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Valuing Local Environmental Amenity with Discrete Choice Experiments: Spatial Scope Sensitivity and Heterogeneous Marginal Utility of Income

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Abstract Using discrete choice experiments we examine preferences for the spatial provision of local environmental improvements in the context of regeneration policies. Amenities we consider are: improvements to areas of open space, recreation facilities and other public spaces; street cleanliness; restoration of derelict properties; and the provision of paths dedicated to cycling and walking. We include the spatial scope of the policy as an attribute, making the trade-off between environmental amenity and its spatial provision explicit. We employ a novel estimator for average willingness to pay (WTP) for mixed logit models with a random cost coefficient, which is robust to the presence of price insensitive respondents and performs well relative to mixed logit estimation in WTP space. We find that the spatial scope of the policy affects both the intensity and heterogeneity of preferences, and that these effects are of statistical and economic significance.

Keywords Non-market valuation · Discrete choice experiments · Local environment · Spatial analysis · WTP estimation · Urban planning

JEL Classification Q51 · Q28 · R53 · R58 · C35 · C21 · C81

1 Introduction

The objective of local regeneration initiatives is to address economic, social and physical environment decline in rural and urban settlements. Whereas the traditional focus of

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regeneration has been on improving economic outcomes in terms of employment and physical infrastructure, non-market amenities such as environmental quality, neighbourhood renewal and community development are now also targeted. However, the paucity of evidence available on the value of regeneration benefits generally precludes cost-benefit comparisons for the purpose of public policy selection (Tyler et al. 2012). Decision-makers also face prioritisation issues related to policy-site selection, such that a relatively small population may benefit from targeted improvements, or the same resources can be spread more thinly over a wider area to benefit a larger population. Controlling for spatially explicit preferences is therefore important, notably for distance decay effects (Hutchinson et al. 1995; Johnston et al. 2002; Bateman et al. 2006; Campbell et al. 2009; Brouwer et al. 2010).

In principle, preferences for the provision of non-market environmental amenities can be identified via a 'surrogate market' approach, exploiting relationships between consumption of a market good and the amenities of interest. Of particular relevance is the hedonic pricing method (Rosen 1974), where variations in property prices are used to infer the value of environmental amenities. Applications of the hedonic pricing method notably provide evidence on the value of woodlands (Tyrväinen and Miettinen 2000; Mansfield et al. 2005), the provision of open spaces, parks and water bodies (e.g. Irwin 2002; Cho et al. 2006), air quality improvements (Chay and Greenstone 2005), and traffic-related noise (Day et al. 2007). However, regeneration initiatives typically target marginal improvements in nuanced dimensions of the residential environment, and the use of the hedonic pricing method is hindered by measurement problems. For example, data on environmental amenities are usually limited to broadly defined goods, such as area of park and distance from property, but quality indices required to identify the value of marginal improvements are not available. Moreover, besides aspects such as noise and air pollution, it can be difficult to provide an objective measure of the quality of environmental amenity. Thus while the aspects of local environmental amenity targeted by regeneration policies will presumably be reflected in property prices, the use of property transactions to identify their value is empirically challenging.

As an alternative this paper uses the discrete choice experiment (DCE) methodology (Louviere et al. 2000) to study preferences for environmental amenity improvements brought about by regeneration initiatives. We consider six environmental amenity attributes: improved areas of open space (e.g. parks); restoration of derelict properties; creation of outdoor recreation facilities (e.g. playgrounds); improved street cleanliness; improved public areas (e.g. town squares and pedestrian-only zones); and the provision of 'green routes' (paths dedicated to cycling and walking). While the main advantage of the DCE approach is the ability to estimate preferences for marginal changes in nuanced environmental amenity attributes, analysing survey-based choices has its own caveats, notably due to the hypothetical nature of the exercise (e.g. Harrison and Ruström 2005). We account for a number of issues raised in the literature and use a set of text entreaties, visual illustrations, and randomisation procedures to mitigate these potential biases. Furthermore, the policy improvements we consider take place in the day-to-day environment of the survey respondents, implying that they are familiar with the goods proposed and that they can meaningfully state preferences for changes in their provision. Extensive validity testing provides evidence about the robustness of the results with respect to protest motives, attribute non-attendance, and potential ordering effects arising from repeated choice tasks.

Besides the public policy implications of economic valuation evidence, the first contribution of this paper is to test for spatial scope sensitivity in preferences for local environmental amenity improvements.[1] Whereas the literature on scope tests in contingent valuation (e.g. Desvousges et al. 1993) and more recently in DCEs (Lew and Wallmo 2011) focuses on sensitivity of welfare measures with respect to an increase in the provision of the good, we elicit preferences for regeneration initiatives that are spatially 'focused' or spatially 'diffuse' and test sensitivity to an increase in the spatial scope of the policy. Evidence on preferences for the spatial scope of the policy also complements growing evidence from DCE applications that quantify how preferences vary with the distance of respondents to the proposed policy improvements (Campbell et al. 2009; Brouwer et al. 2010). In contrast however, all respondents to our survey reside in the same settlement, and we make trade-offs between the location of improvements and their provision explicit by including the spatial coverage of the policy as an attribute in the DCE exercise. We then quantify preferences for the location of improvements by interacting the spatial scope of improvements with each environmental amenity attribute. In order to efficiently identify these first order interaction effects, we employ a constrained experimental design based on the D-error criteria (see e.g. Street and Burgess 2007). This also allows us to rely on a relatively small sample and focus resources on conducting face-to-face interviews where survey administration and respondents' attention can be monitored.

From our sample, we find that residents have strong preferences for improvements in local environmental amenity, and that these preferences are dependent on the spatial scope of the policy. In general, as the spatial scope of the policy increases, the value of improvements at the average of the sample declines, whereas preference heterogeneity increases. Tests for spatial scope sensitivity confirm that for most environmental amenities, a large share of benefits are spatially concentrated close to the site, implying very little non-use value. For some attributes, some respondents display negative surplus for the provision of improvements in other nearby urban agglomerations, which signals competition for the appropriation of rivalrous benefits. From a resource allocation perspective, this suggests that investments in local environmental amenity of nearby neighbourhoods are substitutes, whereas investments in more distant areas are complements.

Our second contribution to the literature is methodological. We propose an estimator for average willingness-to-pay (WTP) that accommodates heterogeneity in the marginal utility of income. This is of practical importance since average WTP is a key result for public policy selection, yet it is typically computed under the assumption that the marginal utility of income is the same for all respondents, which is empirically implausible (Meijer and Rouwendal 2006). In addition, our data suggest that a small but significant fraction of respondents were not sensitive to the price levels that were specified or did not consider the price attribute when making choices. In the usual random utility framework this prevents identification of their WTP, and simulated WTP distributions are unreliable. For inference about average WTP to remain valid in this setting, we derive an expression based on a second order Taylor approximation for the expectation of the ratio of two random variables. We compare this approach to WTP space estimation (Train and Weeks 2005), which presumes the existence of marginal WTP for each respondent in the sample, and we find that our estimator generates results that are plausible and consistent with alternative specifications. In our sample allowing for the presence of price insensitive respondents provides a better fit to the data relative to a specification in WTP space, and also implies higher average WTP estimates.

[1] While this study is the first to study marginal values for a broad range of local environmental amenities in the context of local regeneration schemes, the DCE approach has previously been used to evaluate preferences for amenities such as urban green spaces (Bullock 2006), improvements to city centres (Alberini et al. 2003) and urban river quality (Hanley et al. 2007).

The remainder of the paper proceeds as follows. Section 2 describes the survey design, including the specification of attributes, questionnaire structure and survey administration. Section 3 describes the econometric methodology, WTP estimation, and experimental design. Section 4 provides the sample description, estimation results and validity tests. Our conclusions are presented in Sect. 5.

2 Survey Design

2.1 Local Regeneration Initiatives: Attributes and Levels

The survey from which our data are derived was designed to be administered in the coastal town of Seaham, in the North East of England. Seaham is a small-sized town located in a former coalfield area, where collieries and a coking works provided 65 % of all employment in the area in the early 1980s. By the mid-1990s these works had closed and the area experienced economic decline. In recent years, Seaham and neighbouring Murton have been subject to physical regeneration projects including transport link improvements, new housing, and commercial development on reclaimed coalfield land, along with some environmental and public realm improvements.

