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Accounting for substitution and spatial heterogeneity in a labeled choice experiment

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Abstract

Many environmental valuation studies using stated preferences techniques are single-site studies that ignore essential spatial aspects, including possible substitution effects. In this paper substitution effects are captured explicitly in the design of a labeled choice experiment and the inclusion of different distance variables in the choice model specification. We test the effect of spatial heterogeneity on welfare estimates and transfer errors for minor and major river restoration works, and the transferability of river specific utility functions, accounting for key variables such as site visitation, spatial clustering and income. River specific utility functions appear to be transferable, resulting in low transfer errors. However, ignoring spatial heterogeneity increases transfer errors.

KEY WORDS

Labelled choice experiment, Distance-decay, Substitution, Value transfer, River restoration

1. Introduction

One of the first stated preferences studies by Hanley et al. (2006) in the United Kingdom, estimating the non-market benefits of river ecology improvements as a result of implementation of the European Water Framework Directive (WFD) kick-started a series of related valuation studies across European member states. Examples include Brouwer (2008), Schaafsma et al. (2012), and Schaafsma et al. (2013) for the Netherlands, Brouwer (2011) for France, Belgium and the Netherlands, Del Saz-Salazar et al. (2009), Brouwer et al. (2010) and Martin-Ortega et al. (2012) for Spain, Bateman et al. (2011) for the UK, Norway, Lithuania and Belgium, Kataria et al. (2012) for Denmark, Metcalfe et al. (2012) and Ferrini et al. (2014) for the United Kingdom, Meyerhoff et al. (2014) for Germany, and Brouwer et al. (2015) for Spain, Greece and Italy. In all of these studies, the non-market benefits are estimated of reaching a good chemical and ecological status of water bodies as prescribed by the WFD, most importantly to assess the extent to which the costs of WFD implementation are proportionate to their benefits (Brouwer, 2008). The studies differ from each other in terms of the extent to which local case study characteristics have been accounted for in the valuation of the non-market benefits. This includes differences in geo-climatic conditions and pollution sources across different parts of Europe (e.g. north and south) and their impact on river basin ecology (e.g. flow rates, concentration levels of different types of chemicals).

A number of studies specifically focused on the general applicability and transferability of these non-market benefits given the lack of studies across Europe examining the benefits of WFD implementation. For an overview of the use and development of benefit transfer in Europe, see Brouwer and Navrud (2015). European demand for transfer values is strongly linked to regulation and legislation. In the specific context of water and the WFD, practical guidelines were developed for the assessment of the nonmarket values of water resources management in the project AquaMoney, accounting for some of the main water management issues across European member states, i.e. ecological restoration of rivers, improvement of water quality levels to a good chemical and ecological state, and water conservation. By developing harmonized water quality ladders and employing state-of-the-art nonmarket valuation procedures, the transferability of the estimated values was tested across member states. Bateman et al. (2011) did this for example for water quality improvements in north-western Europe, Brouwer et al. (2015) for water conservation in south Europe, and Brouwer et al. (2016) for ecological restoration of the international Danube river. Experiences in these case studies were converted into guidelines for future applications of value transfer.

Compared to contingent valuation, discrete choice experiments (DCE's) have been argued to be particularly well suited to account for differences in local spatial context and facilitate the transferability of estimated non-market values (e.g. Jiang et al. (2005) and Johnston (2007)) and are therefore increasingly used also in the water valuation domain. A spatially sensitive value function approach may not only produce better verifiable and validated results, but also produces more conservative and hence acceptable values for decision makers (Brouwer and Navrud, 2015). Still, unit value transfer remains the most widely applied valuation method in Europe for use in cost-benefit analysis, although it has been shown that the transfer of a constant unit value can lead in some cases to large errors (e.g. Liekens et al., 2013). Research in this particular field is ongoing to determine (i) more valid and reliable benefits transfer procedures based on spatially sensitive value functions as in this particular study, (ii) ways to update benefit transfer functions to account for temporal instability of preferences (e.g. Schaafsma et al. (2014)) and (iii) cases in which unit value transfer is acceptable (e.g. Bateman et al. (2011)).

The number of studies focusing on the non-market valuation of the benefits of ecological river restoration is very limited (e.g. Loomis et al. (2000), Bliem et al. (2012) and Brouwer et al. (2016)). In this study, not only water quality levels are often improved, but especially also the local characteristics of the water bodies' hydro-morphology and hence their visual attractiveness to residents and visitors. In this latter case, a water body's specific location and the spatial distribution of the population of beneficiaries often plays a more important role than in the case of non-spatially defined water quality management measures aimed at pollution and abstraction sources in a watershed or river basin more generally. As a result, distance-decay and substitution effects are also expected to play a more important role in these cases where the specific location of a water quality improvement or restoration project takes place. The inclusion of these spatial considerations is expected to improve the transferability of the estimated values (Colombo and Hanley, 2008). Similarly, policymakers will be interested to know which water bodies they should restore first in order to obtain most value for their money given their limited budgets.

