Testing Choice Experiment for Benefit Transfer with Preference Heterogeneity

Sergio Colombo, Javier Calatrava-Requena, and Nick Hanley

Benefit transfer is a cost-effective method for estimating the value of environmental goods that relies on information obtained in previous studies. The multiattribute approach of choice experiments should provide advantages in terms of benefit transfer, allowing differences in environmental improvements between sites as well as differences in socioeconomic and attitude characteristics between respondent populations. This article investigates the capability of choice experiment method to be used in environmental benefit transfer when a random parameters approach is used to allow for preference heterogeneity: we find that the inclusion of respondents' taste heterogeneity reduces the magnitude of the transfer error.

Key words: benefits transfer, choice experiment, heterogeneity, random parameter model.

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Environmental valuation is a costly yet important aspect of the policy appraisal process in an increasing range of cases (Pearce 2005). Since time and financial resources are often insufficient to carry out an original valuation work, benefits transfer has been developed as a means of obtaining an approximation of the desired value estimates at lower cost, albeit with a concomitant loss of precision and validity. In benefits transfer, existing estimates of a nonmarketed good, from one or more sites (known as study sites) are used to predict the value for the same or for a similar good at a different site (known as the policy site).

Benefit transfer applications, despite worries over their validity, have been used more and more frequently in the last decade. Figure 1 shows the increasing trend of environmental benefit transfer applications from 1992 to 2004. Most of the benefit transfer studies listed in figure 1 have used contingent valuation and the travel cost model as elicitation methods. However, Morrison et al. (2002) have argued the choice experiment (CE) method has good potential for benefit transfer since it has the advantage over contingent valuation that it is possible to allow for differences in improvements in environmental quality as well as differences in sociodemographics when transferring value estimates. In CE the good of interest is described by means of its attributes, following Lancaster's characteristics theory of value (Lancaster 1966), so that it is possible to value any policy alternative that is within the space described by these attributes. Indeed, in the last decade CE have been used more and more frequently for the economic evaluation of nonmarketed goods, although to our best knowledge, there are only five studies that have used CE estimates to transfer values from a study site to a policy site that have been published in peer-reviewed journals.

One approach is to run separate CE studies in similar environmental settings and then test the transferability of implicit prices or welfare measures. This is what Morrison et al. (2002) and Morrison and Bennett (2004) do for two Australian wetlands and for the water quality of five different catchments, respectively. The comparison of implicit prices showed the hypothesis of convergent measures being accepted for most of the implicit prices, although the transferability of compensating surplus equivalence was rejected. A similar approach is taken by Hanley, Wright, and Alvarez-Farizo (2006). Another approach is to compare CE estimates with contingent valuation estimates: this is what Mogas and Riera (2003) do. Their results showed the marginal

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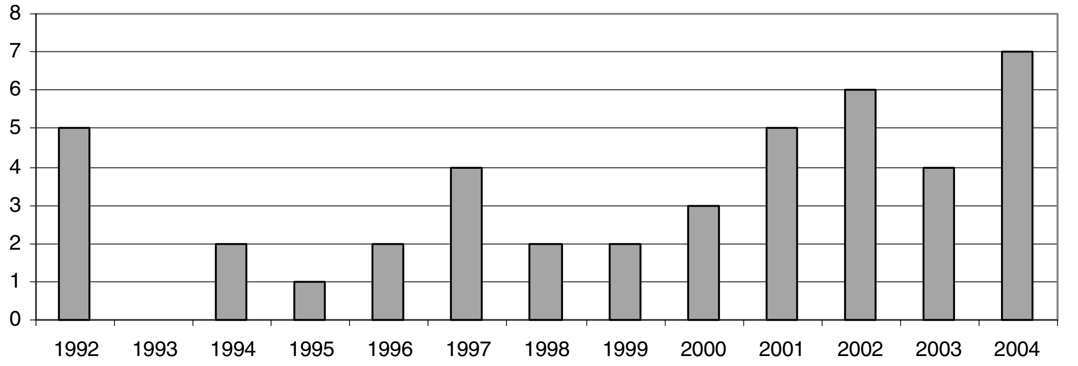

Note: 2004: Rozan; Muthke and Holm-Mueller; Morrison and Bennett; Bor, Chien, and Hsu; Braden and Johnston; Ready et al.; Bueren and Bennett. 2003: Leon, Vazquez-Polo, and Gonzalez.; Chattopadhyay; Shrestha and Loomis; Mogas and Riera. 2002: Robinson; Barton; Morey, Chanan, and Waldman; Smith and Pattanayak; Smith, Wan Houtven, and Pattanayak; Leon et al.; Morrison et al. 2001: Ruijgrok; Piper and Martin; Navrud; Shrestha and Loomis; Witzke and Urfei. 2000: Oglethorpe et al.; Rosenberger and Loomis; Brouwer. 1999: Brouwer and Spaninks; Bateman, Vett, and Brainard. 1998: Piper; Scott et al. 1997: Lovett, Brainard, and Bateman; Alberini et al.; Feather and Hellerstein; Kirchhoff, Colby, and LaFrance. 1996: Eade and Moran; Shaw; Downing and Ozuna. 1995: Bergland, Magnussen, and Navrud. 1994: Unsworth and Bishop; Kask and Shogren. 1992: Brookshire and Neill; Boyle and Bergstrom; Desvousges, Naughton, and Pearson; Loomis; Walsh, Johnson, and McKean.

Figure 1. Environmental benefit transfer studies from 1992 to 2004

attribute values derived from the CE were suitable for benefit transfer. Variations in the policy context in which CE studies are applied are another way of considering the issue of benefits transfer. Bueren and Bennett (2004) found attribute values estimated in a regional context were significantly higher than those estimated in the national context, providing an insight into the scaling adjustment that is required if national implicit price estimates are to be transferred to a regional context. Finally, Jiang, Swallow, and McGonagle (2005) conducted benefit transfer tests looking at the impacts of both policy context and model specification.

All the studies listed above included respondents' socioeconomic characteristics as a simple way of taking into account the possibility that respondents' preferences will vary, but used either conditional logit (CL) or nested logit models. Since respondents' tastes may in fact be heterogeneous in a way not fully explained by socioeconomic variables, there might be advantages to employing an approach that explicitly allows for this heterogeneity for benefit transfer purposes. If tastes indeed vary among respondents, CL estimates will not give an accurate description of this spread of preferences, and will provide misspecified welfare estimates. Such misspecified welfare estimates are not the best basis on which to develop a benefits transfer framework. Second, since models with heterogeneous preferences can capture more of the variability in values within their parametric structure than CL models, it is a reasonable speculation (which can be tested empirically) that they will do a better job of transferring values across sites and between populations, producing smaller transfer errors when transferred and original-study compensating surplus estimates for a given policy change are compared. The random parameter logit (RPL) model, through a more complex estimation process, allows for such variation in preferences across individuals (Train 1998). In this article we carry out the first benefits transfer test of CE estimates using the RPL model to incorporate respondents' taste heterogeneity; this article is thus an attempt to address the methodological issues that affect the validity and accuracy of benefits transfer (Jiang, Swallow, and McGonagle 2005). We also allow for differences in the scale parameter between data sets, and for possible correlation between preferences across attributes and their levels.