Six local environmental amenity attributes were specified for inclusion in the survey, based on consultation regeneration policy experts. They are summarised in Table 1 and reflect the typical initiatives that can be implemented at the local level.[2] Two attributes are concerned with removing disamenity: 'derelict properties restored' and 'street cleanliness'. The derelict properties attribute is defined in terms of improvements in the aesthetic appearance of buildings and disused land. This was to distinguish such improvement from market values that could be generated by restoring either the residential or commercial use of unused buildings and land. The 'street cleanliness' attribute is defined in terms of litter, detritus, graffiti and fly-posting.[3]

Distinctions between the 'open space', 'public areas' and 'community facilities' attributes relate to land use and its management. 'Open space' (e.g. parks) is managed for the purposes of informal recreation (walking, dog-walking, etc.) and aesthetic amenity while 'community facilities' are focused on formal recreation activities (e.g. sports pitches) or even consumptive uses (e.g. allotments and community gardens). 'Public areas' refers to places such as town squares, pedestrian streets and promenades, which can feature a variety of amenities (e.g. benches), landscaping, sculptures and public art installations. The final local environmental amenity attribute, 'green routes', which is a form of infrastructure with the primary purpose of providing access links for the local population, enhances recreation opportunities and also facilitates healthier lifestyle choices (e.g. cycling).

For local residents, the extent to which they can appropriate the benefits of improvements hinges upon their relative distance to improved amenities, and we test for a spatial scope effect by specifying the spatial coverage of improvements as an attribute (see Fig. 1). The largest area over which improvements could be spread (L1) is the East Durham area. This spans approximately 280 km^2, including urban agglomerations that are larger than Seaham

[2] A more detailed description of the attributes presented to survey respondents can be found in the online appendix for this paper.

[3] This definition is consistent with with UK's National Indicator (NI 195), which is measured at the Local Government level in England as a part of the regulatory framework for assessing the performance of Local Authorities. Note that the status quo (Grade C) is not the worst possible classification, but we do not consider a degradation in street cleanliness.

Table 1 Discrete choice experiment attributes and levels

Attribute	Level 0 (status quo)	Level 1	Level 2	Level 3	Level 4	Level 5
Block 1						
Improvements to areas of open space	No improvements	Improvements to 5 hectares	Improvements to 15 hectares	–	–	–
Derelict properties restored	No properties restored	5 properties restored	10 properties restored	–	–	–
Block 2						
Amount of outdoor community facilities	No additional facilities	1 extra facility	2 extra facilities	–	–	–
Street cleanliness	Grade C: some litter etc.	Grade B: mostly clear of litter	Grade A: very little litter	–	–	–
Block 3						
Improvements to public areas	No improvements	Improved: new paving, benches, etc. maintained in good condition	–	–	–	–
Green routes	2.5 km of green routes in Seaham	2 km extra of green routes	4 km extra of green routes	–	–	–
All blocks						
Location of improvements	–	Improvements spread across all of East Durham area	Improvements spread across the wider local area	All improvements in Seaham	–	–
Price (increase in council tax, £ per year)	£0	£5	£10	£20	£30	£50

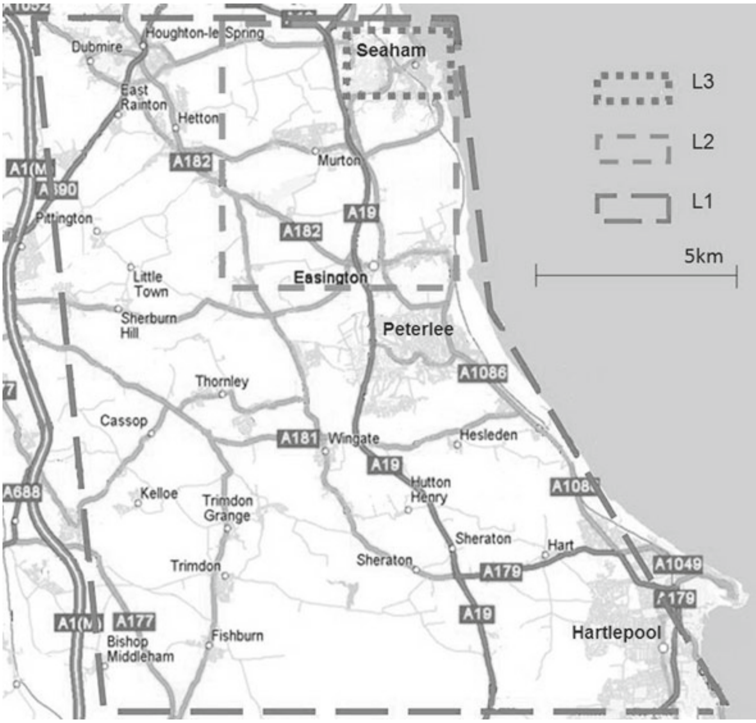

Fig. 1 Specification of the spatial scope of improvements (*source*: http://maps.google.com)

(Peterlee and Hartlepool), and has total population of over 100,000 residents. At Level 2, improvements are spread across Seaham and the wider local area (L2), with a population of around 30,000 and an area of approximately 30 km^2. Seaham is the largest urban area in L2, and all the neighbouring settlements (Murton, Easington) are part of the same jurisdiction. The smallest area concentrates all improvements in the town of Seaham (L3), with 21,000 residents and an area of approximately 6 km^2. The status quo level of the spatial attribute is undefined since in the absence of regeneration initiatives no improvements take place in any locations.

For improvements to areas of open space, restoration of derelict properties, the provision of community facilities and green routes, an increase of the area covered by the policy implies that a larger population can potentially benefit from improvements, but at a reduction in the provision of improvements on a per person or per km^2 basis. If non-use values are small and based on altruistic motives, increasing the spatial scope of the policy will reduce the expected individual benefits. In contrast, the improvements to public areas and street cleanliness increases with the spatial scope of the policy since improvements are applied uniformly across the policy area. Thus from the standpoint of Seaham residents, the benefits of larger spatial coverage hinges upon the perception of improvements for residents in other areas ('non-locals') relative to local residents.

Finally the cost ('price') attribute is defined in terms of an increase in annual council tax bill paid by the respondent's household. Council tax is the main system of local taxation in England, with revenues contributing to publicly funded services that include environmental quality, so it provides a credible payment vehicle for the hypothetical market.[4] Nevertheless, the pre-testing phase of the questionnaire suggested that defining the payment as a temporary increase (even over several years) lacked credibility, as a decrease in taxes after the end of the funding period was not deemed plausible. Hence we use a 'per year' payment. Further, to avoid complicated calculations for respondents and to keep the price tag transparent, we specify the increase in local taxes in absolute terms.

2.2 Questionnaire Structure and Administration

The questionnaire follows the typical structure for a stated preference survey (Bateman et al. 2002) and was pre-tested through focus groups and cognitive interviews. After introductory questions focusing on the perceptions of local environmental amenity and priorities for improvement, respondents were introduced to the attributes and choice tasks of the DCEs. In order to ease the cognitive burden of trading-off all attributes, a 'block' design was employed (Willis et al. 2005), where the six environmental amenity attributes were grouped into three blocks (see Table 1).[5] We elicited the preferences of each respondent for all three blocks of attributes, so that the questionnaire comprised three separate DCEs. Each DCE comprised four attributes in total: two local environmental amenity attributes, the spatial scope attribute and the price attribute. In each choice task, respondents selected their preferred option out of the status quo and two alternatives options. For the interview length to remain reasonable and to avoid potential fatigue effects, we followed Caussade et al. (2005) and set the total number of choice tasks to 12, leaving four choice tasks per block for each respondent. The final section of the questionnaire included a series of follow-up questions focused on respondents' motivations for their choices and feedback on how easy or difficult they found the choice questions. Feedback from the interviewer was also provided about the care and attention taken by respondents in answering the survey.

The repeated choice task format and multiple blocks of attributes utilising the same payment vehicle can induce bias in preferences revelation. First, the order in which the choice tasks are presented can influence observed choices (Day and Pinto Prades 2010). Second, while experimental evidence suggests that repeated tasks need not impair incentive compatibility (Collins and Vossler 2009), no such evidence exists on block designs. To identify potential differences in tastes across choice tasks and attribute blocks, the sequence of blocks and tasks within blocks was randomly assigned. In Sect. 4.3, we exploit this random assignment to test for ordering effects, specifically examining if there are differences in preferences for the first choice task or for the attribute block presented first.

In order to control for the provision of information to respondents and to ensure adequate attention is given to the DCE exercises, the questionnaire was administered by professional interviewers via face-to-face (in-home) computer aided interviews. Importantly, the testing phase confirmed that the context and amenities considered were well-understood and related to familiar facets of respondents' day-to-day surroundings.[6] To mitigate the hypothetical bias

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[4] While regeneration initiatives are typically funded from a variety of sources and initial capital outlays could be the responsibility of national or European initiatives, maintenance of improvements will most likely be the responsibility of Local Government. Note also that at the time of the survey, a £50 increase in council tax was approximately a 4–5% increase in the average household council tax bill.