In the study reported in this paper, we add to the limited empirical evidence base and investigate the impact of substitution and distance-decay on the non-market valuation of water body restoration using a labelled DCE in the context of WFD implementation in two river basins in Flanders in Belgium. The main objective of the study is to test to what extent the labelled DCE generates water body specific or generic value functions, accounting for the spatial characteristics of the restoration projects and the spatial characteristics of the population of beneficiaries, including the distance they live from the two different water bodies and current and past visitation behavior. Finding a generic value function implies that the estimated utility functions are transferable, which would mean that they can be used more generally also to other restoration sites. If, however, the utility functions are water body specific, this means that they are not transferable and a new valuation study would be needed in principle every time a new restoration project requires valuation of its non-market benefits. Schaafsma et al. (2012) investigated the effects of the spatial characteristics of water quality improvements and the spatial distribution of the population of beneficiaries in the north-western lake district in the Netherlands by means of labeled DCEs and concluded that a generic distance-decay function might not be sufficient to capture all spatial heterogeneity. We put this finding to the test in this study focusing specifically on river restoration.

The paper is organized as follows. Section 2 first describes the theoretical model and research methodology, including the data collection procedure. This is followed in Section 3 by a description of the case study area and the two water bodies to be restored. Section 4 presents the results and Section 5 concludes.

2. Modeling framework and research methodology

2.1. Modelling framework and hypothesis testing

The choices of the survey participants in the DCE are modelled in a random utility framework (e.g. Ben-Akiva and Lerman (1985)). In this framework, a respondent's utility is decomposed into an observable deterministic part and an unobservable random part. The multinomial logit (MNL) model is the most used model in choice analysis because of its convenient closed form (Hensher et al., 2005). However, the MNL model is subject to a number of restrictive assumptions, such as independence of irrelevant alternatives (IIA) and associated proportional substitution. Moreover, it does not account for possible unobserved preference heterogeneity. Mixed logit models are more flexible and allow relaxing the above mentioned restrictions.

In this paper an error component random parameters logit (ECRPL) model is estimated. The indirect utility specification U of alternative j for individual i at choice moment t for such a model is presented in equation (1). In this function α_j refers to the alternative specific constant (ASC) for alternative j and X_{ijt} and β_{ij}^{x} represent the vectors with choice attributes X of alternative j for individual i in choice task t and their parameters, respectively.

$$U_{ijt} = \alpha_j + \beta_{ij}^{x} X_{ijt} + \beta^{y} Y_i + \beta_j^{d} D_{ij} + \beta_j^{s} D_{ik} + \beta_j^{du} D_{ij} * User_{ij} + \lambda_{ij} H_j + \varepsilon_{ijt} \quad (1)$$

The first hypothesis that will be tested in this study is equality of the labelled alternatives for the two specific water bodies for which restoration works are planned:

$$H_0^1\colon \alpha_j = \alpha_k \text{ for all } j \neq k \quad (2)$$

Rejection of the first hypothesis implies that the labelled water bodies are valued significantly different and the water bodies have a distinct value of their own, i.e. not captured by the alternative characteristics embodied in the choice attributes, which is not directly transferable.

The preference parameters in equation (1) are allowed to vary across individuals, hence β_i with a density function $f(\beta)$. The parameters associated with the choice attributes are furthermore also assumed to be alternative specific. This brings us to the second hypothesis:

$$H_0^2\colon \beta_j^{x} = \beta_k^{x} \text{ for all } j \neq k \quad (3)$$

Rejection of the second hypothesis implies that the restoration characteristics related to the two water bodies are valued significantly different, making the utility functions non-transferable.

The vector β^y in equation (1) measures the influence of the socio-demographic characteristics Y_i of the beneficiaries of the restoration works on choice behavior, and is generally expected to be the same for both alternatives. However, this does not apply to one of the main issues of interest in this study, i.e. the distance D_i survey participants i live from each labeled water body alternative j and k. The third hypothesis tested in this study is that the distance-decay effects differ for the two water bodies:

$$H_0^3: \beta_j^d = \beta_k^d \text{ for all } j \neq k \quad (4)$$

This includes testing of different functional forms of the distance survey participants live from the water bodies to be restored. Distance is measured here as the Euclidean distance ('as the crow flies') between a respondents' home to each of the two water bodies to be restored.

Substitution effects between the two water bodies are measured through the inclusion of the distance to water body k (D_{ik}) in the utility specification of water body j and vice versa (Schaafsma et al., 2013). The substitution effect of water body k on alternative j is picked up by the coefficient β_j^s and is expected to be positive instead of negative for the distance-decay parameter β_j^d. Distance-decay measures the impact of increasing distance and hence costs to a certain location on choice behavior. Utility and demand are expected to decrease for an alternative that is located further away. The substitution effect reflects the impact of the distance to an alternative water body k on demand for water body j. The further away the alternative water body k, the higher demand for water body j. To what extent these substitution effects are the same or differ between the two alternative water bodies is tested in hypothesis 4. Rejection of H_0^4 implies that substitution effects are experienced differently for the two water bodies, again undermining the general applicability and hence transferability of the estimated utility functions.

$$H_0^4: \beta_j^s = \beta_k^s \text{ for all } j \neq k \qquad (5)$$

The existence of significantly different distance-decay effects between users and non-users (e.g. Jørgensen et al. (2013)) is tested in hypothesis 5 below. If the fifth and final hypothesis cannot be rejected, this means that the distance-decay effect is similar across users and non-users of the water sites. In other words, there is no effect of prior visitation on choice behavior.

$$H_0^5: \beta_j^{du} = 0 \qquad (6)$$

λ_{ij} in equation (1) is a shared error component between the hypothetical alternatives. The error components are normally distributed with zero mean and variance σ^2: $N(0,\sigma^2)$. The variance captures the magnitude of the error correlation between the nested alternatives (Train, 2003). Specifying the model in this way, it also controls for potential status quo bias (Scarpa et al., 2005). Finally, ε_{ijt} is the standard extreme value type 1 distribution of the errors which allows deriving the ECRPL model.