Two surveys in two different watersheds located in the southeast of Spain are used as case studies. The estimated models account for the benefits of programs aimed at reducing the off-site impacts of soil erosion. The models

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take into account a range of policy attributes, socioeconomic characteristics, and attitudinal variables for the two benefiting populations. We thus carry out a transfer test of equivalence across both sites and populations. The policy scenarios used in the Guadajoz watershed (policy site) are fully described by the CE attribute levels used in the Genil basin (study site). The choice functions, implicit prices, and compensating surplus estimates obtained from estimation will be compared to check the validity of CE for benefits transfer in this case, and to compare transfer errors from the CL and RPL models.

Methodology

In this section, we first review approaches to benefits transfer, before outlining the RPL model to be employed in this study.

Benefit Transfer

Two main approaches can be distinguished in benefit transfer: value transfer and function transfer. In the former case, both unadjusted and adjusted value transfers have been proposed. Unadjusted value transfer is the easiest way to transfer the benefit from one site to another, and simply assumes that the welfare change experienced by the average person in the study site is the same as that experienced by the average person in the policy site. Formally, the test hypothesis is that the mean willingness to pay for similar changes in environmental quality at the study and policy sites is the same

(1) $\quad \mathrm{WTP}^s = \mathrm{WTP}^p$

where WTP^s is the calculated mean (household) willingness to pay at the study site and WTP^p is the calculated mean (household) willingness to pay at the policy site, in both cases calculated using both the standard (Hanemann 1984) utility difference expressions, and by comparing implicit prices, the calculation of which is explained below. Adjusted value transfer tries to improve the benefit transfer by adding information about the demographic or socioeconomic characteristics of beneficiaries at the policy site. In this case, the test hypothesis to be met is that the adjusted willingness to pay at the study site, using the valuation function from the study site with sample information from the policy site, equals the observed willingness to pay at policy site, that is,

(2) $\quad \text{adjusted WTP}(\beta^s, X^p) = \mathrm{WTP}^p$

where adjusted WTP (β^s, X^p) is the willingness to pay at the policy site estimated using the parameters of the benefit function of the study site and the X values (site attributes, socioeconomic characteristics, etc.) of the policy site and WTP^p is defined above. We do not undertake a test of equation (2) in this article.

An alternative approach is benefit function transfer. In contrast to the value transfer method this approach transfers the entire value function estimated for the study site (or, in some cases, a group of study sites) to the policy site. The relevant test is then whether the benefit function at the policy site has the same parameters as the benefit function at the study site, that is,

(3) $\quad \beta^s = \beta^p$

where β^s and β^p are the vector coefficients at the study and policy site, respectively. We test equation (3) in this article, but have to allow for possible differences in error variance in doing this, as explained in the next paragraph. Benefit transfer tests may be carried out across different sites, different populations, or both. In the first case, the analyst is interested in determining the effects of the physical characteristics of the nonmarket good on the equivalence of results; in the second case he considers the effect of population characteristics. In this article we test the transferability of results both across sites and across populations by first comparing the benefit function coefficients and later by testing the unadjusted and adjusted welfare measures transfer.

A complication with benefits transfer using CE is that it is not possible to compare directly the benefit function parameters as in equation (3)—the parameters of the deterministic part of the indirect utility function under a random utility specification—since they are confounded with the scale parameter (λ). The values of the estimated parameters β^s and β^p are equal to the values of the true parameters β^s_t and β^p_t multiplied by their scale parameters ($\beta^s = \lambda^s\ \beta^s_t$ and $\beta^p = \lambda^p\ \beta^p_t$). The scale parameter is equal to $\pi^2/6\sigma^2$ where π is 3.1416 and σ^2 is the variance of the error term, or the random part of the utility function. The scale parameter cannot be estimated for a single data set,

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and only the ratio of scale parameters from different data sets can be estimated. Benefits function transfer in CE therefore requires a comparison of the underlying β vectors once differences in scale factors across data sets have been taken into account. Swait and Louviere (1993) provided a procedure to estimate the ratio of scale parameters from two data sets, which consists of stacking the two data sets, in which the second has been rescaled (multiplied by a hypothesized value of the relative scale parameter). In Swait and Louviere, a series of multinomial logit models are then run on this single, stacked data set, conducting a one-dimensional grid search using different hypothesized values of the scale parameter to find that value, which maximizes the log likelihood (see figure 1 in Swait and Louviere for more details).

A complication arises when comparing the parameter vectors under a random parameter approach since the null hypothesis of parameters equality requires that all the standard deviations of the random parameters are the same, so that the test not only examines the equality of mean parameters but also the equality of the distribution of the random parameters. This "re-scaling" procedure is not needed when comparing the implicit prices or the welfare measures of multiple data sets, because the scale parameter of each data set cancels out in the calculations.

Stated formally, the comparison of the implicit prices and compensating surplus estimates leads to the following hypothesis:

$$(4) \qquad H_0 : IP_{i,A} = IP_{i,B}; \quad H_1 : IP_{i,A} \neq IP_{i,B}$$

and

$$(5) \qquad H_0 : CS_{j,A} = CS_{j,B}; \quad H_1 : CS_{j,A} \neq CS_{j,B}$$

where IP_i is the implicit price of the attribute i, and CS_j is the compensating surplus for the scenario j. Testing these hypotheses is accomplished using the bootstrapping approach (Krinsky and Robb 1986), here using 1,000 random draws from the multivariate normal distribution with mean and variance equal to the β vectors and the covariance matrixes of the estimated logit models. The test of Poe, Severance-Lossin, and Welsh (1994) will be used in the comparison of the resulting compensating surplus welfare measures. The transfer error will be calculated with the formula

$$(6) \qquad \textit{Transfer Error} = \frac{|\textit{Predicted Value}_{policy\,site} - \textit{Estimated Value}_{policy\,site}|}{\textit{Estimated Value}_{policy\,site}}$$

