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Spatially induced disparities in users' and non-users' WTP for water quality improvements—Testing the effect of multiple substitutes and distance decay

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ABSTRACT

Costs and benefits of water restoration projects are not necessarily evenly spread out over the entire area affected by the project. The physical distribution of benefits is, therefore, an important parameter when conducting economic analyses of water restoration projects. Two particularly relevant spatial issues relate to 1) the location of the population relative to the location of the waterbody, and 2) the availability and characteristics of substitute water bodies.

Based on a contingent valuation (CV) study of the demand for restoring Odense River in Denmark a spatial demand model which accounts for travel time both to the river subject for valuation and to potential substitute sites is estimated. It is concluded that the spatial distribution of benefits is unlikely to be homogeneously determined by a one-dimensional spatial model. Moreover, the results suggest that the effect of spatial issues on preferences varies between users and non-users. For non-users the spatial impacts from potential substitutes significantly reduce demand for improvements in Odense River. This indicates that focus on estimation of distance decay effects may be an important tool in relation to ensuring proper geographical delimitation of the population in a given context.

1. Introduction

The Water Framework Directive (WFD) (European Commission, 2000) prescribes that all water bodies in the EU countries should attain what is termed a "good ecological status" by 2015. It is, however, possible that some water bodies can be exempted from the WFD requirements if costs associated with attaining the objectives are suspected to be disproportionately high compared to the benefits (WFD, article 4, cf. European Commission, 2000, 2009). When determining whether a given waterbody can be exempted from the specified objectives the WFD emphasises economic analyses as an important tool. This could be an economic analyses focusing on comprehensive assessment of the environmental and resource costs and benefits associated with fulfilling the WFD objectives in a given waterbody. Such an analysis serves to identify if the costs are disproportionately high compared to the benefits (WFD, article 4, cf. European Commission, 2000, 2009).

Seen from a spatial perspective the costs and benefits of WFD projects are not necessarily evenly spread out over the entire area affected by the project. Therefore, it may also be expected that there are spatial differences in the distribution of costs and benefits within each specific project site. In connection with the assessment of project related benefits two of the most important spatial issues relate to 1) the location of the population relative to the location of the waterbody, and 2) the availability and characteristics of substitute water bodies.

In relation to the former, it is important to recognise that the population who benefits from water quality improvements in a waterbody may be spread across a wide geographical area. As a result the welfare economic value associated with the water improvements may in fact depend on the relative location of peoples' residence and the waterbody. An example of this potential interdependency between spatial issues and size of benefits is distance decay, which implies that willingness to pay (WTP) is expected to be a decreasing function of the distance from respondents' place of residence to the waterbody (Sutherland and Walsh, 1985). The rationale behind distance decay is that the opportunities of taking advantage of improvements of a given resource are greater the closer one lives to the resource. Commonly, the costs, (e.g. time and transportation costs) associated with using the resource, are found to be proportional to the distance between respondents' residence and the resource. As such, when talking about distance decay the focus is typically on use related arguments suggesting that the effect primarily is related to preferences expressed by users of the good subjected to valuation. Arguments related to whether or not the effect should be expected to apply to non-users preferences have pointed in different directions,

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see for example Bateman et al., 2006b. Since the population who benefits from WFD-improvements is expected to consist of both users and non-users, users as well as non-users are expected to be willing to pay for the improvements related to WFD implementation. Seen from this perspective it is therefore considered relevant to investigate the relationship between respondents' spatial location, their use of the resource, and their WTP. In the present paper this is done by estimating models, which explicitly include interactions between spatial location and whether the respondent is a user or non-user of the resource. In this connection, it may be noted that it could be equally relevant to include respondents' expectations regarding future use in the analyses of WTP; this however, require detailed information on these expectations. Such information has not been gathered as part of the present study, and therefore potential interactions between expectations concerning future use, spatial location, and WTP is not investigated.

As already mentioned the availability of substitutes may also affect the benefits of a given project (Pate and Loomis, 1997). This substitute effect may to some degree be confounded with the just described distance decay effect. Thus, as the number of available substitute sites—all else equal—is expected to increase with increasing distance to the site of interest. An effect like this may be expected to translate into WTP declining with increasing distance, similar to the distance decay effect. However, two points are worth stressing in this relation. First of all, assuming that the availability of substitutes is linearly increasing with increasing distance might be overly simplistic. Secondly, such an approach will make it difficult to separate the effect of distance and the effect of substitute on the stated preferences. Hence, depending on the specific context the spatial location of substitutes may be very heterogeneous. This implies that proper incorporation and identification of substitute effects in analyses requires specification of models, which are spatially explicit about the location of substitutes. In the present paper we specify models which explicitly account for the spatial location of several substitutes, thereby, facilitating an investigation of the impact of availability of substitutes on WTP estimates while at the same time controlling for distance decay.

The analyses are based on data from a contingent valuation method (CVM) study of the demand for restoring the River Odense River in Denmark.[1] The valuation scenario concerns improvements of the water quality in the river from moderate to very good ecological status.