[5] The assignment of attributes to blocks mitigates the potential complementarities between attributes within each block based on focus groups' qualitative results.

[6] Nevertheless the evaluability of the choice tasks was facilitated by a number of showcards read-out by the interviewer and presented to the respondents. The verbal description of each attribute was accompanied by illustrations, including a set of maps for describing the spatial scope attribute.

associated with stated choices, and following previous findings (e.g. Cummings and Taylor 1999; List 2001; Landry and List 2007), we included a number of cheap talk entreaties to remind respondents of consequences of their choices and income constraints.[7]

For the purpose of validity testing, we collected data to supplement the interviewers' feedback. First, we assessed attribute non-attendance through self-reported consideration given to each attribute after completing each DCE block, termed serial non-attendance by Scarpa et al. (2010). Second, we elicited respondents' motivations for their choices during the DCEs. Finally, respondents were asked, in principle, whether they would be willing to see their council tax bill increase if all the improvements were to take place in Seaham.[8] Respondents who declined payment were then asked for their reasons for stating so, which allows us to identify potential protest motives.

3 Discrete Choice Experiment

3.1 Econometric Models and WTP Estimation

We follow the standard random utility model (RUM), where an individual i chooses a policy bundle or alternative j over j' in choice task t if the utility of j is greater than the utility of j'. The utility of respondent i associated with alternative j is:

$$U_{ijt} = V_{ijt} + \epsilon_{ijt}, \quad i = 1, \ldots, N, \quad j = 1, \ldots, J, \quad t = 1, \ldots, T,$$

where V_{ijt} is the deterministic part of the utility function, and ϵ_{ijt} is an idiosyncratic component which arises because the researcher only imperfectly observes how individuals process the information. The probability of observing individual i choosing alternative j over j' is:

$$Pr(U_{ijt} > U_{ij't}, \quad \forall j \neq j') = Pr(\epsilon_{ij't} < \epsilon_{ijt} + V_{ijt} - V_{ij't}, \quad \forall j \neq j')$$

which is the cumulative distribution of $\epsilon_{ij't}$ conditional on ϵ_{ijt}, V_{ijt} and $V_{ij't}$. As customary, we assume that the random error is independently and identically distributed (iid) according to a Gumbel distribution, which gives rise to the familiar logit formulation:

$$Pr(U_{ijt} > U_{ij't}, \quad \forall j \neq j') = \frac{\exp V_{ijt}}{\exp V_{ijt} + \sum_{j'} \exp V_{ij't}}$$

We impose structure on V_{ijt} and assume it is a linear function of the attribute levels in $\{j, t\}$.[9] Defining the spatial coverage of the policy as a set of l dummy variables

[7] For example, prior to proceeding to the series of DCEs, the respondents were read and given a showcard stating: "Before making your choices, please consider:

- Whether or not these improvements are important to you;
- Any money you would pay towards the improvements here will not be available for you to spend on other things;
- Other household bills may go up or down affecting the amount of money you have to spend in general; and
- That there may be other aspects of local services that also require improvements which may increase bills."

[8] The question wording was: "Considering a choice involving changes to all of the environmental features you have considered, would you in principle be willing to pay some amount of money per year, in terms of an increase in your council tax bill, to ensure that all of the environmental improvements were made?".

[9] Non-linearities in the utility function are potentially important (Lanz et al. 2010; Viscusi and Huber 2012). In the present context, however, comparison of model statistics based on a non-parametric (dummy-coded) utility function suggests that a linear representation of preferences is appropriate.

$\{L_{ljt}\}_{l=\{\text{L1,L2,L3}\}}$, we allow preferences for improvements to vary with the location of attributes through the following utility function:

$$V_{ijt}^{MNL} = \sum_k \sum_l \beta_{kl} X_{kjt} L_{ljt} + \gamma P_{jt}$$

where the β's measure the marginal utility (or tastes) for improvements undertaken in area l, X_{kjt} are levels of improvement specified in alternative $\{j, t\}$, γ is the negative of the marginal utility of income, and P_{jt} is the price attribute. The utility specific to the status quo is captured by an alternative specific constant (ASC).

In this setting, marginal utility coefficients can be estimated via maximum likelihood based on log-likelihood function:

$$lnL = \sum_i \sum_t \sum_j y_{ijt} \ln Pr_{ijt}(X_{kjt}, L_{ljt}, P_{jt}; \theta) \tag{1}$$

where $\theta = (\beta, \gamma)^T$ is the vector of parameters to be estimated from the data and y_{ijt} is an indicator variable which is equal to one if i chooses j in t, zero otherwise. This structure is known as the multinomial logit (MNL) choice model. Average WTP for marginal changes in the provision of attributes is the ratio of the marginal utility for attribute k and location l to the marginal utility of income (McFadden 1984):

$$\text{WTP}_{kl} = -\frac{\beta_{kl}}{\gamma}. \tag{2}$$

This can be interpreted as a compensating surplus (Freeman 2003).

The MNL model is convenient for its tractability, but it imposes heavy structure on observed choices. Specifically, the iid property of the error term across alternatives, homoscedasticity assumption among individuals, and the assumption that all respondents make their choices based the same utility function imply restrictive substitution patterns among alternatives, known as the 'irrelevance of independent alternatives' property. A more flexible alternative is the 'mixed logit' (MXL) model (Revelt and Train 1998), which exploits the panel data structure to accommodate preference heterogeneity at the individual level:

$$V_{ijt}^{MXL} = \sum_k \sum_l \beta_{ikl} X_{kjt} L_{ljt} + \gamma_i P_{jt}.$$

This model requires parametric structure on the distribution of tastes among individuals, and in our analysis we assume that taste parameters are normally distributed ($\theta_i \sim N(\overline{\theta}, \Sigma)$). The estimation of the MXL model is also based on log-likelihood (1), but with unconditional choice probabilities defined as:

$$Pr(U_{ijt} > U_{ij't}, \quad \forall j \neq j') = \int \frac{\exp(V_{ijt})}{\exp(V_{ijt}) + \sum_{j'} \exp V_{ij't}} \phi(\theta \mid \overline{\theta}, \Sigma) d\theta$$

where $\phi(\cdot)$ is the multivariate normal density. Since this expression has no closed-form, the parameters are estimated with simulated maximum likelihood (Train 2003), where the integral is approximated numerically based on 500 Halton draws.

The assumption that preferences are normally distributed is parsimonious and numerically well behaved, and hence widely used in applied work. Yet the support of a normal distribution is not bounded, so that marginal utility estimates are allowed to have the 'wrong sign'. In particular, estimates of the price coefficient falling in the positive domain indicate negative marginal utility of income. Nevertheless, since our main objective is to provide a good account of observed choices at the mean of the sample to derive average WTP figures, this structure has the advantage of allowing for the potential presence of price insensitive respondents. Price insensitivity is empirically plausible, and may signal non-compensatory trade-offs due to very strong preferences for improvements or indifference to the specified price levels, or because some respondents did not engage with with hypothetical market (e.g. protest responses). In turn, in the presence of respondents with a marginal utility of income near zero over the defined price vector, the normal distribution will give rise to a probability mass in the positive domain of the distribution even if no choices revealed such preferences.[10]

Estimation of average WTP from the MXL model follows the same logic as for the MNL model. However, with individual taste parameters modelled as random variables, the expected value of a ratio is generally not equal to the ratio of expectations, and evaluating (2) at the mean of taste distributions will provide biased estimates of average WTP. Since (2) remains valid at the individual level, the usual approach is to compute average WTP from a simulated WTP distribution, taking a large number of draws from the taste distribution of each attribute and computing the WTP-ratio for each draw. Under distributional assumptions that allow for the existence of price insensitive respondents, draws of γ in the neighbourhood of zero will give rise to implausible WTP values.[11] Although the occurrence of these extreme draws is typically small, they heavily influence average WTP, and the particular sequence of random draws considered will unduly influence the simulations, even if using a trimmed estimator for the average. In practice, this issue is often avoided by the ad-hoc assumption that the price coefficient is the same for all respondents, so that WTP follows the same distributions as marginal utility estimates.