The RPL Model

There are various models that can be used to estimate the coefficients that maximize the probability of choice. The approach most often followed in CE modeling is the CL model, where respondents' preferences are assumed to be homogeneous in the sample. The approach that we follow here focuses on the RPL, which is becoming increasingly popular in applied research. In this approach the utility function for respondent n choosing over alternatives j ($j = 1,2,\ldots,J$), U_{jn}, is augmented with a vector of parameters η that incorporate the individual preference deviations with respect to the mean preference values that are expressed by vector β:

$$(7) \qquad U_{jn} = C_j + \textstyle\sum_k \beta_{jk} X_{jkn} + \sum_m \gamma_m S_{mn} C_j + \sum_k \eta_{kn} X_{jkn} + \varepsilon_{jn}$$

where C_j is an alternative specific constant (C_J=0, for identification purposes), X_{jkn} is the kth attribute value of the alternative j; β_{jk} is the coefficient associated with the kth attribute, S_{mn} is the mth socioeconomic characteristic of individual n, and γ_m is the coefficient associated with the mth individual socioeconomic characteristic. Note that socioeconomic characteristics are invariant across choice occasions for each individual in the sample, so are interacted with the alternative specific constant.[1] Furthermore, η_{kn} is a vector of k deviation parameters, which represents the individual's tastes relative to the average (β) and ε_{jn} is an unobserved random term, which is independent of the other terms in the equation, and which is identically and independently Gumbel distributed. The researcher can estimate β, γ, and η; the η terms, as they represent personal tastes, are assumed constant for a given individual across all the choices they make, but not constant across people. RPL

[1] The socioeconomic characteristics—gender, age, marital status, and occupation—were coded using dummy variables, the coding of which can be seen in the notes of table 2. The variables solidarity and enjoyment enter as values on a ten-point scale, the variable erosion is what % of 1 euro of public spending the respondent would want to allocate to erosion control programs, and the variable income is entered in euros per household per year.

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probabilities are weighted averages of the logit formula evaluated at different values of β, with the weights given by the density f(β). The probability that respondent *n* chooses alternative *i* is given by

$$(8) \qquad P_{ni} = \int L_{ni}(\beta) f(\beta) d(\beta)$$

where $L_{ni}(\beta)$ is the logit probability evaluated at parameters β. Since the integral equation (8) has no closed form, parameters are estimated through simulation and maximizing the simulated log-likelihood function. In order to estimate the model it is necessary to make an assumption over how the β coefficients are distributed over the population. Here we assume that preferences for all the environmental attributes follow a normal distribution, except for the *jobs* and *price* attributes for which preferences were assumed to be homogeneous.[2]

Standard RPL approaches consider that choices over attributes and their levels are uncorrelated, but this assumption may be too restrictive (Layton and Brown 2000). In this article we also estimate RPL models that allow for free correlation between the random coefficients since, in principle, significant correlation might exist between preferences within attribute levels (between "medium" and "high" water quality, for instance) and between attributes (for instance, between landscape desertification and flora and fauna density). This procedure complicates the estimation of the model, requiring the computation of twenty-one possible covariance parameters (see table 3).

The Study

The policy scenario presented to respondents was the reduction of the off-site impacts of soil erosion in two watersheds in southern Spain, the Genil and the Guadajoz. Due to soil and climatic conditions and long-term human exploitation, soil erosion levels in these catchments are well in excess of national average levels, and are known to result in widespread environmental costs (Colombo and Calatrava-Requena 2003). Soil erosion causes many off-farm negative effects on society; among the most important being advancing desertification, the siltation of water bodies, and reductions in biodiversity. To reduce these impacts it is necessary to provide subsidies to farmers to encourage them to adopt soil conservation measures in their land management. To help define the optimal size and distribution of this subsidy, policy makers need information on the economic impacts of soil erosion. Benefits transfer could provide a low-cost solution to this need, if it was shown to produce "acceptable" estimates of the benefits of alleviating erosion.

The benefit transfer exercise was based on two parallel surveys conducted concurrently in the two watersheds. Favorably to benefit transfer, the two watersheds present similar environmental and physical features in all aspects but size: the Genil watershed (5,000 km^2) is almost twice the size of the Guadajoz (2,425 km^2). Because of this environmental similarity, differences in welfare measures are expected to be found more in population characteristics (their preferences, beliefs, and socioeconomic factors) than in differences in the environmental attributes considered in the study. To account for the respondents' beliefs, norms, and ideological values, we added specific attitude variables to the general socioeconomic characteristics model.

The policy scenario depicted in the questionnaire was identical in the two catchments and described the environmental conditions (referring to the main off-farm effects of soil erosion) expected in the watershed over the next fifty years if no action is taken to reduce the current high erosion rates. The change scenarios outlined the environmental improvements expected with the implementation of a soil erosion reduction project that consisted mainly of sowing a grass cover in olive orchards and reforesting degraded hill and mountain slopes. The soil erosion process and its effects, the baseline and alternative scenarios, were summarized for respondents by means of a color information package. The questionnaires used were identical in the two basins with the exception of site-specific information. In the first part of the questionnaire, respondents were asked about the importance that they gave to soil erosion relative to other environmental problems (water, air pollution, and biodiversity), the need to preserve natural capital for future

[2] When we allowed heterogeneity over preferences toward the jobs attribute the models obtained by stacking the two data sets when applying the Swait and Louviere procedure for testing for scale differences did not converge, so we restricted this attribute to be fixed. Fixing the price attribute is a customary practice that makes welfare measurement easier. Preferences toward the other attributes are assumed to be normally distributed: some individuals will have negative parameters and others positive, with the proportion of each group determined by the mean and standard deviation of the distribution.

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generations, and their relationship with the environment. Respondents were then required to choose their most preferred policy alternatives in a set of four choice cards each containing three alternatives.

The attributes and attribute levels selection was carried out by consulting experts in the soil erosion field and by using focus groups. The specification of the nonmonetary attribute levels was achieved using the Geographic Information System of the Andalusian Community (SINAMBA): this allowed a more precise definition of the expected change in the levels due to project implementation. For instance, relating the area of olive orchards that would have grass cover with the increased productivity of vegetated fields, we estimated the additional agricultural jobs created using the formula provided by López (1992). By providing experts with information regarding the number of hectares that would be reforested and with which trees or bush species, we predicted the expected density of flora and fauna with and without project execution. Special care was used in the monetary attribute levels selection, due to their central role in welfare change estimation (Hanley, Adamowicz, and Wright 2005). A contingent valuation study (Colombo, Calatrava-Requena, and Hanley 2003) was carried out to establish the distribution of willingness to pay, prior to the design of the choice experiment.