2.2. Survey design and discrete choice experiment

The survey used in this case study to test the various hypotheses consisted of 4 sections. In the first section respondents were asked for their recreational behavior in and near water in general. The second section focuses specifically on two water bodies located in 2 different river basins in Belgium. Respondents are asked for their knowledge and information about the two water bodies, whether they ever visited the two water bodies and if so, how often, and their perception of the water bodies' water quality. This is followed by a short description of the actual water quality state of both water bodies and the required official water quality standard of good ecological status (GES). Respondents are informed about the possibility of restoring the two water bodies to different degrees to improve their water quality levels as a preamble to the third section, where the DCE is introduced. More details about the DCE follow below. The fourth and final section includes queries about the respondents' socio-demographic household characteristics to assess the sample's representativeness.

The third section includes the DCE and starts off by introducing the characteristics of the restoration of the two specific water bodies and explaining the choices respondents are asked to make, namely which of the two water bodies they prefer to be restored given the associated restoration characteristics. These characteristics are described in detail and illustrated with pictograms. An instruction card is used to explain the choices and corresponding trade-offs respondents are being asked to make between enjoying the restoration benefits on the one hand and paying the costs of securing them on the other hand. The restoration characteristics consist of the (i) extent of the restoration intervention (from no restoration to a minor or major return to more natural water body conditions), (ii) length over which the water body is restored (from zero meters (no restoration) to a maximum of 20 km), (iii) impact on water quality (from current moderate water quality levels to good or very good water quality), (iv) impact on species richness (from currently low conditions to moderate or high species richness), (v) with or without public recreational access. Together, (i), (iii) and (iv) capture the three relevant hydro-morphological, chemical and biological key characteristics of water body restoration, while (v) is used to assess whether the public also holds non-use values for the benefits of river restoration. Alternative restoration options for the two water bodies were created including these characteristics for which respondents were asked to pay additional annual household water taxes to the Flemish federal government. The features of the DCE design are presented in Table 1.

INSERT TABLE 1 HERE

The pictograms used for the first attribute (restoration efforts) are presented in Figure 1. Respondents were told that the water bodies are classified as heavily modified and canalized with dikes on both sides. Restoration would entail water body specific changes to the currently regulated flows. The minor water body restoration efforts meant in both cases that the river banks would be made less steep and only living or biologically degradable materials would be used to make the banks look more natural. Lowering the dikes would turn surrounding land in wetlands. A major change would additionally involve the creation of wider bank areas that serve as a transition zone between the river and the valley, the creation of inland ponds and marches, re-meandering and reconnection of the main river to its branches.

INSERT FIGURE 1 HERE

Color coding was used to represent the different water quality levels, following the same colors used by the Flemish water management authority based on the WFD water quality levels. Species richness is measured based on the official ecological quality indicator levels used by the Flemish Environment Agency for phytoplankton, water plants, macro-invertebrates, and fish. Hanley et al. (2006) used a similar attribute, but their description of the levels was not supported by pictograms like here. Low species richness was defined as only having common fish species and few birds and water plants species, moderate species richness as having an average number and diversity of fish, birds and water plants with no endangered species present, and high species richness as an abundance of fish, birds, and water plants, including endangered species.

In view of the fact that respondents could not be shown all 288 possible profiles for each water body based on the design presented in Table 1, a D-efficient main effects fractional factorial design was generated in SAS, yielding 72 choice cards containing 2 labelled alternatives and an opt-out representing the status quo. To create the design, fixed priors obtained from a pretesting round were used. The levels of the attributes in the opt-out alternative were also included in the experimental design of the hypothetical policy alternatives. The 72 choice cards were randomly divided over 12 blocks of 6 choice cards each. Every respondent was randomly shown one of these 12 blocks and hence stated his or her preferences 6 times in 6 choice tasks for one of the two labelled alternatives, i.e. the restoration of two water bodies, or the status quo.

3. Case study area and data collection

The case study area consists of two river basins located in the Flemish region in the northern part of Belgium (Figure 2). Oude Kale is a smaller river in the river basin Ghent Canals measuring 12.3 km from the town of Nevele to Vinderhoute and Leie is a bigger river measuring 51.3 km situated in the Lys river basin, running from the town of Wervik to Deinze. Both water bodies have been heavily modified over the past centuries. Parts of Oude Kale have been diverted and straightened, its river banks have been reinforced for flood protection purposes, whereas other parts have been kept in their natural state. Oude Kale and the valley through which it flows are promoted by the local Flemish tourist board as providing scenic routes, which serve multiple recreational purposes (mainly walking and cycling), attracting mainly local visitors. However, its water quality was defined as moderate in the first WFD reports and also the area's species richness is considered somewhat poor by the Flemish Environment Agency.

INSERT FIGURE 2 HERE

The river Leie is fully channelized from start to finish. These modifications mainly served commercial shipping and flood protection purposes. Also this case study area is promoted by the local tourist board as scenic in which multiple recreational activities can be undertaken (mainly walking and cycling), attracting also here local visitors. The water quality of Leie was just like the one for Oude Kale reported to be poor to moderate under the implementation of the WFD. The same applies to the species richness in the area according to the Flemish Environment Agency.