Given that our distributional assumptions allow for the the presence of price insensitive respondents, we consider a truncated distribution for the cost coefficient such that $P(|\gamma| < \varepsilon) = 0$, $\varepsilon > 0$. Choosing ε small enough does not modify the shape of the estimated cost distribution, but ensures a finite mean for the WTP distribution. Since a truncated cost distribution with ε small can still be problematic for the purpose of simulations, and choosing a numerical value for ε is arbitrary, we avoid this issue by approximating the average WTP based on the second order Taylor series expansion for a ratio of random variables. Specifically, consider a continuous function of random variables $g(\beta, \gamma)$, assumed to be twice differentiable in the neighborhood of (β^0, γ^0). Denoting the first and second derivatives with respect to argument $k = \{\beta, \gamma\}$ as $g_k(\beta, \gamma)$ and $g_{kk}(\beta, \gamma)$ respectively, the second order Taylor expansion around (β^0, γ^0) is given by:

$$
\begin{aligned}
g(\beta, \gamma) \cong\; & g(\beta^0, \gamma^0) + g_\beta(\beta^0, \gamma^0)(\beta - \beta^0) + g_\gamma(\beta^0, \gamma^0)(\gamma - \gamma^0) \\
& + g_{\beta\beta}(\beta^0, \gamma^0)\frac{(\beta - \beta^0)^2}{2} + g_{\gamma\gamma}(\beta^0, \gamma^0)\frac{(\gamma - \gamma^0)^2}{2} \\
& + g_{\beta\gamma}(\beta^0, \gamma^0)(\beta - \beta^0)(\gamma - \gamma^0).
\end{aligned}
$$

[10] A more sophisticated approach proposed by Campbell et al. (2010) is to use a mixture of distributions to generate bimodal mixing distributions. While this is beyond the scope of our analysis, we note that their estimated taste distribution also implies that a fraction of respondents have a negative marginal utility of income.

[11] For respondents with zero marginal utility of income, the individual WTP is not identified, and the RUM assumptions mechanically imply an infinite WTP. In turn, this implies that the distribution of the WTP has no finite moments (Meijer and Rouwendal 2006).

In the case of the WTP approximation, $g(\beta, \gamma) = \frac{\beta}{\gamma}$, $\beta^0 = \overline{\beta}$ and $\gamma^0 = \overline{\gamma}$. Taking expectation on both side, and using the linearity property of the expectation operator, it follows that:

$$E\left(\frac{\beta}{\gamma}\right) \cong \frac{\overline{\beta}}{\overline{\gamma}} + \frac{-1}{\overline{\gamma}^2}E[(\beta - \overline{\beta})(\gamma - \overline{\gamma})] + \frac{\overline{\beta}}{\overline{\gamma}^3}E[(\gamma - \overline{\gamma})^2].$$

Denoting the variance and covariance terms as $\sigma_\gamma^2 = E[(\gamma - \overline{\gamma})^2]$ and $\sigma_{\beta\gamma} = E[(\beta - \overline{\beta})(\gamma - \overline{\gamma})]$ respectively, we have:

$$E(WTP) \cong -\frac{\overline{\beta}}{\overline{\gamma}}\left(1 + \frac{\sigma_\gamma^2}{\overline{\gamma}^2} - \frac{2\sigma_{\beta\gamma}}{\overline{\beta}\overline{\gamma}}\right). \tag{3}$$

This expression shows that the bias implied by simply taking the ratio of expectation will generally be positive.

Since normally distributed tastes allow deviations from standard RUM assumptions, a different line of argument favours the use of bounded mixing distributions (see e.g. Hess et al. 2005). We thus compare empirical results under the previous distributional assumptions with an assumption that the marginal utility of income is log-normally distributed. Constraining the marginal utility of income to be positive for all individuals ensures that WTP is defined for all individuals in the sample, and we model choices directly in WTP space by scaling the utility function with the marginal utility of income (Train and Weeks 2005):

$$V_{ijt}^{WTP} = \gamma_i\left(\sum_k\sum_l WTP_{ikl}X_{kjt}L_{ljt} + P_{jt}\right).$$

As for the preference space specification, estimation is based on simulated maximum likelihood, and we assume that individual WTP are normally distributed. Note that by construction WTP space estimation rules out price insensitive respondents since utility would be scaled by zero, making the choice primitive undefined.

3.2 Experimental Design

The experimental design specifies the combinations of attribute levels offered to the respondents in each choice task based on the set of feasible outcomes for each attribute (Table 1). With no prior information on the parameters value, we use D-error as the design selection criteria, which amounts to minimising the determinant of the asymptotic variance-covariance (AVC) matrix of estimates scaled by the number of parameters to be estimated. The AVC is equal to the inverse of the second derivative of the log-likelihood function, hence we minimise:

$$\det\left(\left[\frac{\partial^2 lnL}{\partial\theta\partial\theta'}\right]^{-1}\right)^{\frac{1}{KL+1}}.$$

From the definition of the spatial attribute, the vector of parameters θ includes first order interaction effects between location and the regeneration attributes. Since the interpretation of both the location and cost attributes require an improvement to take place, we constrain the design to avoid environmental amenity attributes being simultaneously set to their status quo level in a given choice occasion. Formally, we require the design to satisfy $\sum_k(X_{kjt}-X_k^0) > 0$, where X_k^0 represent the status quo level.

As two of the three DCE blocks have an identical structure in terms of attribute levels, only two experimental designs were needed. Thirty-six choice cards were generated for both designs. These were grouped into nine sets of four choice cards by using an additional four-level factor to derive the design.

4 Results

4.1 Sample Summary and Descriptive Statistics

The survey fieldwork took place in January 2010 in the town of Seaham. Quotas based on population statistics were set on gender, age and socio-economics status, and a screening question applied to retain only respondents that were either responsible or jointly responsible for paying the household's bills. The sample consists of 106 respondents, with an average interview length of less than 30 minutes. Feedback questions at the end of the interview reveal that only a handful of respondents indicated that the questionnaire was difficult to understand (4 %) and/or not credible (7 %). Around 15 % of respondents stated that the DCE exercise was 'fairly difficult'. However, most respondents found the questionnaire interesting (75 %) and interviewers reported that more than 95 % of respondents took the DCE exercises seriously. Also informative in relation to respondent's engagement in the survey, a 100 % response rate was achieved on the question eliciting household's income.

Table 2 summarizes the data from the introductory questions focused on the respondent's perception of current level of local environmental amenity.[12] Overall, the low rate of 'don't know' responses suggests that most respondents have a clear opinion about the need for improvements. The highest uncertainty concerns the need for improvements to 'nature areas', which was not included in the DCEs. We also note that over 80 % of respondents have been living in Seaham for 20 years or more, thus indicating a fair degree of familiarity with the local environment amenity.

Of the eight features listed in Table 2, six were stated to need improvement by more than 50 % of the sample. The general perception is thus that improvements are desirable for most aspects of the local environment in Seaham. 'The amount and quality of facilities for children and teenagers' and 'the cleanliness of streets and amount of litter and graffiti' were reported to be greatest priorities for improvements by around 30 % of the sample each. The 'amount and quality of local nature reserves' and 'the amount of pedestrian and cycle paths away from roads' were stated to need improvement by only 43 % and 49 % of survey respondents respectively and gathered a very small number of votes in the prioritisation exercise.

In a follow-up question to the DCEs, respondents were asked to state their view as to which local environmental amenity attribute would be the most effective to: (i) improve the visual appearance of the local area; (ii) encourage people to visit the local area; (iii) encourage people to move to the local area to live; and (iv) attract new businesses to the local area. Results are reported in Fig. 2. The attribute 'street cleanliness' was stated to have the greatest effect on visual appearance and also a relatively high impact on the other three outcomes. 'Restoration of derelict properties' was rated as having the greatest effect in encouraging new businesses to move to Seaham. Likewise, 'the amount of outdoor community facilities' was seen as the

[12] The list of amenities differs from the DCE attributes, breaking down the community facilities attribute ('facilities for children and teenagers', and other 'outdoor facilities') and including local nature reserves ('nature areas'). Local nature reserves were not included as an attribute in the DCEs since they are typically not the subject of regeneration initiatives. Nevertheless their inclusion in this initial question intended to provide a comprehensive coverage of the features of the local environment in Seaham.

Table 2 Perception of local environment amenity provision (N = 106)

Local amenity	Perception of current provision			Ranking[a]
	Needs improvement	Does not need improvement	Don't know	Priority for improvement
Amount and quality of facilities for children and teenagers	79.2	10.1	10.7	34.2
Street cleanliness (litter and graffiti)	74.7	25.3	0.0	31.7
Quality of public areas (town center and pedestrian streets)	63.1	32.3	4.6	8.8
Amount and quality of open space	56.7	36.6	6.7	8.1
Amount of derelict land and buildings	62.6	29.4	8.0	7.2
Amount and quality of outdoor community facilities	60.4	26.1	13.5	3.8
Amount and quality of nature areas (local nature reserves)	43.2	39.5	17.3	4.1
Amount of pedestrian paths and cycle paths away from roads	49.3	45.2	5.5	1.0

[a] Column does not sum to 100 % since approximately 2 % of sample stated that no local environment features needed improving.