The attributes and attributes levels finally selected are summarized in table 1. These attributes provided too large a number of profiles to be evaluated by respondents if a full factorial was used. We thus employed a fractional factorial design, which allowed the estimation of main effects and two-way interactions, obtaining 108 profiles that were blocked into twenty-seven groups of four choice cards. The environmental attributes were coded with qualitative levels, due to problems in predicting the exact change in environmental conditions expected in the watersheds after fifty years. Scenarios were clearly explained to respondents; for instance they were told that a "poor quality" of the flora and fauna attribute corresponded to a loss of 350 birds per km^2 relative to current conditions. A pilot study of fifty randomly selected citizens was carried out to fine-tune the questionnaire, and to allow the training of interviewers. The two main surveys were carried out between March and June 2002. The sample size was 345 citizens in the Genil and 358 in the Guadajoz, and the survey format was face-to-face interviews.

Table 1. Attributes and Attributes Levels Used in the CE Study

Attributes	Levels for Genil	Levels for Guadajoz
Landscape change: desertification of the semiarid areas	*Degradation*	*Degradation*
	Slight improvement	Slight improvement
	Big improvement	Big improvement
Surface and ground water quality	*Low*	*Low*
	Medium	Medium
	High	High
Flora and fauna quality	*Poor*	*Poor*
	Medium	Medium
	Good	Good
Agricultural jobs created (number)	*0*	*0*
	100	65
	200	130
Area of project execution (km^2)	*0*	*0*
	330	154
	660	308
	990	462
Extra tax (euros)	*0*	*0*
	6.01	6.01
	12.02	12.02
	18.03	18.03
	24.04	24.04
	30.05	30.05
	36.06	36.06

Note: The attribute levels of the status quo situation are represented in italic.

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Results

Of the total number of responses for the Genil watershed, nineteen surveys were found unusable, while seventy-four respondents gave a protest answer regarding the proposed project; these individuals considered that reductions in soil erosion should be funded by the federal government budget. Protest bids were removed from the sample. An additional fifty-one people always chose the status quo option, while 201 fully completed the survey, providing 1,008 (201 + 51 ∗ 4) observations for model estimation. In the Guadajoz basin, the response rate was similar with eighty-eight protesting, fifty-two respondents always choosing the status quo, and 217 surveys in which interviewees chose either the status quo or alternative A or B, providing 1,076 valid observations. The mean values of socioeconomic and attitudinal characteristics in the two samples are very similar, differing only in the degree of support for community interests and in occupation status.

The Genil Watershed Models

Table 2 shows the estimated models. Column 2 shows the CL model coefficients and columns 3

Table 2. Estimated Coefficients of the Genil Watershed Models

Variables	CL	RPLa: Independent Coefficients	RPLb: Correlated Coefficients
Mean			
Constant	−7.590***	−8.970***	−12.729***
Landscape desertification: slight improvement	1.017***	1.454***	2.344***
Landscape desertification: big improvement	1.516***	2.368***	4.035***
Surface and ground water quality: medium	1.052***	1.613***	2.787***
Surface and ground water quality: high	1.502***	2.199***	3.435***
Flora and fauna quality: medium	0.774***	1.147***	1.838***
Flora and fauna quality: good	1.049***	1.391***	2.100***
Jobs created	0.007***	0.011***	0.015***
Area of project execution	0.001***	0.0006	0.001
Tax	−0.057***	−0.101***	− 0.153***
Constant ∗ Solidarity[a]	0.022***	0.034***	0.036**
Constant ∗ Enjoyment[b]	0.023**	0.018	0.041
Constant ∗ Erosion[c]	0.005***	0.005	0.003
Constant ∗ Gender[d]	0.058	0.090	0.097
Constant ∗ Age[e]	−0.107***	−0.176***	− 0.313***
Constant ∗ Marital status[f]	0.093***	0.119**	0.094
Constant ∗ Occupation[g]	0.161***	0.268***	0.428***
Constant ∗ Income[h]	0.00021***	0.00026***	0.00022
Standard Deviation			
Landscape desertification: slight improvement		0.808	2.325***
Landscape desertification: big improvement		0.728	1.156***
Surface and ground water quality: medium		1.040***	3.030***
Surface and ground water quality: high		1.354***	3.768***
Flora and fauna quality: medium		0.664**	2.079***
Flora and fauna quality: good		1.244***	2.573***
Area of project execution		0.003***	0.004***
Number of observations	1,008	1,008	1,008
Log likelihood at convergence	−821.945	−752.263	−721.452
LR	455.11	710.276	771.898
Pseudo R^2	0.258	0.321	0.349

Note: Asterisks (e.g., *,**,***) denote significance at 10%, 5%, and 1% level, respectively.
[a] Importance that respondents assigned to solidarity (Likert scale 1–10).
[b] Importance that respondents assigned to leisure activities in a natural environment (Likert scale 1–10).
[c] Percentage share of 1 euro of public spending that respondents gave to the funding of soil erosion reduction projects among other natural resource care projects (improve air, water, and biodiversity quality).
[d] Respondents' gender (female: 0; male: 1).
[e] Respondents' age (Less than 50: 0; More than 50: 1).
[f] Respondents' marital status (Not married: 0; Married : 1).
[g] Respondents' occupation (Not an active worker: 0; Active Worker: 1).
[h] Respondents' income in euros.

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and 4 present the RPL coefficients with independent random parameters (model a) and correlated random parameters (model b). Overall, all of the models are highly significant and show a good fit when comparing the log likelihood values at zero and at convergence. Incorporating respondents' heterogeneity using the RPL specification and socioeconomic characteristics improves the model fit significantly. All the regression coefficients of the CL model are highly significant and have a priori expected signs. Given the coding of the status quo choice in any choice task, the negative and significant constant term implies some kind of status quo effect in our responses: people derive utility from sticking with the current situation. This possibility has been noted before in choice experiments (Adamowicz et al. 1998), and possible reasons include the existence of an endowment effect, a lack of trust in the government to implement soil erosion control projects, or that respondents found some choices to be too difficult and so chose the status quo as an easy opt-out.

The RPL models show a similar preference structure to the CL model in terms of mean effects. Looking at the column headed RPLa, it can be seen that improvements in all of the environmental attributes (landscape desertification, water quality, and flora/fauna quality) increase utility on average, as does an increase in the number of rural jobs. These results are qualitatively identical to those of the CL model, with the exception of the "area of project execution" attribute, the parameter on which is not significant in either RPL model. This is very important for benefit transfer purposes, since it shows that, once heterogeneity is taken into account, respondents are unwilling to pay to expand the area of the catchment over which the soil erosion control program is extended. In contrast, the CL model shows people are willing to pay for an extension of this area. Another interesting feature of the RPL results is that most of the standard deviation terms are significant, indicating considerable preference heterogeneity. It is noteworthy that the standard deviation of the area of project execution attribute is greater than its mean value. RPL coefficient values are consistently bigger than those of CL model since the RPL approach treats the variance in parameters as a separate component of the error ($\eta_{jk}\ X_{jk}$) such that the remaining error (ε_{nj}) is free of this variance. This does not happen in the CL model, where the error term encompasses all the variance not explained by the model.

