On the positive side, people would enjoy a decrease in the level of air pollution and erosion, as well as an increase in some recreational activities. On the other hand, people could see some restrictions in other types of recreational activities and would have to pay for the program to be implemented. However, 90% of people perceived the forestation program as an overall positive or very positive initiative.

Design of the alternatives

One of the first steps in designing the stated preference exercise is to decide the attributes or characteristics that will constitute the different afforestation alternatives. After consulting with policy makers, forestry researchers, conducting focus group sessions, and analyzing the pilot interviews, six attributes were selected, as shown in Table 1. The table also shows the result of the step that follows the definition of the attributes, which is to determine the different values or levels each attribute would take in the exercise. They were decided in a similar fashion to the selection of the attributes. Payment values were originally expressed in Spanish pesetas, although in this paper they are reported in euros.

Table 1 - Attributes and levels of the stated preference exercises

Attribute	Description	Levels
PICNIC	Picnicing allowed in the new forests (SQ= No)	Yes No
DRIVING	Driving by car allowed through the new forests would be allowed (SQ= No)	Yes No
MUSHROOMS	Picking mushrooms allowed in the new forests (SQ= No)	Yes No
CO_2	CO_2 sequestered annually by the new forests. Equivalent to the pollution produced annually by a city of... (SQ = 0)	300.000 people 400.000 people 500.000 people 600.000 people
EROSION	The new forest will be located in land which otherwise would have a risk to be... (SQ =0)	Very eroded (unproductive in 100 years time compared to SQ) Quite eroded (unproductive in 300 years time compared to SQ) Slightly eroded (unproductive in 500 years time compared to SQ) Hardly eroded (unproductive in 700 years time compared to SQ)
PRICE	The afforestation cost per person and year## (SQ = 0)	6 euros 12 euros 18 euros 24 euros

SQ: Status Quo

Payment values were originally expressed in Spanish pesetas, although in this paper they are reported in euros

There exist $(2^3x4^3)x(2^3x4^3)$ possible combinations of attribute levels or pairs of afforestation alternatives in the choice experiment, and 2^3x4^3 afforestation alternatives in the contingent ranking. The number of combinations in the choice experiment (262,144) and in the ranking (512) is too high for any given person to be able to face them all. To select the subset of alternatives that actually would be presented to respondents an orthogonal fractional factorial design was applied (HAHN and SHAPIRO, 1966). In this way, 64 sets of pairwise comparisons were obtained. The 64 combinations were grouped into 16 versions of 4 choice decisions. In each choice decision, the person interviewed had to choose between the *status quo* (no afforestation) and two afforestation alternatives. Appendix A shows one of the choice sets used in the interviews.

A similar procedure was applied to the contingent ranking approach. Again, an orthogonal fractional factorial design was applied to get 16 alternatives, which were further grouped in sets of four alternatives (HAHN and SHAPIRO, 1966). In this way, respondents were asked to rank four alternatives in their order of preference, including the status quo situation. Appendix B reproduces one of the choice sets.

Design of the questionnaire

The questionnaire was structured in three parts. The first one introduced the forestation program and questioned people about the relative importance of some forest issues. The last one was devoted to inquiry about the use of forests and to collect socioeconomic data from the respondents. Both parts were identical for choice experiment and contingent ranking respondents, while the middle part was specific for each method and contained the elicitation question.

Sample and data collection

The choice experiment and the contingent ranking questionnaires were administered to a sample of the Catalan population over 18 years of age. Two subsamples were obtained, one for the choice experiment (1200 individuals) and one for the contingent ranking application (800 people). Both followed a mixture of random selection corrected for representativity in age, gender, and size of the city of residence.

The average response rate in the choice experiment was 95 per cent, while for the contingent ranking was 78 per cent. The discrepancy between the rates of response is often found in the literature. One possible explanation is that the contingent ranking was a bit harder to answer than the choice experiment. Since in the choice experiment each individual faced four successive choices, the number of observations was larger than the number of sampled individual: 4576 observations. In the contingent ranking the number of valid observations was 626, given the response rate and the fact that each individual faced one ranking only The interviews were conducted face-to--face, at the household residence during the second half of 1999.