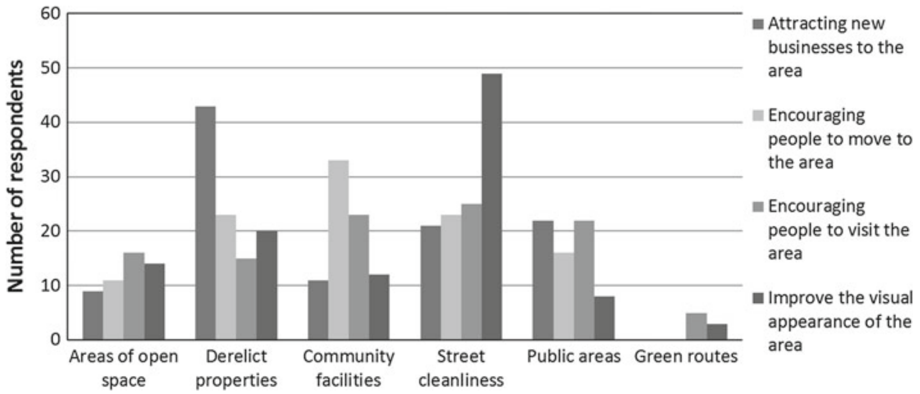

Fig. 2 Significance of local environmental amenity to improving aspects of the local area

most effective action for encouraging people to move to the local area. Generally, respondents did not believe that 'green routes' would have much effect on the stated outcomes.

4.2 Estimation Results

In this section, we report results from the econometric analysis of each DCE. For each local environmental amenity attribute we estimate three coefficients corresponding to: (L1) improvements spread across all of East Durham area; (L2) improvements spread across Seaham and the wider local area; and (L3) all improvements in Seaham. We expect positive coefficient estimates for all local environmental amenity attributes.

Table 3 reports MXL models estimated in preference space in Column (I) and WTP space results in Column (II).[13] While goodness of fit statistics are relatively high for both models, and the relative magnitude of coefficients is similar, preference space estimation outperforms WTP space estimation for each block. This supports distributional assumptions on taste heterogeneity underlying the preference space estimation. In both specifications the mean and standard-deviation (SD) coefficients associated with the price variable are highly statistically significant. For the preference space models, these results imply that about 15 % of the distribution for the marginal utility of income has the 'wrong' sign.[14] In fact, the existence of price insensitive respondents is confirmed by data on motivations for choices, either because they selected improvements regardless of their costs or did not attend the price attribute of alternatives (see Sect. 4.3). This is also related to the finding that mean taste estimates for the status quo ASC are negative, which indicates that, on average, there is a demand for improved levels of environmental amenity in Seaham and the surrounding area, even at a cost.[15]

Despite lower goodness of fit statistics, welfare measures from WTP space specifications are more precisely estimated. Indeed with the exception of 'green routes', all mean effects associated with environmental amenities are statistically significant at the 1 % level. Under the preference space specification, all mean coefficients for improvements in Seaham (L3) are statistically significant at 5 or 1 % level, but evidence on L1 and L2 is mixed. For all environmental amenities, the coefficients for the largest geographical spread of improvements (L1) are the smallest in magnitude. We also observe a tendency for taste heterogeneity to be larger when improvements are spread over the larger areas, which can be interpreted as variations in willingness to contribute to public goods outside the immediate local area and in the perception of non-use benefits.

We report average WTP estimates for preference space models based on Eq. (3) in Column (I) of Table 4. Column (II) reproduces average WTP estimates from WTP space estimation. In addition, Column (III) provides WTP estimates from a preference space MXL model where the cost coefficient is fixed. This estimation approach is a widely used alternative since average WTP estimates can be computed based on Eq. (2). In our sample, this specification features model statistics that are significantly lower, which confirms the importance of heterogeneity in the marginal utility of income.[16] Note that we do not report average WTP derived from simulated WTP distributions based on preference space MXL model.

[13] We find that controlling for unobserved heterogeneity in tastes dramatically improves the models' explanatory power, and we thus focus on MXL specifications. AIC/pseudo R^2 measures for MNL models are 862.0/9.2, 857.1/9.7, and 844.9/11.0 for each block respectively.

[14] The small number of choices per respondent makes the estimation of individual-level coefficients hazardous, but computations indicate that 13 respondents are best described as bearing a negative marginal utility of income in Block 1, 17 in Block 2 and 11 in Block 3, corresponding respectively to 12, 16 and 10 % of the sample. Evidence from a latent class model also suggests that a small group of respondents are best described with a negative marginal utility of income, although estimates are not statistically significantly different from zero.

[15] To further quantify this finding, we estimated a mixed logit model with a dummy-coded price variable to separately identify the valuation of each price level. Results suggest a positive but statistically insignificant effect of the smallest price level (L1). Hence on average, respondents were not sensitive to the smallest price level, and for this price preferred proposed improvements over the status quo.

[16] AIC / pseudo R^2 measures for the MXL model with fixed cost estimates are 664.4/32.2, 660.0/32.4, and 727.9/25.1 for each block respectively.

Table 3 Mixed logit model estimates (N = 106 respondents, T = 4 choices)

Attribute × location (units)		MXL model in preference space (I) Mean	(SE)	SD	(SE)	MXL model in WTP space (II) Mean	(SE)	SD	(SE)
Block 1									
Areas of open space (per ha)	× L1	0.01	(0.04)	0.01	(0.05)	0.38***	(0.09)	0.08	(0.12)
	× L2	0.05	(0.05)	0.21**	(0.10)	1.11***	(0.17)	1.72***	(0.31)
	× L3	0.14***	(0.05)	0.16	(0.10)	1.67***	(0.10)	0.75***	(0.11)
Derelict properties (per property)	× L1	0.20**	(0.09)	0.36**	(0.16)	3.44***	(0.17)	1.76***	(0.13)
	× L2	0.37***	(0.10)	0.02	(0.09)	4.51***	(0.31)	0.43***	(0.17)
	× L3	0.26***	(0.08)	0.02	(0.15)	3.67***	(0.16)	0.14	(0.15)
Cost[a]		−0.15***	(0.04)	0.14***	(0.04)	−1.19***	(0.35)	2.47***	(0.31)
Status quo ASC		−3.01**	(1.34)	8.71***	(2.68)	−1.39	(1.71)	12.11***	(4.11)
Log-likelihood		−297.2				−303.7			
AIC		626.4				639.3			
Pseudo R^2		36.2				34.8			
Block 2									
Community facilities (per facility)	× L1	0.50	(0.32)	0.69	(0.81)	4.46***	(0.99)	5.02***	(1.23)
	× L2	1.02***	(0.39)	1.15*	(0.69)	9.79***	(1.15)	15.17***	(1.46)
	× L3	1.18***	(0.36)	0.45	(0.63)	10.18***	(1.51)	0.36	(1.90)
Street cleanliness (per grade)	× L1	0.44	(0.36)	1.21*	(0.70)	4.14***	(0.90)	14.46***	(2.30)
	× L2	1.42***	(0.44)	0.17	(0.49)	13.17***	(1.78)	1.86*	(1.10)
	× L3	1.25***	(0.38)	1.05	(0.90)	12.26***	(1.38)	13.82***	(2.91)
Cost[a]		−0.14***	(0.04)	0.14***	(0.04)	−1.37***	(0.31)	1.84***	(0.18)
Status quo ASC		−4.13**	(1.62)	8.78***	(2.46)	−10.63***	(3.99)	20.06***	(6.66)
Log-likelihood		−292.6				−297.0			
AIC		617.3				626.1			
Pseudo R^2		37.2				36.2			
Block 3									
Public areas (discrete change)	× L1	0.80*	(0.47)	1.87**	(0.93)	4.58***	(1.69)	6.05***	(0.93)
	× L2	1.57***	(0.52)	0.05	(1.27)	9.67***	(1.42)	5.72***	(1.27)
	× L3	1.98***	(0.59)	1.70*	(0.88)	12.87***	(2.32)	11.27***	(0.88)
Green routes (per km)	× L1	0.15	(0.14)	0.43*	(0.27)	−0.53	(0.91)	6.70***	(0.27)
	× L2	0.27*	(0.14)	0.43*	(0.25)	2.71***	(1.00)	0.58	(0.25)
	× L3	0.34**	(0.16)	0.18	(0.34)	3.39***	(0.61)	1.03**	(0.34)
Cost[a]		−0.14***	(0.03)	0.12***	(0.03)	−1.03**	(0.40)	2.07***	(0.34)
Status quo ASC		−2.54***	(0.75)	4.19***	(0.95)	−3.26***	(0.96)	6.29***	(2.02)
Log-likelihood		−327.2				−334.2			
AIC		686.4				700.5			
Pseudo R^2		29.8				28.2			