The model that allows for correlation (RPLb) provides better fit to the data, but at the cost of twenty-one additional parameters to be estimated. Table 3 shows the estimated covariance matrix of preferences. Attributes show some significant correlations between them, both at intraattribute levels and between attributes. It is possible to observe that people who like a medium level of water or biodiversity quality also like a high level of them. The direction of these relationships is not always as expected: for instance, in the case of landscape desertification people who like a big improvement in landscape did not seem to like only a slight improvement; also the flora and fauna quality attribute levels are inversely correlated to water quality although this correlation is weak. The area of project execution is not related to any other environmental attributes. Moving to the RPLb model from RPLa slightly modifies the effects of the attitudinal and socioeconomic variables: marital status and income are no longer significant determinants of the choice. Furthermore, all the random attributes show a high degree of

Table 3. Preference Covariance Matrices

	Land Desertification Slight Improvement	Land Desertification Big Improvement	Water Quality Medium	Water Quality High	Flora and Fauna Quality Medium	Flora and Fauna Quality High	Area of Project Execution
Land desertification slight improvement	5.40						
Land desertification big improvement	**−2.60*****	1.34					
Water quality medium	2.27	−0.28	9.18				
Water quality high	**5.52***	−1.93	**10.22*****	14.20			
Flora and fauna quality medium	−0.73	0.11	−2.92	−3.41	4.32		
Flora and fauna quality high	−1.40	0.31	−3.74	−3.23	**3.47***	6.62	
Area of project execution	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: Asterisks (e.g., *,***) denote significance at 10% and 1% level, respectively.

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heterogeneity, since all the standard deviations are significant at 1% level in the RPLb model.

The Guadajoz Watershed Model

The interpretation of model coefficients of the Guadajoz watershed (table 4) is exactly the same as in the Genil case, so we will focus on the differences in the structure of preferences between the two watersheds, since this may affect value transferability. Among the attitudinal and socioeconomic variables only the respondents' gender is significant when respondents' taste heterogeneity is included in the model using the RPL approach. Preference heterogeneity for this watershed is therefore almost entirely explained by the random parameters specification, in contrast to the Genil sample: this has clear implications for benefits transfer, since there is less need to incorporate any attitudinal or socioeconomic information in the model (often these are not available for the policy site) if random parameters explain most of the variance otherwise picked up by attitudinal and socioeconomic variables, a result which we believe has not been noted elsewhere. Looking at the pseudo R^2 values it is possible to observe the rise in model fit in moving from the CL model to the RPL model. The significance of the standard deviation of the random parameters indicates that respondents' preferences differ, again being more heterogeneous when correlation is taken into account (i.e., when the RPLb model is compared to RPLa).

Benefit Transfer Tests

The first test we are interested in is the equivalence of choice model parameters. Figure 2

Table 4. Estimated Coefficients of the Guadajoz Watershed Models

Variables	CL	RPLa	RPLb
Mean			
Constant	−6.713***	−7.725***	−11.686***
Landscape desertification: slight improvement	1.555***	2.488***	2.920***
Landscape desertification: big improvement	1.651***	2.730***	3.123***
Surface and ground water quality: medium	1.456***	2.243***	2.606***
Surface and ground water quality: high	2.080***	3.022***	3.730***
Flora and fauna quality: medium	0.830***	1.455***	1.548***
Flora and fauna quality: good	1.096***	1.667***	1.942***
Jobs created	0.012***	0.019***	0.022***
Area of project execution	0.003***	0.004***	0.005***
Tax	−0.067***	−0.115***	−0.139***
Constant ∗ Solidarity	0.007	−0.009	−0.001
Constant ∗ Enjoyment	0.020**	0.025	0.067
Constant ∗ Erosion	0.003*	0.003	0.006
Constant ∗ Gender	0.064***	0.095**	0.185***
Constant ∗ Age	0.025	0.069	0.020
Constant ∗ Marital status	0.034	0.028	−0.003
Constant ∗ Occupation	0.038	0.038	−0.011
Constant ∗ Income	0.00002	0.00007	0.00009
Standard Deviation			
Landscape desertification: slight improvement		0.855**	1.509***
Landscape desertification: big improvement		0.029	1.609***
Surface and ground water quality: medium		1.117***	1.600***
Surface and ground water quality: high		1.597***	2.808***
Flora and fauna quality: medium		0.556	1.580***
Flora and fauna quality: good		1.225***	1.412***
Area of project execution		0.006***	0.006***
Number of observations	1,076	1,076	1,076
Log likelihood at convergence	−850.97	−774.586	−749.430
LR	491.40	762.31	812.619
Pseudo R^2	0.263	0.330	0.351

Note: Asterisks (e.g., *,**,***) denote significance at 10%, 5 %, and 1% level, respectively.
All demographic variables are defined in notes to Table 2.

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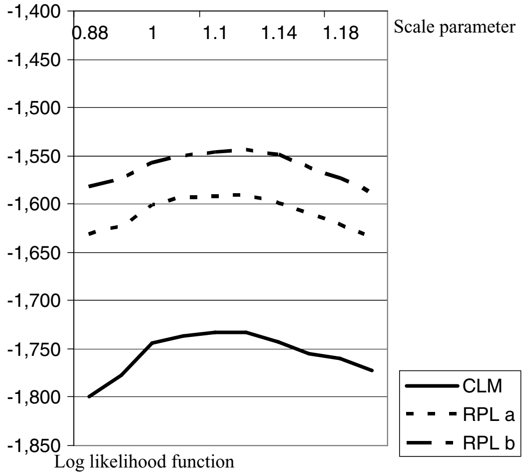

Note: CL: Swait and Louviere test $\chi^2 = 119.51$; tabulated $\chi^2_{19} = 30.14$. RPLa: Swait and Louviere test $\chi^2 = 129.70$; tabulated $\chi^2_{26} = 38.88$. RPLb: Swait and Louviere test $\chi^2 = 147.569$; tabulated $\chi^2_{47} = 64.50$.

Figure 2. Scale parameter grid search and χ^2 tests for parameter equality

shows the scale parameter grid search for all reported models and the resulting test statistic for the LR test of parameter equality (Swait and Louviere 1993). It can be observed that test values are greater than the tabulated critical chi-square values at the 5% level, therefore the null hypothesis of parameter equality is rejected and it can be concluded that choice models of the two basins are different, even after taking scale differences into account.