In both cases, the deterioration of water quality is partly caused by the man-made modifications to the water system in the past. Reaching GES as prescribed by the WFD is only possible with the necessary restoration work, requiring an integrated water management approach, simultaneously tackling nutrient runoff from diffuse pollution sources such as agriculture and wastewater treatment from point sources (Vlaamse milieumaatschappij afdeling water, 2005). The water bodies are not located very far apart and attract visitors from nearby surroundings, as evidenced by the fact that 20 percent of the sample population in this study visited both water bodies.

In order to assess public preferences for the restoration of these two alternative water bodies as part of implementation of the WFD, the survey was administered online after face-to-face pretesting in Flanders and sent to just over 2,750 local and regional households. Respondents were part of a wider consumer panel consisting of 300,000 households, located at different distances of the two water bodies. Fifty percent lived in a radius of less than 10 km of one of the water bodies, 25 percent in a radius between 10 and 20 km of one of the water bodies, and 25 percent more than 20 km away from one of the water bodies. The respondents were furthermore sampled based on age, gender, household size and education level in order to have as much as possible a representative cross-section of the Flemish population. A total of 264 households replied, yielding a response rate of 10 percent. This is very low, but comparable to other web-based surveys carried out in Flanders focusing on environmental issues (e.g. Liekens et al. (2013)). The red dots in Figure 2 show the spatial distribution of the survey respondents.

4. Results

4.1. Sample characteristics and choice behavior

The main socio-demographic characteristics of the sample are presented in Table 2, including those of the population from which the sample was drawn. The sample is fairly representative. Only slightly more higher educated, middle aged men are included and members of an environmental organization. The latter overrepresentation suggests some degree of self-selection bias. Similar results are reported in Liekens et al. (2013) and Schaafsma et al. (2014).

INSERT TABLE 2 HERE

Turning to their choice behavior in the DCE, 14 out of the 264 respondents (5%) consistently chose the opt-out for a protest reason, most importantly because they believed the polluter should pay. No significant differences could be detected between these 14 respondents and the other 250 respondents in terms of socio-demographic characteristics. Neither were they more or less often member of an environmental protection organization. Following common practice in stated preference research (e.g. Dziegielewska and Mendelsohn (2007)), these 14 respondents were omitted from further analysis.

Aggregated across all choice tasks, which consisted of 1,500 choice occasions (i.e. 250 respondents choosing 6 times an alternative), the restoration alternative for Oude Kale was chosen in 31 percent of the cases, the restoration alternative for Leie in 44 percent of the cases and the status quo (no restoration) in 25 percent of the cases. Hence, restoration of the river Leie is expected to be preferred over and above restoration of Oude Kale in all choice tasks. Respondents still appear to prefer restoration of Oude Kale over the status quo,

4.2. Estimated choice models

Two different models were estimated and the results of the estimations in willingness to pay (WTP) space are presented in Table 3. Estimation in WTP space allows direct estimation of the marginal WTP values and their distribution (Scarpa et al., 2008). The first model includes the choice attributes only, while the second model includes the covariates that are of prime interest here, in particular the distance from a respondent's home to his or her preferred river (measuring distance decay) and the distance to the alternative river (measuring substitution). Additionally, tests are carried out to see whether distance-decay differs among users and non-users and to what extent respondents' actual visitation behavior affects the value attached to the restored rivers' future accessibility. Possible spatial clustering of respondents is captured through the inclusion of a dummy variable representing the basin in which respondents live. Income is included as the most important socio-economic sample characteristic reflecting ability to pay and is expected to significantly influence WTP.

INSERT TABLE 3 HERE

The models were run with 1,000 Halton draws in NLOGIT 5 assuming a uniform distribution for the random parameters of the dummy variables as recommended by Hensher et al. (2005), a normal distribution for restoration length, and a fixed coefficient for the tax to avoid the possibility of obtaining a positive utility for this latter attribute. Specifying a fixed price coefficient causes the distribution of the derived attribute WTP to be the same as the distribution of the random attribute coefficient. Consequently, all random coefficients should be interpreted as mean marginal WTP estimates. The fixed coefficients are shown in preference space and hence represent their influence on utility.

The estimated models in Table 3 have two alternative specific constants (ASC's) and generic coefficient estimates for the other choice attributes. The first hypothesis of equal ASC's for the labeled river restoration alternatives (H_0^1) is rejected, but not the second hypothesis of equal coefficient estimates between the two rivers (H_0^2). Hence generic coefficient estimates are presented in Table 3, because they are the same for the two rivers to be restored. This implies that the restoration characteristics encapsulated in the choice attributes are valued in the same way by the public across the two rivers and are hence transferable, but the rivers have a distinct non-transferable value in themselves, captured by the ASC's. The ASC for Leie is, as expected, significantly higher than the ASC for Oude Kale. The Wald test results for the first and second hypothesis are presented in Table 4.

INSERT TABLE 4 HERE

All estimates have the expected signs. There is a positive demand for river restoration compared to the status quo (positive ASC's), and similarly minor and major restoration along longer stretches of river are preferred to no restoration. The latter results suggest sensitivity to scope (Hanley et al., 2001). Also the proposed increases in water quality from moderate to good and very good status and species richness from low to moderate and high species richness are valued positively. However, the differences between the attribute levels are not statistically significant. Finally, if access is denied or annual water taxes are increased utility decreases.