Statistical analysis

A conditional logit model (McFADDEN, 1973) and a rank-ordered logit model (BEGGS *et al*., 1981) were

applied respectively to the choice experiment and the contingent ranking approaches. In both models the utility function V_{ij} is assumed to be linear in the parameters and additively separable. The independent variables are those from Table 1. The data of the categorical attributes (picnic, 4-wheel drive, and mushrooms) were transformed into effects-codes (-1, 1) following ADAMOWICZ *et al*. (1994). Similarly, the values of the quantitative attributes were transformed to be centred in their mean in order to reduce colinearity (LOUVIERE and WOODWORTH, 1983).

Results

Table 2 shows the main results of the regression analysis for the choice experiment and contingent ranking methods. The signs of the parameters are consistent with *a priori* expectations. The positive coefficients of picnicking, picking mushrooms, and CO_2 sequestered, suggest that afforestation programs were more likely to be chosen when picnic and picking mushrooms were permitted and the amount of CO_2 sequestered was high, and erosion was postponed longer. However, the use of cars in forests, and higher costs for afforestation programs, contribute negatively to utility and are therefore less likely to be selected. The negative coefficient of erosion suggests that the afforestation in lands with high erosion is preferred than the afforestation in lands with low erosion.

Referring to the t statistic, the choice experiment model has a larger number of significant variables, since only PICNIC is not significant at 5% error, while the contingent ranking has three (PICNIC, MUSHROOMS, and CO_2). However, when comparing both methods, the different number of observations ought to be born in mind.

Table 2 - Choice experiment and contingent ranking models estimation

Variable (Attribute)	Choice experiment	Contingent ranking
CONSTANT	1.007251606** (24.559)	0.7896384264** (27.996)
PICNIC	0.04043544789* (1.920)	-0.0003498519586 (-0.013)
DRIVING	-0.08017112982** (-3.799)	-0.06750939811** (-2.553)
MUSHROOMS	0.05361552932** (2.560)	0.02259003903 (0.855)
CO_2	0.7754065145E-06** (4.020)	0.1860443516E-06 (0.732)
EROSION	-0.000301284400** (3.179)	-0000394207436** (3.126)
PRICE	-0.01857626336** (-5.835)	-0.03361992693** (-7.896)
Log Likelihood	-4600.954	-2664.397
χ^2	60.82	58.12
Observations	4,576	626

t statistical values in brackets

**,*Significant at a maximum error level of 5% and 10% respectively

Comparison between methods

Test for equivalence between methods

Since the same Random Utility Maximization model is behind both methods, one could expect that the utility measure from the choice experiment and from the contingent ranking method ought to be similar, if both methods constitute reliable ways to obtain that measure. In this section, the equivalence of the marginal willingness to pay (WTP) measures obtained from each model will be tested.

If the estimated utility function has a linear form, the utility of afforestation alternative j can be expressed as

$$V_j = \beta_{CONSTANT} + \beta_{PICNIC}\, PICNIC + \beta_{MUSHROOMS}\, MUSHROOMS + \\ + \beta_{DRIVING}\, DRIVING + \beta_{CO_2} CO_2 + \beta_{EROSION}\, EROSION + \beta_{PRICE}\, PRICE$$

The marginal WTP for each attribute or implicit price can be inferred by calculating the ratio $-\beta_n/\beta_{PRICE}$, where β_n is the regression coefficient of the physical attribute and β_{PRICE} is the coefficient of the PRICE (McFADDEN, 1973).

Table 3 shows the different estimated marginal WTP and their confidence intervals, which have been obtained using the KRINSKY and ROBB (1986) procedure. This procedure simulates the probability distribution using a bootstrap approach. In this instance, 1000 random extractions were used to calculate (1000 times) each marginal value and the confidence interval was deduced from the distribution of these 1000 estimations following the percentile approximation of EFRON and TIBSHIRANI (1993).

The different WTP correspond to the annual payments for the rest of the respondents' life in euros of 1999 values. The WTP in PICNIC, DRIVING and MUSHROOMS are contributions in order to allow such activities in the new forests instead of banning them. The value for CO_2 accounts for the mean annual maximum willingness to pay for a quantity of carbon sequestered in the growing forest equivalent to 6.8 tonnes per year, which is the mean annual amount of emissions that a Catalan citizen add to the atmosphere. Finally, the WTP for EROSION is interpreted as the mean annual value for marginally delaying one year the economically productive life of the soil.