The second test focuses on the equality of implicit prices. Before performing the benefit transfer test, it is advisable to check if, within the same basin, the CL and RPL models give the same estimates.[3] Table 5 gives results: 95% confidence intervals estimated using the Krinsky and Robb (1986) procedure are given in parenthesis, while the last two columns show the approximate significance levels resulting from the Poe, Severance-Lossin, and Welsh (1994) test of equality of means. In both catchments the mean values of implicit prices of the RPLa model are lower than the CL, but they do not differ statistically except with regard to the area of project execution implicit price in the Guadajoz basin. Thus, the implicit prices for most of the attributes do not differ significantly between the two watersheds: six of the eight implicit prices are equal in the CL model, and five of the eight are equal in the RPL model. The inclusion of taste heterogeneity causes some differences that are, however, noteworthy: the implicit prices for a small improvement in landscape desertification differ between the two watersheds under the RPL specification, as do the implicit prices for the number of jobs created. To ignore this source of variation (as under the CL approach) would therefore lead to a misleading benefit transfer. Overall, though, results are supportive of the use of implicit prices for benefit transfer, a result found in previous studies (Morrison et al. 2002; Mogas and Riera 2003).

The last and perhaps most policy-relevant test focuses on the equivalence of compensating surplus estimates for different policy designs. This might also be considered the most important test of benefits transfer, since obtaining welfare estimates for alternative policy designs is the main goal of benefit transfer for use in cost–benefit analysis. Comparing the compensating surplus estimates requires the definition of the scenarios used in the estimation, since in CE it is possible to calculate multiple estimates of welfare change by changing the attribute values. This is often recognized as strength of CE, since it grants flexibility to the benefit transfer process in terms of what we are valuing. On the other hand, as pointed out by Morrison et al. (2002), it is also a limitation, since the magnitude of the differences may diverge depending on the scenarios chosen. In this article, to reduce the dependence of transfer results on the scenarios selected, a fraction of the full factorial representing a main effects plan that should explore the whole experimental space was used to define the profiles used for the compensating surpluses estimates. The twenty-seven profiles thus selected are described in table 6 and the resulting welfare estimates are shown in table 7, together with their 95% confidence intervals.

The null hypothesis of compensating surplus equality is roundly rejected for all the twenty-seven scenarios in the CL and in twenty-six of the twenty-seven scenarios in the RPLa model (table 7). The Guadajoz estimates of compensating surplus are greater than the Genil estimates in virtually all policy scenarios. If we consider the differences between the absolute values of compensating surpluses in the CL and RPL model, i.e., if we carry out a simple value transfer as described in equation (1),

[3] The implicit prices and the compensating surpluses welfare measures estimated using the RPLb model did not differ statistically at the 95% confidence level from those estimated for the RPLa model.

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Table 5. Implicit Prices and Confidence Intervals

Attributes	Genil Implicit Prices CL	Genil Implicit Prices RPLa	Guadajoz Implicit Prices CL	Guadajoz Implicit Prices RPLa	Prob. H_{01}[a]	Prob. H_{02}[b]
Landscape desertification: slight improvement	17.78 (12.02; 25.21)	14.43 (9.90; 19.80)	23.38 (18.09; 30.63)	21.66 (17.79; 27.69)	0.121	0.023
Landscape desertification: big improvement	26.51 (20.05; 35.76)	23.50 (18.57; 29.91)	24.80 (19.59; 32.21)	23.76 (19.31; 30.29)	0.371	0.457
Surface and ground water quality: medium	18.39 (12.67; 25.96)	16.01 (10.57; 21.79)	21.88 (16.98; 28.13)	19.52 (14.92; 24.83)	0.217	0.178
Surface and ground water quality: high	26.27 (20.10; 34.67)	21.82 (16.97; 27.97)	31.25 (25.76; 39.17)	26.30 (21.68; 32.45)	0.157	0.142
Flora and fauna quality: medium	13.53 (7.96; 19.54)	11.39 (7.31; 16.17)	12.48 (8.22; 18.19)	12.04 (9.01; 17.29)	0.396	0.350
Flora and fauna quality: good	18.34 (13.11; 24.57)	13.81 (9.48; 19.29)	16.47 (11.94; 22.15)	13.75 (10.49; 19.65)	0.315	0.416
Jobs created	0.119 (0.088; 0.160)	0.104 (0.080; 0.134)	0.181 (0.140; 0.230)	0.161 (0.129; 0.206)	0.016	0.007
Area of project execution	0.014 (0.007; 0.023)	N.A.[c]	0.050 (0.036; 0.067)	0.031 (0.018; 0.046)	0.000	N.A.

[a] H_{01}: implicit price CL Genil = implicit price CL Guadajoz.
[b] H_{02}: implicit price RPL Genil = implicit price RPL Guadajoz.
[c] N.A.: not applicable.

Table 6. Scenarios Description

Attributes	Land Desertification	Water Quality	Flora and Fauna	Jobs	Area
Scenario 1	Big improvement	High	Good	150	500
Scenario 2	Big improvement	High	Medium	100	400
Scenario 3	Big improvement	High	Poor	50	300
Scenario 4	Big improvement	Medium	Good	150	300
Scenario 5	Big improvement	Medium	Medium	100	500
Scenario 6	Big improvement	Medium	Poor	50	400
Scenario 7	Big improvement	Low	Good	150	400
Scenario 8	Big improvement	Low	Medium	100	300
Scenario 9	Big improvement	Low	Poor	50	500
Scenario 10	Slight improvement	High	Good	100	300
Scenario 11	Slight improvement	High	Medium	50	500
Scenario 12	Slight improvement	High	Poor	150	400
Scenario 13	Slight improvement	Medium	Good	100	400
Scenario 14	Slight improvement	Medium	Medium	50	300
Scenario 15	Slight improvement	Medium	Poor	150	500
Scenario 16	Slight improvement	Low	Good	100	500
Scenario 17	Slight improvement	Low	Medium	50	400
Scenario 18	Slight improvement	Low	Poor	150	300
Scenario 19	Worsening	High	Good	50	400
Scenario 20	Worsening	High	Medium	150	300
Scenario 21	Worsening	High	Poor	100	500
Scenario 22	Worsening	Medium	Good	50	500
Scenario 23	Worsening	Medium	Medium	150	400
Scenario 24	Worsening	Medium	Poor	100	300
Scenario 25	Worsening	Low	Good	50	300
Scenario 26	Worsening	Low	Medium	150	500
Scenario 27	Worsening	Low	Poor	100	400

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Table 7. Compensating Surpluses and Confidence Intervals per Household and Year