The ECRPL model including the relevant covariates is presented in Table 3 on the right-hand side. All of the estimates again have the expected signs, but their size is almost always systematically lower compared to the first model including the attributes only, except for the ASCs and accessibility, which are insignificant due to their interactions with the introduced covariates. These interactions are used to test the next set of hypotheses. As expected, disposable household income has a significant positive effect on choice behavior. Having a higher income level increases the probability of WTP for river restoration. The same applies to respondents' use intensity of the rivers: the more often someone visits, the more likely he or she is in favor of river restoration. More frequent visitors dislike restoration alternatives which would not allow them to visit anymore in the future. No evidence of spatial clustering can be detected in the estimated model: respondents living in the Lys basin do not value river restoration significantly different from respondents living in the basin of the Ghent canals.

Turning to the last set of hypotheses, the distance from a respondent's home to his or her preferred river to be restored (ASC*distance) exhibits the expected negative sign, but fails to reach significance. Different functional forms were tested, but the logarithmic transformation of the distance variable presented in Table 3 was found to provide the best statistical fit compared to a linear or quadratic distance based on the Likelihood Ratio test. The third hypothesis of equal distance-decay functions for both rivers in an alternative specific choice model for each river (H_0^3) cannot be rejected using the Wald test. A significant positive coefficient estimate was found for the logarithmic distance variable to the other river (ASC*substitution). This implies that the further the respondents live from the Leie (Oude Kale), the more likely they are to choose the alternative in which Oude Kale (Leie) is restored, indicating that they are substitutes. No significant difference can be found between the coefficient estimates when the models are estimated separately for Leie or Kale, meaning that we are not able to reject the fourth hypothesis of alternative specific substitution effects (H_0^4).

The fifth and final hypothesis cannot be rejected. An insignificant generic distance decay effect is found when examining the influence of visiting frequency on the distance respondents live from their preferred river. Hence, it is concluded that distance decay does not differ between users and non-users.

4.3. Consumer surplus estimates and transfer errors

Consumer surplus (CS) estimates are calculated using the Krinsky and Robb (1986) bootstrapping procedure with 10,000 draws. In order to test the impact of accounting for the effects of distance decay and substitution, we present here the mean CS values and transfer errors for 4 different restoration scenario's based on Model 1 and Model 2. The latter model specification includes the covariates and hence captures the effects of individual-specific characteristics on total WTP, including spatial heterogeneity and substitution effects. The scenarios are defined in Table 5 and the results in Table 6. Scenarios 1 and 3 and 2 and 4 respectively represent a minor and major restoration with associated changes in water quality from moderate to good and very good levels and species richness from low to moderate and high. Public access is guaranteed in Scenarios 1 and 2, but restricted in Scenarios 3 and 4. All scenarios involve restoration works over a length of 5 km. In view of the fact that the accessibility coefficient is not significant in model 2, the results of scenario's 1 and 3 and 2 and 4 are identical.

INSERT TABLE 5 HERE

INSERT TABLE 6 HERE

The presented CS estimates in Table 6 seem reasonable given the average amount of water taxes paid by households in Belgium, i.e. about €150 per year. Mean CS is slightly higher for model 1 in the scenarios without access. Mean CS is slightly higher for model 2 in the scenarios with access due to the insignificant accessibility coefficient. Using the attributes only model, the CS varies between 138 and 196 euros per household per year. The values generated based on the second model are between 156 and 185 euros per household per year.

This is equivalent to about 0.6% to 0.8% of the sample's average disposable annual household income. The transfer errors are calculated based on the procedure presented in Bateman et al. (2011). Transfer errors are furthermore calculated for both transfer directions, i.e. from Oude Kale to Leie and the other way around from Leie to Oude Kale. The results in Table 6 show that taking the effects of substitution into account decreases the relative transfer error irrespective of the transfer direction. As a result of the non-significance of the observed differences, the transfer errors are at the lower end of what has been reported in the literature but are not uncommon for water valuation studies (e.g. Martin-Ortega et al. (2012)). As expected, the consumer surplus is highest for Leie, suggesting that policy makers best prioritize their restoration efforts there. Restoration of the Leie is expected to provide substantially more benefits as it is longer than the Oude Kale and passes more cities on its way such as Gent, Deinze, Waregem and Kortrijk. The Oude Kale is a relatively smaller river in a rural area near Gent where less people are expected to benefit from the proposed restoration efforts.

4.4. Comparison with the existing literature

Seeing that this paper takes a similar approach to the one presented in Schaafsma et al. (2013), we outline here the main insights than can be derived from comparing the results. The main differences in the design of the research and the results are the following: (1) we investigate sites that mainly serve as scenic routes whereas Schaafsma et al. (2013) compare choice behavior for sites offering different types of water-based recreation opportunities; (2) we are mostly interested in transferability, whereas in their case study the emphasis was on the effects of distance-decay on WTP; (3) generic coefficients for all attributes were obtained here, whereas Schaafsma et al. (2013) find alternative-specific values for some of the attributes; (4) no evidence of distance decay or dependence of distance decay on being a user or non-user was found in our study whereas they do find site-specific distance decay effects and different distance decay effects for users and non-users in 2 out of the 3 alternatives; (5) substitution effects are captured explicitly in our design whereas in their case substitution effects were modelled ex-post as the distance to the nearest neighboring water body providing similar services; (6) our approach incorporates random parameters whereas in their case study the attribute coefficients seem to have been fixed. From the comparison it can be concluded that the lack of variation in the attributes, distance-decay and related user effects can be explained in our case study by the similar amenities provided by the sites under investigation. Finally, although a straightforward comparison of WTP values is not possible, the order of magnitude of the WTP estimates (€100-200 per household per year) is remarkably similar.