Table 3 - Marginal annual willingness to pay from the choice experiment (WTP_C) and contingent ranking (WTP_R), in 1999 Euros

Variables	**WTP_C**	**WTP_R**	**WTP_C / WTP_R**
PICNIC	4.35# (-0.33, 9.60)	-0.02# (-3.40, 2.84)	217
DRIVING	-8.63 (-15.28, -4.10)	-4.02 (-7.43, -0.92)	2.15
MUSHROOMS	5.78 (1.43, 11.47)	1.34# (-1.92, 4.78)	4.30
CO_2	4.17E-005 (1.93E-05, 7.42E-05)	5.53E-006# (-9.70E-06, 2.17E-05)	7.55
EROSION	-0.016 (-0.030, -0.0063)	-0.011 (-0.021, -0.0046)	1.48

#Non significant coefficient
95% confidence intervals in brackets
WTP estimations use effect codes in PICNIC, DRIVING and MUSHROOMS variables

The results in Table 3 show that although the utility of each attribute has the same sign (except PICNIC), all the WTP estimations obtained from the choice experiment are higher than the counterpart estimated from the contingent ranking method. For instance, for the CO_2 attribute, the marginal WTP is nearly 10 times higher in the choice experiment than in the contingent ranking application. To see whether the differences are significant in statistical terms, the following hypotheses can be tested.

$$H_o: \beta(C)_n/\beta(C)_{PRICE} - \beta(R)_n/\beta(R)_{PRICE} = 0$$

$$H_A: \beta(C)_n/\beta(C)_{PRICE} - \beta(R)_n/\beta(R)_{PRICE} > 0$$

where β_n is the coefficient of the non-monetary attribute of interest, β_{PRICE} is the coefficient of the monetary variable, *C* indicates choice experiment, and *R* contingent ranking.

The statistic to be used in the test of equivalence between valuation methods is the non-parametric one proposed by POE *et al.* (1997). The procedure implies the estimation of the confidence interval of the difference between the mean WTP from the choice experiment and the contingent ranking methods. Table 4 gives the results based on 1,000 draws.

The equivalence between the marginal WTP obtained from the two alternative valuation methods can be rejected, which is interpreted as the choice experiment giving a significantly higher valuation of the forest attributes analyzed.

Differences from the statistical design

However, even if at first sight there seems to be a discrepancy between both ways of calculating the same welfare measures, the variation may not be attributable to the different valuation methods, since the particular experimental design used was different in both applications. A way to isolate the difference in methods is to unify the experimental design *a posteriori*. The basic difference in the design is the number of alternatives selected to be presented to respondents out of all possible ones. In the contingent ranking the number was 64, whereas in the choice experiment only 16 were selected. The reason for using different designs obeys to a research program which goes beyond the scope of this paper.

Since the 16 alternatives from the choice experiment were not a subset of the 64 of the contingent ranking, the solution could not be to select the appropriate 16 alternatives and estimate again the results from the corrected contingent ranking design. To overcome this problem, a bootstrap approach was implemented (EFRON and TIBSHIRANI, 1993). The simulation involved the random extraction of 1000 sets of 16 alternatives out of the set of 64. The marginal WTP for each attribute was then calculated for each of the 1000 new combinations.

The new null hypothesis to test is

$$H_o: WTP_{CS} - WTP_R = 0$$

$$H_A: WTP_{CS} - WTP_R \neq 0$$

where WTP_R is the marginal willingness to pay for a particular attribute obtained from the contingent ranking method, and WTP_{CS} the one for the new simulated choice experiment exercise. Again a POE *et al.* (1997) non-parametric test was conducted, the results of which are presented in Table 5.