	Genil		Guadajoz			
Scenarios	CL	RPLa	CL	RPLa	Prob. H_{01} [a]	Prob. H_{02} [b]
Scenario 1	40.98 (34.95; 47.15)	39.03 (33.06; 46.09)	61.39 (53.13; 70.39)	54.46 (47.08; 63.66)	0.000	0.000
Scenario 2	28.63 (22.74; 34.43)	30.84 (25.37; 36.57)	43.42 (37.91; 49.54)	41.43 (35.96; 48.08)	0.000	0.000
Scenario 3	7.56 (−0.18; 13.49)	13.67 (6.98; 19.18)	16.97 (12.30; 21.21)	17.58 (12.31; 22.20)	0.000	0.004
Scenario 4	30.27 (23.68; 36.59)	32.12 (26.02; 38.35)	42.10 (36.33; 48.64)	41.43 (35.42; 47.98)	0.000	0.000
Scenario 5	22.17 (16.41; 27.81)	25.58 (20.14; 30.71)	39.02 (33.77; 45.22)	37.77 (31.79; 44.33)	0.000	0.000
Scenario 6	1.10 (−7.73; 7.62)	8.41 (1.44; 13.83)	12.57 (7.45; 17.04)	13.92 (7.63; 18.77)	0.000	0.000
Scenario 7	13.29 (4.84; 18.52)	16.66 (10.48; 22.29)	25.19 (19.38; 30.51)	25.04 (19.35; 30.66)	0.000	0.000
Scenario 8	0.94 (−8.32; 7.44)	8.46 (1.77; 13.98)	7.22 (1.69; 11.89)	12.01 (6.85; 16.17)	0.000	0.017
Scenario 9	−15.88 (−28.42; −7.91)	−7.04 (−14.77; −0.84)	−4.34 (−12.55; 1.65)	−2.48 (−9.31; 3.88)	0.000	0.016
Scenario 10	23.30 (17.36; 28.34)	23.64 (18.28; 29.22)	40.99 (36.09; 47.37)	38.05 (33.54; 43.56)	0.000	0.000
Scenario 11	15.20 (8.90; 20.49)	17.10 (11.93; 22.54)	37.92 (32.47; 43.79)	34.39 (28.88; 40.55)	0.000	0.000
Scenario 12	12.50 (5.29; 18.08)	15.60 (9.90; 20.91)	38.51 (33.24; 45.02)	34.73 (29.63; 40.78)	0.000	0.000
Scenario 13	16.84 (11.07; 21.88)	18.38 (12.75; 23.91)	36.60 (31.89; 42.36)	34.39 (29.33; 39.86)	0.000	0.000
Scenario 14	4.49 (−3.71; 10.74)	10.18 (4.02; 15.37)	18.63 (13.58; 23.07)	21.36 (16.92; 25.74)	0.000	0.000
Scenario 15	6.04 (−1.93; 11.18)	10.35 (4.23; 15.32)	34.11 (28.29; 40.46)	31.07 (25.39; 37.27)	0.000	0.000
Scenario 16	−0.14 (−8.48; 5.72)	2.92 (−3.79; 8.80)	19.68 (14.00; 24.79)	17.99 (11.78; 24.15)	0.000	0.000
Scenario 17	−12.49 (−23.45; −5.31)	−5.28 (−13.31; 1.24)	1.72 (−5.22; 7.68)	4.96 (−1.43; 10.69)	0.000	0.000
Scenario 18	−15.19 (−28.65; −7.06)	−6.77 (−14.87; −0.60)	2.30 (−5.27; 8.20)	5.30 (−0.87; 10.48)	0.000	0.000
Scenario 19	0.81 (−9.05; 7.23)	4.54 (−2.96; 10.47)	13.59 (7.78; 18.59)	11.45 (5.26; 16.74)	0.000	0.000
Scenario 20	6.83 (−1.83; 12.13)	12.01 (6.11; 16.85)	22.67 (17.18; 27.74)	22.61 (17.52; 27.66)	0.000	0.000
Scenario 21	−10.70 (−22.82; −3.22)	−3.77 (−11.65; 2.31)	8.62 (2.09; 13.95)	6.57 (−0.28; 12.19)	0.000	0.000
Scenario 22	−5.65 (−16.64; 1.39)	−0.72 (−9.21; 6.25)	9.20 (2.14; 15.13)	7.79 (0.44; 13.86)	0.000	0.000
Scenario 23	0.37 (−8.60; 6.29)	6.75 (0.64; 11.78)	18.27 (12.03; 23.82)	18.95 (13.54; 24.80)	0.000	0.000
Scenario 24	−20.70 (−34.33; −11.31)	−10.41 (−19.23; −3.40)	−8.18 (−16.95; −1.29)	−4.90 (−11.91; 1.24)	0.000	0.002
Scenario 25	−26.88 (−42.48; −16.46)	−17.84 (−27.92; −9.83)	−22.61 (−34.13; −14.55)	−17.97 (−26.69; −11.28)	0.015	0.531
Scenario 26	−16.61 (−30.17; −8.61)	−8.70 (−17.01; −2.79)	1.35 (−7.23; 7.74)	2.55 (−5.07; 8.88)	0.000	0.000
Scenario 27	−37.68 (−56.47; −26.02)	−25.87 (−36.08; −17.69)	−25.10 (−37.84; −17.00)	−21.30 (−30.50; −14.00)	0.000	0.015

[a] H_{01}: compensating surplus CL Genil = compensating surplus CL Guadajoz.
[b] H_{02}: compensating surplus RPL Genil = compensating surplus RPL Guadajoz.

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Table 8. Compensating Surplus Differences and Transfer Error for the Twenty-Seven Scenarios

	Absolute Value Difference ()		Genil vs. Guadajoz		Guadajoz vs. Genil	
Scenarios	CL[a]	RPLa[b]	CL	RPLa	CL	RPLa
Scenario 1	20.41	15.43	29.27%	24.84%	47.48%	43.67%
Scenario 2	14.79	10.59	28.44%	20.99%	48.32%	39.61%
Scenario 3	9.41	3.91	41.06%	11.44%	111.78%	40.45%
Scenario 4	11.83	9.31	22.31%	17.90%	35.94%	34.05%
Scenario 5	16.85	12.19	36.92%	27.25%	71.69%	53.99%
Scenario 6	11.47	5.51	71.81%	25.92%	952.60%	84.71%
Scenario 7	11.90	8.38	37.55%	25.87%	82.37%	60.01%
Scenario 8	6.28	3.55	53.14%	13.69%	564.66%	61.01%
Scenario 9	11.54	4.56	209.55%	107.77%	66.65%	87.81%
Scenario 10	17.69	14.41	37.21%	32.89%	71.86%	67.83%
Scenario 11	22.72	17.29	53.47%	44.75%	143.12%	110.58%
Scenario 12	26.01	19.13	61.21%	49.59%	200.47%	132.91%
Scenario 13	19.76	16.01	47.32%	41.03%	111.66%	95.92%
Scenario 14	14.14	11.18	62.77%	43.43%	293.26%	125.68%
Scenario 15	28.07	20.72	75.14%	60.57%	449.08%	215.87%
Scenario 16	19.82	15.07	88.32%	73.20%	1329.63%	571.51%
Scenario 17	14.21	10.24	685.75%	168.07%	106.09%	224.62%
Scenario 18	17.49	12.07	653.47%	191.85%	108.88%	202.18%
Scenario 19	12.78	6.91	76.08%	43.80%	1458.33%	188.19%
Scenario 20	15.84	10.60	59.10%	38.48%	217.89%	101.73%
Scenario 21	19.32	10.34	195.76%	128.47%	171.68%	317.05%
Scenario 22	14.85	8.51	134.88%	84.87%	245.91%	1401.87%
Scenario 23	17.90	12.20	84.61%	54.33%	4574.70%	204.58%
Scenario 24	12.52	5.51	123.16%	73.76%	55.86%	68.49%
Scenario 25	4.27	−0.13	8.10%	11.32%	12.34%	8.31%
Scenario 26	17.96	11.25	1147.94%	366.29%	102.39%	147.93%
Scenario 27	12.58	4.57	40.42%	12.55%	30.86%	23.93%