5. Conclusions

In this paper, public preferences for the restoration of two rivers, "Oude Kale" and "Leie", were investigated applying a novel labelled choice experiment design. Both rivers are situated in the Flemish region of Belgium and are mostly enjoyed by local residents for recreational activities such as walking or biking. In view of the fact that the two rivers are not located that far away from each other, substitution was deemed to be an issue here when deciding which one of the two to restore. Although substitution and distance decay effects are interdependent, they are rarely addressed at the same time in the stated preference literature, let alone that their effect on the transferability of river restoration benefits are accounted for. The labeled discrete choice experiment was set up in such a way that it allowed us to investigate explicitly the public's preferences for changes in one of the two river systems' hydromorphology, and associated changes in their water quality, species richness, and accessibility. In addition, the length of river restoration was varied and local residents were asked to trade-off the presented river restoration benefits against raising additional water taxes. The estimated error component random parameters logit models aimed at finding out to what extent restoration benefits are river specific, affecting their transferability, and public preferences are influenced by distance decay, substitution, and past visiting frequency. The rivers have a distinct value of their own, which is not directly transferable. Given limited governmental budgets, most benefits accrue by prioritizing spending towards restoration of the river Leie. The preference parameters associated with the river restoration characteristics are despite the rivers' differences in size and navigability the same, most likely due to the similar ecosystem services provided by the two rivers to visitors. This is good news for the practical application of the estimated benefits associated with river restoration across different rivers in the context of the European Water Framework Directive, but we still observe increasing transfer errors if spatial preference heterogeneity measured through distance decay and substitution effects are omitted from the value transfer function. More research is needed to test to what extent the findings reported here also apply to international transfer of restoration benefits.

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References

Bateman, I. J., Brouwer, R., Ferrini, S., Schaafsma, M., Barton, D. N., Dubgaard, A., Hasler, B., Hime, S., Liekens, I., Navrud, S., De Nocker, L., Ščeponavičiūtė, R. and Semėnienė, D. (2011). "Making Benefit Transfers Work: Deriving and Testing Principles for Value Transfers for Similar and Dissimilar Sites Using a Case Study of the Non-Market Benefits of Water Quality Improvements Across Europe." Environmental and Resource Economics **50**(3): 365-387.

Ben-Akiva, M. and Lerman, S. (1985). Discrete Choice Analysis: Theory and Application to Travel Demand. Camebrigde, Massachussets, MIT press.

Bliem, M., Getzner, M. and Rodiga-Lassnig, P. (2012). "Temporal stability of individual preferences for river restoration in Austria using a choice experiment." Journal of Environmental Management **103**: 65-73.

Brouwer, R. (2008). "The potential role of stated preference methods in the Water Framework Directive to assess disproportionate costs." Journal of Environmental Planning and Management **51**(5): 597-614.

Brouwer, R. (2011). "A mixed approach to payment certainty calibration in discrete choice welfare estimation." Applied Economics **43**(17): 2129-2142.

Brouwer, R., Bliem, M., Getzner, M., Kerekes, S., Milton, S., Palarie, T., Szerényi, Z., Vadineanu, A. and Wagtendonk, A. (2016). "Valuation and transferability of the non-market benefits of river restoration in the Danube river basin using a choice experiment." Ecological Engineering **87**: 20-29.

Brouwer, R., Martin-Ortega, J. and Berbel, J. (2010). "Spatial Preference Heterogeneity: A Choice Experiment." Land Economics **86**(3): 552-568.

Brouwer, R., Martin-Ortega, J., Dekker, T., Sardonini, L., Andreu, J., Kontogianni, A., Skourtos, M., Raggi, M., Viaggi, D., Pulido-Velazquez, M., Rolfe, J. and Windle, J. (2015). "Improving value transfer through socio-economic adjustments in a multicountry choice experiment of water conservation alternatives." Australian Journal of Agricultural and Resource Economics **59**(3): 458-478.

Brouwer, R. and Navrud, S. (2015). The Use and Development of Benefit Transfer in Europe. Benefit Transfer of Environmental and Resource Values: A Guide for Researchers and Practitioners. J. R. Johnston, J. Rolfe, S. R. Rosenberger and R. Brouwer. Dordrecht, Springer Netherlands: 71-83.

Colombo, S. and Hanley, N. (2008). "How can we reduce the errors from benefits transfer? An investigation using the choice experiment method." Land Economics **84**(1): 128-147.

Del Saz-Salazar, S., Hernandez-Sancho, F. and Sala-Garrido, R. (2009). "The social benefits of restoring water quality in the context of the Water Framework Directive: A comparison of willingness to pay and willingness to accept." Science of the Total Environment **407**(16): 4574-4583.

Dziegielewska, D. A. and Mendelsohn, R. (2007). "Does "No" mean "No"? A protest methodology." Environmental & Resource Economics **38**(1): 71-87.

Ferrini, S., Schaafsma, M. and Bateman, I. (2014). "Revealed and stated preference valuation and transfer: A within-sample comparison of water quality improvement values." Water Resources Research **50**(6): 4746-4759.

Hanley, N., Mourato, S. and Wright, R. (2001). "Choice Modelling Approaches: A Superior Alternative for Environmental Valuatioin?" Journal of Economic Surveys **15**(3): 435-462.