*** p value <0.01, ** p value <0.05, * p value <0.1 [a]For WTP space specifications, these estimates refer to the mean and standard deviation (SD) of a normally distributed factor underlying the log-normally distributed price coefficient

Table 4 Average WTP estimates and location of improvements (£/household/unit/year)

Attribute (units)	East Durham (L1)			Wider Seaham area (L2)			Seaham only (L3)		
	(I)	(II)	(III)	(I)	(II)	(III)	(I)	(II)	(III)
Areas of open space (per ha)	0.11	0.38***	0.13	0.59	1.11***	0.62	1.75**	1.67***	1.52***
	(0.49)	(0.09)	(0.44)	(0.67)	(0.17)	(0.56)	(0.69)	(0.10)	(0.49)
Derelict properties (per property)	2.55**	3.44***	1.94**	4.77***	4.51***	3.82***	3.30***	3.67***	2.89***
	(1.20)	(0.17)	(0.89)	(1.54)	(0.31)	(0.82)	(1.11)	(0.16)	(0.66)
Community facilities (per facility)	7.74	4.46***	6.99**	15.82**	9.79***	11.68***	18.33***	10.18***	12.10***
	(5.51)	(0.99)	(3.22)	(7.01)	(1.15)	(4.24)	(6.97)	(1.51)	(3.64)
Street cleanliness (per grade)	6.78	4.14***	4.13	22.07***	13.17***	10.92***	19.51***	12.26***	11.95***
	(6.19)	(0.90)	(3.53)	(8.00)	(1.78)	(4.04)	(7.02)	(1.38)	(4.41)
Public areas (discrete change)	9.69*	4.58***	13.63**	18.97***	9.67***	12.19***	23.95***	12.87***	18.34***
	(5.75)	(1.69)	(5.30)	(6.01)	(1.42)	(4.62)	(7.12)	(2.32)	(5.11)
Green routes (per km)	1.77	−0.53	0.57	3.32**	2.71***	1.87	4.09**	3.39***	2.24
	(1.66)	(0.91)	(1.76)	(1.68)	(1.00)	(1.47)	(1.84)	(0.61)	(1.71)

(I) Derived from MXL models in preference space with random cost coefficient based on Eq. (3); (II) Results from MXL models in WTP space; (III) Derived from MXL models in preference space with fixed price coefficient based on Eq. (2)
Standard-error in parenthesis; *** p value <0.01, ** p value <0.05, * p value <0.1

As expected, the occurrence of extreme WTP draws makes average WTP sensitive to the particular sequence of draws, so that these results unreliable.

Overall, improvements in local environmental amenity are of significant value to the local residents. Although average WTP estimates are quite consistent across estimation approaches, average WTP estimates derived from preferences-space MXL model with heterogeneous marginal utility of income generally suggest larger benefits. Train and Weeks (2005) report similar findings, although in the present case it is not due to the simulation of implausible WTP, but rather to the presence of price insensitive respondents. We also note that heterogeneity in marginal utility of income is relatively large and the bias adjustment suggested by (3) is around 100 % for each block. Nevertheless, the WTP estimates are of reasonable magnitude, and the valuation of maximum improvements in each attribute is consistent with the prioritisation exercise reported in Table 2.

In Block 1, marginal utility estimates for improvements to 'areas of open space' if spread over L1 or L2 are not statistically significant. Only WTP space estimation suggests a small but statistically significant average WTP for these attribute × location interactions. For local improvements (L3), average WTP estimates are statistically highly significant across all specifications, and taste heterogeneity is smaller than for improvements spread over L2. The 'derelict properties' attribute is highly valued, with average WTP being statistically significant at the 5 % level or higher for all areas and specifications. Moreover, the SD estimates shows that preference heterogeneity is inversely related to the spatial coverage of the policy, and it is not statistically significant for L3 area.

In Block 2, preference space estimation with taste heterogeneity for income suggests that average WTP for improvements to community facilities is statistically significant only for the local (L2 and L3) areas. However, other estimation approaches provide statistically significant evidence across all spatial provisions. Average WTP for the local (L3) interaction is the

Table 5 Spatial scope tests: differences between WTP estimates

Attributes (units)	H$_0$: WTP$_{L2}$ − WTP$_{L1}$ = 0		H$_0$: WTP$_{L3}$ − WTP$_{L2}$ = 0		H$_0$: WTP$_{L3}$ − WTP$_{L1}$ = 0	
	(I)	(II)	(I)	(II)	(I)	(II)
Areas of open space (per ha)	0.48 (0.76)	0.73*** (0.19)	1.16 (0.87)	0.56*** (0.19)	1.64** (0.74)	1.29*** (0.13)
Derelict properties (per property)	2.22 (1.43)	1.07*** (0.34)	−1.47 (0.98)	−0.84*** (0.30)	0.75 (1.21)	0.23 (0.22)
Community facilities (per facility)	8.08 (6.83)	5.34*** (1.42)	2.51 (6.30)	0.38 (1.75)	10.59 (6.73)	5.72*** (1.77)
Street cleanliness (per grade)	15.29** (7.64)	9.03*** (1.84)	−2.56 (5.96)	−0.91 (2.12)	12.73* (7.37)	8.12*** (1.57)
Public areas (discrete change)	9.27 (6.77)	5.09** (2.06)	4.98 (6.40)	3.20 (2.85)	14.26* (7.61)	8.30*** (2.92)
Green routes (per km)	1.54 (2.00)	3.24** (1.26)	0.77 (1.97)	0.68 (1.08)	2.32 (2.03)	3.92*** (1.07)

(I) Derived from MXL models in preference space with random cost coefficient based on Eq. (3); (II) Results from MXL models in WTP space; Standard-error in parenthesis; ***p value <0.01, **p value <0.05, *p value <0.1.

largest, with no statistically significant preference heterogeneity. For the ‘street cleanliness’ attribute, average WTP for L1 improvements interaction is not statistically significant for preference space estimation. Moreover, preference heterogeneity for the L1 interaction is quantitatively large and statistically significant at the 10 % level, and taste heterogeneity estimated in WTP space specification is very large. Recalling that for this attribute increasing the spatial scope of the policy does not reduce the provision of improvements in the Seaham only (L3) area, this suggests that some respondents are reluctant for improvements to take place in other urban agglomerations.

In Block 3, the value of improvements to ‘public areas’ is statistically significant for all three locations, and declines as the spatial scope increases. As for ‘street cleanliness’, these results imply that Seaham residents give, on average, a negative value to improvements outside their local area. Note that SD estimates for this attribute are large relative to the low WTP for the L1 area. Finally, ‘green routes’ is the only attribute where we consistently find no evidence of positive benefits when spread over the entire East Durham area. However, we observe highly significant preference heterogeneity. Average WTP estimates when improvements spread over L2 and L3 areas are statistically significant.

Most estimates of average WTP are statistically significantly different from zero at the conventional levels, which implies that increasing their provision impacts welfare. However, sensitivity to spatial scope hinges upon the statistical significance of differences between average WTP in different locations. Table 5 reports spatial scope tests based on preference and WTP space estimation results.[17] Specifically, we report estimates of the difference between WTP for alternative spatial coverage of the policy with associated standard errors and p values. In this setting, a positive value implies that WTP increases with the spatial scope.

While results show that the ranking of welfare measures across spatial areas is the same for both specifications, WTP space estimation suggests a smaller impact of the spatial pro-

[17] Results from MXL specification with fixed cost coefficient are similar to those from MXL models with random cost coefficient, and thus not reported.

vision on average WTP. Nevertheless, welfare measures from WTP space specifications are more precisely estimated so that it provides more conclusive statistical evidence on spatial scope sensitivity. We also find evidence that average WTP for improvements spread over the larger East Durham area (L1) is systematically lower than for the proximate spatial area (L2/L3). Hence respondents prefer spatially focused improvements to local environmental amenities.

Preferences for spatial concentration is most pronounced for 'areas of open space', where we find statistically significant evidence that $\text{WTP}_{L1} < \text{WTP}_{L2} < \text{WTP}_{L3}$. This suggests the proximity to open space is a key driver of economic values, with little associated non-use value, a finding that is in line with results reported in Hutchinson et al. (1995). On the contrary, benefits associated with the restoration of 'derelict properties' is highest if spread over the L2 area, and we find no evidence that per property WTP spread over L1 and L3 are different. For all other attributes, improvements focused in Seaham (L3) are valued more than those that are spread within the wider local area (L2), although the difference is mostly not statistically significant. Hence based on statistical evidence, our results suggest that $\text{WTP}_{L1} < \text{WTP}_{L2} \cong \text{WTP}_{L3}$. For 'street cleanliness' and 'public areas', this finding suggests competitive motives towards other neighbouring urban agglomerations for the appropriation of rival benefits.