In the following section we describe the existing literature related to the modelling of distance decay and the relationship between distance decay and degree of use. Also, the literature related to interdependencies between distance decay and the availability of substitutes is discussed. Subsequently, Section 3 contains a description of the data used in the empirical analysis. In Section 4 we present the results of the empirical analysis, and finally Section 5 concludes and discusses the results of this paper.

2. Literature Review and the Frame of the Analysis

The importance of accounting for the spatial distribution of the benefits of environmental preservation or restoration in welfare economic analysis has been acknowledged in many years and has been given considerable attention the recent years. As a result, flexible and advanced spatial demand models have been derived. Most recently, the project Aquamoney (www.aquamoney.com) has focused on the importance of distance decay, scope and substitution for the WTP, and the geographical aggregation of benefits in relation to assessing the welfare economic impacts of improving the quality and ecological status of water bodies (Barton et al., 2010; Bateman et al., 2008; Bliem and Getzner, 2008; Hasler et al., 2010; Liekens et al., 2010).

One of the first economic valuation studies that addressed spatial issues was a contingent valuation study in the US concerning the demand for river water quality (Sutherland and Walsh, 1985). The study indicated that the further the respondents lived from the river; the lower was the likelihood that the respondent had visited the river at least once during the previous year. A single dimensional "distance decay" spatial demand model was established as the visit rate was found to have a significant and positive influence on demand. Subsequently, several studies indicate that the demand for environmental quality is likely to decrease with the distance from residency of the respondents to the resource in focus, see for example (Bliem and Getzner, 2008; Georgiou et al., 2000; Kniivilä, 2006; Loomis, 2000; Moore et al., 2011; Mouranaka, 2004). However, the likelihood is dependent on the conditions and predictions in these specific studies, and other studies find that it is not in all cases that the distance decay is significant (Barton et al., 2010; Bulte et al., 2005; Hanley et al., 2003; Johnston et al., 2011; Payne et al., 2000).

Since the Sutherland and Walsh (1985) paper, the subsequent papers focusing on the spatial properties in demand have moved in different directions. Within the distance decay literature at least two relevant strands of research concerns are seen: 1) the relationship between distance decay effects and degree of use, i.e. users vs. non-users of the resource, and 2) potential correlations between scope effects and distance decay effects (Bateman and Langford, 1997; Bateman et al., 2006b; Hanley et al., 2003). Both Bateman et al. (2006b) and Hanley et al. (2003) find significant distance decay effects among non-users in CVM studies focusing on demand for river water quality improvements. However, a direct test of differences in the relative strength in the distance decay relation between users and non-users is not carried out.[2] Different (non-)user definitions have been explored in the literature and found to influence the preference structure (Johnston et al., 2005; Kniivilä, 2006; Whitehead et al., 1995). Nevertheless, the relation between the respondent's present use or non-use of the good and the spatial properties of the good has to the authors' knowledge only been tested (in terms of specific tests of differences in the relations between users and non-users) in Schaafsma (2011) She finds that users' preferences are less sensitive towards the distance to the good compared to non-users, and that the non-users demand declines faster with the distance to the resource (see later in this section).

Ecosystem services such as, e.g. water quality are seldom uniformly and continuously distributed in the landscape but are more patchy and discrete in their presence. Ideally, economic demand models should take this into account (Bockstael, 1996). In this perspective, the implicit assumption that preferences conform to a globally continuous pattern, by representing spatial location with a single variable measuring the distance to the resource, has been challenged and argued to be too simplistic. See Bateman (2009) and Johnston et al. (2011) for a discussion. Accordingly, the literature has moved towards models which allow for more spatial patchiness in the preference structure. To the authors' knowledge, Pate and Loomis (1997) was the first paper to make such an attempt by estimating a demand model. They combined a distance decay measure and the level/quantity of substitutes resources (on a state level) in a CVM study. In the study, WTP for three programmes was assessed: 1) WTP for the protection and expansion of wetland, 2) WTP for a reduction in wild life contamination in the San Joaquin valley in the USA, and 3) WTP for improvement of salmon stocks in San Joaquin River. First of all they find a significant distance decay effect (log distance) in relation to the two programmes concerning Wetland and Contamination Control Improvement. Furthermore, they find that the availability of substitutes, measured as the number of acres of wetlands in the sampling area (California, Oregon, Washington and Nevada),

[1] This Danish study is part of the European Aquamoney study. The questionnaire used in this survey, including the information provided to the respondents on the scenarios and the resulting changes in water quality, is developed amongst the Aquamoney-partners dealing with water quality improvements: UK, Belgium, The Netherlands, Norway, Lithuania and Denmark (Bateman et al., 2011). The water quality information is generic for these studies but adjusted to specific characteristics in each study site.

[2] Bateman et al. (2006b)) estimate one model for all respondents and one model for non-user. Hanley et al. (2003) estimate separate models for user and non-user. However, neither of the studies reports a test of whether the distance decay is significantly different between the two groups.