Hanley, N., Wright, R. E. and Alvarez-Farizo, B. (2006). "Estimating the economic value of improvements in river ecology using choice experiments: an application to the water framework directive." Journal of environmental management **78**(2): 183-193.

Hensher, D., Rose, J. and Greene, W. (2005). Applied Choice Analysis: A Primer. Camebridge, Cambridge University Press.

Jiang, Y., Swallow, S. K. and McGonagle, M. P. (2005). "Context-sensitive benefit transfer using stated choice models: Specification and convergent validity for policy analysis." Environmental & Resource Economics **31**(4): 477-499.

Johnston, R. (2007). "Choice experiments, site similarity and benefits transfer." Environmental & Resource Economics **38**(3): 331-351.

Jørgensen , S., Olsen, S. B., Ladenburg, J., Martinsen, L., Svenningsen, S. and Hasler, B. (2013). "Spatially induced disparities in users' and non-users' WTP for water quality improvements-Testing the effect of multiple substitutes and distance decay." Ecological Economics **92**: 58-66.

Kataria, M., Bateman, I., Christensen, T., Dubgaard, A., Hasler, B., Hime, S., Ladenburg, J., Levin, G., Martinsen, L. and Nissen, C. (2012). "Scenario realism and welfare estimates in choice experiments - A non-market valuation study on the European water framework directive." Journal of Environmental Management **94**(1): 25-33.

Krinsky, I. and Robb, A. (1986). "On approximating the statistical properties of elasticities." The Review of Economics and Statistics **68**(4): 715-719.

Liekens, I., Schaafsma, M., De Nocker, L., Broekx, S., Staes, J., Aertsens, J. and Brouwer, R. (2013). "Developing a value function for nature development and land use policy in Flanders, Belgium." Land Use Policy **30**(1): 549-559.

Loomis, J., Kent, P., Strange, L., Fausch, K. and Covich, A. (2000). "Measuring the total economic value of restoring ecosystem services in an impaired river basin: results from a contingent valuation survey." Ecological Economics **33**(1): 103-117.

Martin-Ortega, J., Brouwer, R., Ojea, E. and Berbel, J. (2012). "Benefit transfer and spatial heterogeneity of preferences for water quality improvements." Journal of Environmental Management **106**: 22-29.

Metcalfe, P., Baker, W., Andrews, K., Atkinson, G., Bateman, I., Butler, S., Carson, R., East, J., Gueron, Y., Sheldon, R. and Train, K. (2012). "An assessment of the nonmarket benefits of the Water Framework Directive for households in England and Wales." Water Resources Research **48**: 1-18.

Meyerhoff, J., Boeri, M. and Hartje, V. (2014). "The value of water quality improvements in the region Berlin–Brandenburg as a function of distance and state residency." Water Resources and Economics **5**: 49-66.

Scarpa, R., Ferrini, S. and Willis, K. (2005). Performance of Error Component Models for Status-Quo Effects in Choice Experiments. Applications of Simulation Methods in Environmental and Resource Economics. R. Scarpa and A. Alberini, Springer Netherlands. **6:** 247-273.

Scarpa, R., Thiene, M. and Train, K. (2008). "Utility in willingness to pay space: a tool to address confounding random scale effects in destination choice to the Alps." American Journal of Agricultural Economics **90**(4): 994-1010.

Schaafsma, M., Brouwer, R., Gilbert, A., van den Bergh, J. and Wagtendonk, A. (2013). "Estimation of distance-decay functions to account for substitution and spatial heterogeneity in stated preference research." Land Economics **89**(3): 514-537.

Schaafsma, M., Brouwer, R., Liekens, I. and De Nocker, L. (2014). "Temporal stability of preferences and willingness to pay for natural areas in choice experiments: A test-retest." Resource and Energy Economics **38**: 243-260.

Schaafsma, M., Brouwer, R. and Rose, J. (2012). "Directional heterogeneity in WTP models for environmental valuation." Ecological Economics **79**: 21-31.

Train, K. (2003). Discrete choice methods with simulation. Cambrigde, Cambridge University Press.

Vlaamse milieumaatschappij afdeling water (2005). "De Oude Kale: Naar een ecologisch herstel van waterloop en vallei." Brussels**:** p1-23.

TABLES

Table 1: Design of the discrete choice experiment

Attribute	Improvement levels	Status quo
Restoration	Minor, major	None
Length	5, 10, 20 km	0 km
Water quality impact	Good, very good	Moderate
Species richness	Moderate, high	Low
Accessibility	Yes, no	No access
Increase in household annual water tax	€10, 25, 50, 75, 125, 200	€0

Table 2: Descriptive statistics of the sample characteristics

Descriptive statistic	**Share**	**Sample** (n=264)	**Population**
Gender	Male	52%	49%
	Female	48%	51%
Age groups	18 - 29 years	12%	22%
	30 - 64 years	72%	57%
	≥ 65 years	16%	21%
Household size	Single person	14%	12%
	≥ 2 persons	86%	88%
Education levels	Elementary school	8%	39%
	Secondary school	47%	34%
	Higher education	45%	27%
Net household income levels	< €750/month	3%	19%
	€750 – 1499	19%	33%
	€1500 – 2499	42%	21%
	€2500 – 2999	8%	10%
	€3000 – 3999	19%	7%
	≥ €4000/month	9%	10%
Environmental organization	Member	18%	8%