4.3 Validity Testing

In this section we review the internal validity of respondent's stated choices and test the robustness of our results with respect to different modelling specifications. This provides further evidence as to the respondents' perceptions of the local environmental amenity attributes, the credibility of the hypothetical scenarios, and the practical relevance of our results.

Following the three DCEs, we elicited the main motivation underlying stated choices. These are reported in the top part of Table 6. We find that a majority of respondents traded-off local environmental amenity improvements against the cost of provision, which is also reflected in the negative impact of the price attribute on observed choices estimated at the mean of the sample. The second prime motivation for choices is the spatial dimension of improvements, which was cited by more than 30 % of respondents. Among these respondents, two-thirds stated they chose improvements that were targeted at the local area. 7.5 % of the sample reported choosing among alternatives "irrespective of their costs".[18] Only one respondent stated he did not understand the choice cards, and none responded based on paternalistic motives.

As a second follow-up to the three DCEs, respondents were asked a payment principle question to further assess the issue of protest motives. Around 70 % of respondents gave a positive response to the payment principle question, indicating that the large majority were willing to participate in the hypothetical market. This is in line with the econometric evidence indicating negative sign of the mean coefficient for the status quo ASC. The motivation of the 30 % of respondent who answered 'no' are reported in the bottom part of Table 6. We find that around 13 % of respondents rejected the payment vehicle, as they objected to paying higher taxes. An additional 5 % appeared to 'protest' against some other aspect of the hypothetical

[18] Note that all respondents declared to be responsible or jointly-responsible for paying bills, but 14 (approx. 13 %) were not able to report their council tax payments. However, we find no correlation between knowledge of council tax payments and ignoring the cost attribute, suggesting that these respondents did consider the payment vehicle seriously.

Table 6 Respondents' reported motivations for choices (N = 106)

Main respondent motivation during the discrete choice experiments	(%)
Chose the options with least cost to my household	26.4
Chose the options which offered most improvement relative to cost	24.5
Chose options that benefited Seaham only	21.7
Chose options that I thought would benefit the whole community	11.3
Was interested in improvements irrespective of cost	7.5
Chose options that affected my household directly	4.7
Did not understand the choice cards	0.9
Chose options that I feel other people should experience, regardless of what they think is best	0.0
Other	1.9
Payment principle question: motivation for refusal	(%)
Not applicable	69.8
Objected to paying higher council tax[a]	13.2
Cannot afford to pay	6.6
Would like to have more information before making a decision	2.8
The local council is not trustworthy[a]	1.9
Objected to the proposed improvements[a]	0.9
The local council should pay for this[a]	0.9
The government should pay for this[a]	0.9
Do not believe these improvements would actually happen[a]	0.9
The environmental improvements are not important to me	0.9
The quality of the local environment is already good enough	0.9

[a] Invalid (protest) motivations in the payment principle question

market, mainly questioning the credibility of improvements actually taking place. Based on these motivations, it appears that around 18 % of respondents did not consider the benefits of the proposed improvements. The remaining 12 % of the sample appear not value the proposed changes at the proposed prices.

We now assess robustness of our estimation results. To simplify the exposition, we use a continuous measure for the spatial scope of improvements. Since the discrete measure used previously generally suggests a negative relationship between the area over which the improvement takes place and the value given to improvements, we interact the level of improvements with the inverse of the number of residents in the area (in hundred thousands).[19] This specification is more parsimonious, requiring the estimation of a smaller number of parameters, but it imposes strong restrictions on preferences and it is therefore only applied for the purpose of validity testing.

The resulting MXL estimates are reported in Tables 7, 8 and 9. For the baseline model, reported in columns (I), all coefficients have the expected sign and all mean coefficients are statistically significant at the 5% level. The magnitude of estimates is consistent with those

[19] An alternative measure of spatial scope is the km^2 area affected by the policy change. We found this measure to have a lower explanatory power, so that we prefer the more direct measure of the population affected. The qualitative results are not affected by the choice of the units.

Table 7 Parametric validity testing for DCE block 1: MXL estimates in preference space

Attribute × interaction	Linear MXL model (I)	Valid choices (II)	Attribute attendance (III)	Block order effect (IV)	Task order effect (V)
Areas of open space					
Mean coef.	0.02** (0.01)	0.01** (0.01)	0.01** (0.01)	0.01 (0.01)	0.02*** (0.01)
× Not attended	–	–	0.01 (0.03)	–	–
× Order effect	–	–	–	0.01 (0.01)	−0.01 (0.01)
Standard-deviation	0.01 (0.02)	0.01 (0.05)	0.01 (0.03)	0.01 (0.03)	0.01 (0.03)
Derelict properties					
Mean coef.	0.05*** (0.01)	0.05*** (0.02)	0.05*** (0.01)	0.05*** (0.01)	0.04*** (0.01)
× Not attended	–	–	−0.01 (0.07)	–	–
× Order effect	–	–	–	−0.01 (0.02)	0.03 (0.02)
Standard-deviation	0.05** (0.02)	0.06* (0.03)	0.05** (0.02)	0.05** (0.02)	0.04* (0.02)
Cost					
Mean coef.	−0.10*** (0.02)	−0.10*** (0.02)	−0.10*** (0.02)	−0.09*** (0.02)	−0.10*** (0.02)
× Not attended	–	–	0.10 (0.07)	–	–
× Order effect	–	–	–	−0.01 (0.03)	−0.02 (0.02)
Standard-deviation	0.10*** (0.02)	0.11*** (0.03)	0.10*** (0.02)	0.10*** (0.02)	0.10*** (0.02)
Status quo ASC					
Mean coef.	−2.39*** (0.87)	−4.49*** (1.21)	−2.39*** (0.92)	−2.36*** (0.91)	−2.48*** (0.95)
Standard-deviation	6.27*** (1.32)	5.56*** (1.40)	6.07*** (1.31)	6.22*** (1.38)	6.15*** (1.26)
Log-likelihood	−307.0	−222.0	−305.7	−306.4	−305.5
AIC	629.9	459.9	633.3	634.7	633.0
Pseudo R^2	34.1	32.6	34.4	34.2	34.4
N/T	106/4	75/4	106/4	106/4	106/4

Standard-error in parenthesis. *** p value <0.01, ** p value <0.05, * p value<0.1

reported in Table 3. As expected, the explanatory power of this model is lower than the formulation using a discrete measure for the spatial scope of improvements.

We contrast these results to a model estimated with a subsample of ‘valid’ respondents only. Scrutiny of questionnaire responses shows that up to 30 % of the sample could be treated with caution. In addition to the 18 % of respondents stating protest motives, we removed respondents that implicitly questioned the credibility of the exercise, reporting that the proposed improvements would be ‘very unlikely’ to occur even if they were to pay for it.

Table 8 Parametric validity testing for DCE block 2: MXL estimates in preference space

Attribute × interaction	Linear MXL model (I)	Valid choices (II)	Attribute attendance (III)	Block order effect (IV)	Task order effect (V)
Community facilities					
Mean coef.	0.20***	0.22***	0.21***	0.19***	0.20***
	(0.05)	(0.06)	(0.05)	(0.06)	(0.05)
× Not attended	–	–	−1.36	–	–
			(0.97)		
× Order effect	–	–	–	0.03	−0.03
				(0.10)	(0.08)
Standard-deviation	0.13	0.21**	0.14	0.13	0.10
	(0.10)	(0.10)	(0.10)	(0.11)	(10.26)
Street cleanliness					
Mean coef.	0.22***	0.28***	0.22***	0.18***	0.26***
	(0.05)	(0.07)	(0.05)	(0.06)	(0.06)
× Not attended	–	–	−0.51	–	–
			(0.54)		
× Order effect	–	–	–	0.12	−0.16*
				(0.09)	(0.09)
Standard-deviation	0.11	0.19	0.12	0.09	0.11
	(0.10)	(0.12)	(0.11)	(0.12)	(0.11)
Cost					
Mean coef.	−0.10***	−0.10***	−0.11***	−0.11***	−0.11***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
× Not attended	–	–	0.13*	–	–
			(0.07)		
× Order effect	–	–	–	0.01	−0.03*
				(0.03)	(0.02)
Standard-deviation	0.11***	0.12***	0.11***	0.11***	0.11***
	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)
Status quo ASC					
Mean coef.	−3.48***	−4.82***	−3.64***	−3.66***	−3.55***
	(1.09)	(1.18)	(1.06)	(1.10)	(1.09)
Standard-deviation	6.71***	4.38***	6.31***	6.79***	6.86***
	(1.39)	(1.14)	(1.30)	(1.40)	(1.43)
Log-likelihood	−297.3	−215.7	−293.6	−296.2	−295.1
AIC	610.7	447.5	609.2	614.4	612.2
Pseudo R^2	36.2	34.5	36.9	36.4	36.7
N/T	106/4	75/4	106/4	106/4	106/4

Standard-error in parenthesis. *** p value <0.01, ** p value <0.05, * p value <0.1

A further small fraction of respondents who stated they understood very little and/or did not give serious consideration to the DCEs, as indicated by the interviewer feedback, were also removed. Estimation results based on the sample of 75 remaining respondents are reported in column (II). We find all preferences estimates to be stable except for the status quo ASC, which almost doubles. This signals that a significant fraction of potential 'invalid' responses did not engage in the market, but also that the inclusion of a status quo ASC controls for this effect. Hence the presence of invalid responses does not alter our main results.