Table 4 - Results of the test of equivalence between methods

WTP_C - WTP_R	95% confidence interval	Approximate level of confidence
PICNIC	2.70, 7.08	0.000
DRIVING	-11.69, 0.90	0.04
MUSHROOMS	-1.50, 11.49	0.05
CO_2	2.58E-05, 5.80E-05	0.000
EROSION	-0.0103, -0.0016	0.000

Table 5 - Results of the test of equivalence between methods corrected by designs

WTP_{CS} - WTP_R	95% confidence interval	Approximate level of confidence
PICNIC	1.75, 8.78	0.003
DRIVING	-9.88, –1.52	0.005
MUSHROOMS	-0.06, 7.95	0.027
CO_2	1.80E-05, 5.41E-05	0.000
EROSION	- 0.010, 0.0076	0.288

EROSION is the only variable where the null hypothesis of equality between means is clearly not rejected. All the rest can be discarded as being equal at 95% confidence. This result reinforces the idea that different stated preference methods may lead in practice to somewhat different WTP estimates.

Differences from the same stated preference method

In his work, MACKENZIE (1993) compares the results obtained from four different stated preference methods: contingent rating, contingent ranking, contingent choice, and pairwise choice to value preferences on hunting trips. The comparison uses the *t*-statistic of the estimated coefficients of the different attributes to test the efficiency of the four models, finding that the contingent rating is the most efficient method, with lower standard errors and smaller confidence intervals. In the comparison, the contingent ranking is also found to be more efficient than the pairwise choice. Efficiency is the main difference between models, since the WTP estimates obtained do not vary significantly in the four approaches. However, Mackenzie obtains the data from a survey using only one format, the contingent rating, and derives the datasets for the other three methods assuming respondents would have expressed ranks or choices totally consistent with the ratings given.

In this section, a similar approach is taken, deriving a pairwise choice dataset from the data obtained in the contingent ranking exercise. In this way, it can be tested whether the differences in the estimated WTP values from the previous section still persist when data for the different methods are derived from a single sample rather than collected from different samples. If in the derived dataset WTP estimates would not vary significantly between models, it could be suggested that applying one stated preference or another results in practical differences not explained by the statistical treatment of data.

The null and alternative hypotheses to be tested are similar to the previous ones, the only change being the way data were collected. The first step to implement the test was to generate a series of simulated choices between pairs of alternatives out of the contingent ranking database. This was possible because the quantity and quality levels of the new forests were described in the contingent ranking using the same attributes and levels as in the choice experiment. A respondent that ranked alternative A above B and the status quo situation is simulated to choose A when compared to B and the status quo options in a hypothetical pairwise choice setting. Then, a multinomial logit model was applied to the new database. Table 6 shows the results of the regression of the simulated series of elections between pairs of alternatives.

Comparing the results from the two choice experiment estimations (tables 6 and 2), it can be seen that the coefficients have the same sign and are overall significant, although three variables in the new estimation are not statically significant at 5% error level. The new simulated choice experiment is more efficient than the ranking model, according to t-statistics. The latter contradicts the results first reported by MACKENZIE (1993), who found that the contingent ranking approach was more efficient than the pairwise choice method.

Table 7 shows the results of the WTP estimations and their confidence intervals for the new simulated choice dataset. Again, the confidence intervals are obtained from 1000 repetitions following the KRINKY and ROBB (1986) procedure. The new WTP estimates are lower than WTP_C but higher than WTP_R (Table 3).

Table 6 - Choice experiment estimation using data generated from the contingent ranking database

Variable (Attribute)	Estimations
CONSTANT	0.4976233379** (12.227)
PICNIC	0.02622753864 (1.150)
DRIVING	-0.09359566489** (-4.086)
MUSHROOMS	0.02060847163 (0.895)
CO_2	0.2613225183E-06 (1.271)
EROSION	-0.0003218468973** (-3.130)
PRICE	-0.0002290508782** (-11.033)
Log Likelihood	-3626.051
χ^2	117.756
Observations	3,432

t statistical values in brackets
**,*Significant at a maximum error level of 5% and 10% respectively

Table 7 - Marginal annual willingness to pay for the simulated choice experiment from the contingent ranking (WTP_{RC}), in 1999 euros

Variables	WTP_{RC}
PICNIC	1.37# (-1.17, 3.93)
DRIVING	-4.91 (-8.04, -2.78)
MUSHROOMS	1.10# (-1.33, 3.85)
CO_2	6.86E-06 # (-3.90E-06, 1.90E-05)
EROSION	-0.0085 (-0.015, -0.0036)

#Non significant coefficient
95% confidence intervals in brackets
WTP estimations use effect codes in PICNIC, DRIVING and MUSHROOMS variables.