Table 3: Estimated ECRPL models

	Model 1: attributes only		Model 2: including covariates	
Attributes	***Coeff. (st. err.)***	***St. Dev. (st. err.)***	***Coeff. (st. err.)***	***St. Dev. (st. err.)***
$ASC_{Oude\ Kale}$	0.687** (0.344)	/	0.743 (0.924)	/
ASC_{Leie}	1.242*** (0.346)	/	0.483 (0.928)	/
Minor change	30.125*** (11.054)	11.259 (193.235)	30.063*** (10.749)	9.786 (187.045)
Major change	44.866*** (10.692)	0.352 (801.121)	43.451*** (10.402)	2.713 (513.478)
Good water quality	66.407*** (12.746)	0.811 (966.789)	64.791*** (12.238)	1.630 (575.359)
Very good water quality	70.444*** (12.607)	4.637 (397.152)	68.474*** (12.450)	5.549 (336.769)
Moderate species richness	50.107*** (11.875)	86.812*** (33.674)	50.473*** (11.421)	86.934*** (30.583)
High species richness	64.884*** (13.309)	106.054*** (28.276)	62.558*** (12.792)	101.508*** (28.632)
No access	-20.943** (9.334)	40.093 (47.684)	-12.279 (10.334)	45.023 (42.895)
Length	1.436** (0.678)	2.147 (1.869)	1.278* (0.688)	3.108** (1.421)
Increase water tax	-0.143*** (0.000)	/	-0.133*** (0.000)	/
Covariates				
ASC*distance			-0.003 (0.114)	/
ASC*substitute river			0.243** (0.110)	/
ASC*distance*number of visits			-0.004 (0.003)	/
ASC*number of visits			0.018*** (0.006)	/
No access*number of visits			-0.013** (0.006)	/
ASC* household income			0.0004* (0.0002)	/
ASC * living in Lys basin			-0.156 (0.506)	/
Error component				
H_j	fixed	228.287*** (22.113)	fixed	213.729*** (21.394)

	LL= -1213.8 ; AIC = 2467.6; N= 1500; Pseudo R^2 = 0.26	LL= -1174.8 ; AIC = 2403.6; N= 1500; Pseudo R^2 = 0.29

Table 4: Wald test results testing the equality of coefficient estimates across the two labelled river restoration alternatives

Alternative specific attributes (Oude Kale versus Leie)	***Wald test statistic (st. err.)***
ASC	-0.56*** (0.07)
Minor river restoration	-0.27 (0.35)
Major river restoration	-0.54 (0.36)
Restoration length	-0.41(0.38)
Good water quality status	-0.06 (0.35)
Very good water quality status	0.53 (0.37)
Moderate species richness	0.41 (0.38)
High species richness	0.35 (0.28)
Accessibility	-0.04 (0.55)
Increase water tax	0.001 (0.002)
Note: ***, **, * ==> Significance at 1%, 5%, 10% level.	

Explanatory note: Based on estimation in preference space for the attributes only model. The same results are found for the second model including the covariates.

Table 5: Specification of the 4 restoration policy scenarios

Policy scenario	Restoration	Length	Water quality	Species richness	Accessibility
Status quo	No	0 km	Moderate	Low	No
1	Minor	5 km	Good	Moderate	Yes
2	Major	5 km	Very good	High	Yes
3	Minor	5 km	Good	Moderate	No
4	Major	5 km	Very good	High	No

Table 6: Consumer surplus (CS) and errors (TE) associated with the transfer of CS across the two rivers, without (Model 1) and with accounting for spatial preference heterogeneity and substitution effects (Model 2)

	Model 1				Model 2			
	CS (€/household /year)Oude Kale	CS (€/household /year)Leie	TE Oude Kale → Leie	TE Leie → Oude Kale	CS (€) Oude Kale	CS (€) Leie	TE Oude Kale → Leie	TE Leie → Oude Kale
Scenario 1	158.6 (20.63)	162.5 (20.64)	2.4%*** (1.6%,3.2%)	2.5%*** (1.6%,3.3%)	155.3 (21.17)	156.0 (21.20)	0.5%** (0.1%,0.9%)	0.5%** (0.1%,0.9%)
Scenario 2	192.2 (18.80)	196.0 (18.85)	1.9%*** (1.4%,2.6%)	2.0%*** (1.4%, 2.6%))	184.4 (19.65)	185.2 (19.69)	0.4%** (0.1%,0.7%)	0.4%** (0.1%,0.7%)
Scenario 3	137.7 (20.93)	141.7 (20.93)	2.7%*** (1.7%,3.8%)	2.8%*** (1.7%,3.9%)	155.3 (21.17)	156.0 (21.20)	0.5%** (0.1%,0.9%)	0.5%** (0.1%,0.9%)
Scenario 4	171.2 (20.24)	175.1 (20.27)	2.2%*** (1.5%,2.9%)	2.3%*** (1.5%,3.0%)	184.4 (19.65)	185.2 (19.69)	0.4%** (0.1%,0.7%)	0.4%** (0.1%,0.7%)

Note: ***, **, * ==> Significance at 1%, 5%, 10% level.

Explanatory note: the values between brackets for the CS values refer to the associated standard errors, the values between brackets for the TE's refer to 95% confidence intervals

FIGURES

Figure 1: Pictograms used in the labelled discrete choice experiment for river restoration

Water body	Status quo	Minor restoration	Major restoration
Oude Kale			
Leie			

Figure 2: Map of the case study locations, Oude Kale and Leie, and of the places of residence of the survey participants