Note: [a] Compensating surplus Guadajoz $_{CL}$ – Compensating surplus Genil $_{CL}$.
[b] Compensating surplus Guadajoz $_{RPL}$ – Compensating surplus Genil $_{RPL}$.

some interesting results emerge. From columns 2 and 3 of table 8 (labeled “absolute value difference”) it can be seen that the RPLa differences are smaller than the CL differences in all scenarios, with the difference between the two compensating surplus estimates smaller by an average of 38%. Incorporating respondents’ taste heterogeneity thus considerably reduces the transfer error expressed as an absolute value difference between the two watersheds. Using the RPLb model (i.e., allowing for correlation) instead of the RPLa model produces similar results, although the relative performance of the preference heterogeneity approach suffers somewhat, in that a lower (absolute) transfer difference now occurs in twenty out of twenty-seven cases, rather than twenty-seven out of twenty-seven cases with the RPLa model (these RPLb comparisons are not shown in table 8).

For each of the policy scenarios it is also possible to calculate the transfer error using the model parameters of one basin and the site attributes and sociodemographic characteristics of the other basin (i.e., by adjusting the value estimates as in equation 2), using equation 6. These transfer errors for the CL and RPL models for a two-way comparison, i.e., interchanging the study and policy site basins, are shown in the last four columns of table 8.

Using the Genil basin as study site and the Guadajoz as policy site (columns 4 and 5) the transfer errors resulting from the CL are greater than those resulting from the RPL model twenty-six out of twenty-seven times. The magnitudes of the transfer error are very different depending on the scenario considered, being greater when the compensating surplus estimates are small. In all these cases the RPL approach offers a much more accurate prediction of the estimated compensating surpluses than the CL. The average transfer error for the CL is 154% while it is reduced to 66% when the RPLa model is used. When

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the Guadajoz watershed is used as study site, the RPL model still provides smaller transfer errors but only in nineteen out of the twenty-seven scenarios. In this case the magnitude of the transfer error is bigger but again the RPL approach outperforms the CL.

It is interesting to compare these transfer errors to others reported in the recent literature. None of the papers that tested choice experiments for benefit transfer calculated the adjusted transfer errors. From the paper of Morrison et al. (2002) it is possible to calculate the unadjusted value transfer errors for the nine representative scenarios they used. The magnitude of the error lies between 4% and 191% depending on the scenario considered. Using the contingent valuation method Ready et al. (2004) observed an average error of about 38%; Smith and Pattanayak (2002), in their review of benefit transfer studies of outdoor recreation, found an average error of 80%; while Rozan (2004) detected an average error of 25% in her contingent valuation exercise.

Conclusions

Benefit transfer is a growth area of environmental economics research, which has been, and is being, encouraged by the demands of policy makers and natural resource managers for estimates of nonmarket environmental values in a world of scarce time and limited research budgets. An important challenge is thus to investigate the circumstances under which it is possible to enhance the reliability of benefit transfer technique by reducing transfer errors.

Most benefit transfer studies up to now have used the contingent valuation or travel cost methods to develop models for benefits transfer. However, choice experiments, by accounting for differences in environmental values and sociodemographic characteristics of the population at study and policy sites, should be well suited to benefit transfer purposes. Despite this, studies employing the CE method in benefit transfer are rather scarce, and have obtained mixed results. None have included respondents' taste heterogeneity through the use of random parameters modeling.

In this study, we compared choice function parameters, implicit prices, and compensating surplus estimates from two choice experiment applications to the benefits of reducing soil erosion in similar watersheds located in the southeast of Spain. The results obtained are mixed: we reject choice function transfer, but the transfer of implicit prices was found to be valid in the majority of cases. The compensating surpluses for twenty-seven hypothetical scenarios were found to be statistically different between the study and policy sites. These results are similar to those obtained by Morrison et al. (2002). However, the main contribution of this article is in showing that allowing for preference heterogeneity using a random parameters approach reduces the transfer error between the sites. This is not to say that allowing for preference heterogeneity through an RPL approach is likely to be the best way of reducing transfer error: valuable information is contained within socioeconomic data on benefiting populations, and this source of variability in values should also be recognized. It is also unclear how "transferable" our results on the superiority of RPL over CL are; while transferring benefits using an RPL approach also assumes that the policy site population has the same variability in preferences around the mean as the study site population, a feature that some economists may find unattractive without further testing.

We also tested the effect of attribute correlation in welfare measures. Although significant correlations were found between the environmental attributes, the welfare measures of the model that allows for correlation did not differ greatly from those estimated assuming independence between attributes. Allowing for correlation between attribute values thus seems less important than allowing for heterogeneity in these values in the context of benefits transfer.

When actual and predicted compensating surplus estimates differ, a very important issue is to know when these differences are likely to fall within an "acceptable range." That is, it is of interest to know the magnitude of the error that is tolerated by policy makers. If we consider that the methods used in the economic evaluation of natural resources often provide a rather approximate value of the good under question, a value transfer error up to 30–80% may be considered acceptable for a cost–benefit analysis, particularly when the benefits clearly outweigh the costs. The levels of difference, which academic economists reject as "too big," may exaggerate the requirements of policy makers and natural resource managers. Cost estimates can also be subject to low precision. In the final analysis, it is in any case left to the discretion of policy makers to decide how much to rely on benefit transfer values, or

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whether to carry out new studies. In the light of these results, we believe there are some positive signals to encourage other tests of the CE method for benefit transfer, given that the need to model preference heterogeneity is accepted.

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