Table 8 shows the results of the test of differences between the new values and those from the contingent ranking model. The conclusion is the rejection of the equivalence between the welfare measures from the original choice experiment and the new choice experiment derived from the contingent ranking data.

Finally, the welfare estimates from the contingent ranking model and the simulated choice experiment can be compared, in a similar way to MACKENZIE (1993). The test results, following the procedures mentioned above, are shown in Table 9.

With the exception of variable PICNIC, the estimates from the simulated choice model are not significantly different than those from the contingent ranking model.

In conclusion, the marginal WTP for the different attributes related to an increase in the surface area occupied by forest in Catalonia are higher, and statistically different, when they are obtained from a contingent ranking method than when they are obtained from a choice experiment of the pairwise type. A similar conclusion is reached when comparing the WTP estimates of the original choice experiment with the simulated choice experiment. Finally, as in MACKENZIE (1993), the WTP measures from the simulated choice experiment and the original contingent ranking model are not significantly different (except for PICNIC, which is non signifycant in both models). Therefore, the welfare measures obtained from the contingent ranking model are only statistically not different from those obtained from a choice experiment inferred from the original ranking data. However, when the choice experiment is actually undertaken in a separate sample, the WTP measures are significantly differrent, indicating that the format of the questioning might matter to respondents. This suggests that Mackenzie's conclusions ought to be taken with caution. In fact both Mackenzie's and our results ought to be backed with a larger number of studies.

Table 8 - Results of the test of equivalence between actual and simulated choice models

$WTP_C - WTP_{RC}$	95% confidence interval	Approximate level of confidence
PICNIC	0.85, 6.1	0.011
DRIVING	-8.43, -0.64	0.000
MUSHROOMS	2.64, 8.60	0.000
CO_2	2.22E-05, 6.04E-05	0.000
EROSION	–0.020, -0.036	0.000

Table 9 - Results of the test of equivalence between contingent ranking and the simulated choice model

$WTP_R - WTP_{RC}$	95% confidence interval	Approximate level of confidence
PICNIC	-2.35, -0.90	0.00
DRIVING	-3.05, 5.84	0.76
MUSHROOMS	-4.37, 4.82	0.5
CO_2	-5,75E-06, 3.75E-06	0.83
EROSION	-0,017, 0.010	0.37

Conclusions

This study illustrates a test of equivalence between two stated preference methods: the contingent ranking and the choice experiment. It differs from previous works in that the comparison comes from separate samples. Both methods are used to estimate the value of some given attributes of an extension of Catalan forest from the current 40% of the region to 50%. The marginal values obtained were for the opportunity to picnic in the new forests, allowing four-wheel drive vehicles, allowing mushroom picking, to sequester the CO_2 emitted by a person in one year, and to delay in one year a terrain to become unproductive due to soil erosion.

When comparing the results obtained by both methods, it appears that the choice experiment approach yields significantly higher willingness to pay estimates than the contingent ranking method. The simulation by *bootstraping* of a main effects design for the choice experiment suggests that the main explanation of the differences between the marginal WTP obtained from the two stated preference methods is the different method employed and not the different experimental design used.

As in MACKENZIE (1993), the WTP measures from original contingent ranking and the simulated choice experiment using the same data are not significantly different. However it doesn't confirm the assumption of Mackenzie that the stated preference methods give the same results if applied in separate subsamples. The statistically significant difference between the original choice experiment and the simulated choice experiment from the contingent ranking data challenges this assumption**.**

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Appendix A

Example of a pair of afforestation alternatives used in the choice experiment exercise

Appendix B.

Example of one of the cards of the contingent ranking method

FOREST UTILITY

RECREATIONAL ACTIVITIES ALLOWED	 DRIVE BY CAR IN DESIGNATED TRAILS  • PICNICKING  • PICKING MUSHROOMS  • HIKING
CO_2 SEQUESTERED ANNUALLY (Pollution produced by a...	 City of **300.000** inhabitants
NEW FOREST IN...	Soil **HARDLY** eroded (Unproductive in **700** years)

ECONOMIC COST

ANNUAL CONTRIBUTION	2000 ptas/year