Our second validity test considers the issue of attribute non-attendance. This is of importance since the random utility framework interprets choices as if they were made using all the information available, whereas in reality individuals could ignore some of it. For each attribute, we find that about 5% of respondents did not consider its level when making their choices. In order to quantify the impact of non-attendance, we interact each attribute with an

Table 9 Parametric validity testing for DCE block 3: MXL estimates in preference space

Attribute × interaction	Linear MXL model (I)	Valid choices (II)	Attribute attendance (III)	Block order effect (IV)	Task order effect (V)
Public areas					
Mean coef.	0.33***	0.34***	0.33***	0.25***	0.29***
	(0.08)	(0.08)	(0.08)	(0.09)	(0.14)
× Not attended	–	–	−0.50	–	–
			(0.56)		
× Order effect	–	–	–	0.29	0.11
				(0.18)	(0.14)
Standard-deviation	0.30**	0.21	0.02**	0.32**	0.29**
	(0.14)	(0.17)	(0.09)	(0.14)	(0.14)
Green routes					
Mean coef.	0.05**	0.04*	0.04**	0.05*	0.04*
	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)
× Not attended	–	–	0.11	–	–
			(0.12)		
× Order effect	–	–	–	0.01	0.02
				(0.04)	(0.04)
Standard-deviation	0.04	0.04	0.02	0.05	0.02
	(0.07)	(0.07)	(0.10)	(0.06)	(0.08)
Cost					
Mean coef.	-0.11***	−0.10***	−0.12***	−0.12***	−0.11***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
× Not attended	–	–	0.06	–	–
			(0.06)		
× Order effect	–	–	–	−0.01	−0.01
				(0.03)	(0.02)
Standard-deviation	0.10***	0.09***	0.10***	0.10***	0.10***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Status quo ASC					
Mean coef.	−2.41***	−2.97***	−2.39***	−2.48***	−2.42***
	(0.56)	(0.59)	(0.54)	(0.57)	(0.55)
Standard-deviation	3.38***	2.21***	3.31***	3.51***	3.41***
	(0.61)	(0.59)	(0.63)	(0.67)	(0.64)
Log-likelihood	−330.1	−239.8	−328.6	−328.4	−329.6
AIC	676.2	495.7	679.3	678.8	681.3
Pseudo R^2	29.1	27.2	29.5	29.5	29.2
N/T	106/4	75/4	106/4	106/4	106/4

Standard-error in parenthesis. *** p value <0.01, ** p value <0.05, * p value <0.1

indicator variable taking a value of one when a particular attribute was systematically ignored by a given respondent. Estimates controlling for the effect of attribute non-attendance are reported in column (III). In most cases we find that respondents who did not consider an attribute have average utility weights close to zero. This effect is not statistically significant, however, except for the price coefficient in block 2. All marginal utility estimates remain stable when controlling for non-attendance. These results suggest that respondents who did not consider the price attribute have near zero marginal utility of income, and that these are captured by SD estimates.

The final two validity tests focus on the impact of repeated choices on preferences and ordering effects. This is important since incentives to truthfully state preferences could change as the choice exercise progresses. The first test of ordering effects provides evidence on the validity of the block design by identifying respondents who saw each block as the first

DCE exercise. These respondents effectively took part in a ‘conventional’ DCE, and through random assignment of blocks we can test if preferences differ when each block was seen first or later in the sequence. To test for systematic differences in tastes, we interact each attribute with a dummy variable equal to one to if a particular choice was made in the first DCE exercise. Results reported in Column (IV) show that none of the interaction terms are statistically different from zero at conventional levels. Overall, mean taste coefficients remain stable when controlling for a block order effect. Importantly, we do not find a systematic effect on price sensitivity, suggesting that price insensitive respondents are not a by-product of this aspect of the survey.

The second test of ordering effects focuses on the impact of repeated choice tasks on preferences. For this purpose, we identify the first choice task presented to respondents in each block, and interact a dummy variable for these choices with each attribute. Importantly, given randomisation of tasks, our experimental design enables us to identify task-specific preference estimates. Results are reported in Column (V). We find that the ‘order effect’ interaction terms have negative and statistically significant impact for ‘derelict properties’ (block 1), and on the price attribute in ‘block 2’. Thus there is some evidence that respondents were on average more price sensitive in the first choice task. We also note a tendency for preferences inferred from the first choice of a sequence to be less pronounced for improvements. But as for the block order effect, the mean preference coefficients are stable, and a consistent order effect is not evident, suggesting that our results are robust.

5 Concluding Remarks

There exists a large body of literature on the value of environmental quality improvements, although few studies have been concerned with small scale amenity improvements brought about by regeneration initiatives. Evaluating benefits of such schemes is required for public policy selection based on social return of public funds. Given the nature of improvements and the familiarity of residents with their local environment, this paper has shown that stated preference surveys can provide valuable evidence on policy benefits. We have found that the survey instrument was well received by respondents, and validity tests undertaken provide evidence that results are robust to a number of bias reported in the literature.

The stated choices reveal significant benefits of improved local environmental amenity. Over the range of improvements considered, restoration of derelict properties and improved street cleanliness were the most highly valued attributes. The analysis of follow-up questions suggests that these attributes are associated with enhancing the visual appearance of and attracting new businesses to the area. In contrast, the provision of ‘green routes’ for cycling and walking was given little value by the respondents.

Our results are consistent with the literature on the spatial aspects of environmental policy, with expected proximity to improvements being a key determinant of welfare measures. Our experimental design has allowed us to provide statistically significant evidence on spatial scope sensitivity. Specifically, average WTP declines if the same provision of amenity is spread out over a larger area, demonstrating a narrow ‘market jurisdiction’ for the local environmental amenity attributes considered. In addition, heterogeneity in preferences generally increases with the spatial coverage of the policy, which can be linked to underlying variations in non-use (altruistic) motives at the individual level. For some attributes, our results also suggest some degree of competition with respect to the appropriation of rival benefits across neighbouring areas.

Methodologically, we have examined in some detail the issue of price insensitive respondents who are mechanically attributed an infinite WTP under the RUM assumptions. We argue in favour of their inclusion in a utility-space analysis that does not impose bounds on taste distributions, and our proposed approximation for average WTP in the presence of preference heterogeneity by-passes the problem of unstable WTP simulations. While we believe that increasing the range of the price attribute would eventually give rise to price sensitivity, it would also affect the credibility of the scenarios, as increases in the council tax are limited by political feasibility. Specifying changes in the price attribute as a proportional rather than an absolute amount could also mitigate the occurrence of price insensitivity, but at the cost of additional cognitive efforts for respondents. Importantly, the issue of price insensitivity is ruled out by WTP space analysis, since a non-zero price responsiveness is needed to scale the individual utility function. In our data, the fit of this specification is found to be slightly lower.

Finally, our analysis suggests at least two topics for future research. First, since we find evidence that investments in local environmental infrastructure of distinct urban settlements are strong complements rather than substitutes, the extent of complementarity could be assessed by administering similar surveys at different locations. Comparing estimates derived from different sub-samples could help quantify what defines boundaries to economic benefits (e.g. densely populated urban areas versus smaller towns and rural settings). Second, our results also suggest that further research should be conducted on ordering effects. On the one hand, while we find evidence that blocking attributes together in separate DCEs did not affect choices, further research on the use of a block design is warranted. On the other hand, our results suggest that preferences stated in the first choice task of each block differed from preferences stated subsequently. In our data, these effects are small and mostly statistically insignificant, but robustness of the DCE methodology estimates could be improved by a better understanding of how such discrepancies could be controlled for.

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