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Valuing local environmental amenity: Using discrete choice experiments to control for the spatial scope of improvements*

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Abstract

We report results from a series of discrete choice experiments designed to elicit preferences for local environmental improvements. Amenities we consider are: improvements to areas of open space, outdoor recreation facilities, street cleanliness, public areas, the restoration of derelict properties, and the provision of paths dedicated to cycling and walking. We include the spatial coverage of the policy as an attribute, making the trade-off between the location of improvements and environmental amenities explicit. We find that subjects derive significant benefits from improvements to their immediate neighborhood, and that the spatial scope of the policy affects both the intensity and heterogeneity of preferences. A fraction of subjects display negative surplus for improvements in more distant agglomerations. From a resource allocation perspective, this suggests that investments in local environmental infrastructure of nearby neighborhoods are substitutes, whereas investments in more distant areas are complements.

Keywords: Non-market valuation; Discrete choice experiments; Spatial analysis; Urban planning; Regeneration policy.
JEL classification: **Q51; Q28; R53; R58; C35; C21; C81**

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1 Introduction

The objective of local regeneration initiatives is to address economic, social and physical environment decline in rural and urban settlements. Until recently, the usual practice has been to evaluate regeneration initiatives on the basis of monitoring data (e.g. establishing the number of additional jobs created), which only permits relatively narrow cost-effectiveness assessments within particular topic areas (e.g. employment). The paucity of evidence available on the value of regeneration benefits generally precludes cost-benefit comparisons which could be used to determine where resources should be directed. Moreover, whereas the traditional focus of regeneration has been on improving economic outcomes in terms of employment and physical infrastructure, non-marketed amenities such as environmental quality, neighborhood renewal and community development are now also targeted. Yet despite the increasing use of economic valuation methods to inform public policy decisions, local environmental amenity improvements delivered by regeneration initiatives have received little attention.

In principle, preferences for environmental amenities can be inferred via a 'surrogate market' approach, exploiting relationships that exist between the provision of a market good and the non-market good of interest. Of particular relevance is the hedonic pricing method (Rosen, 1974), which uses variation in property market values to identify the demand schedule for local environmental amenities. Empirical applications of this approach are numerous, and recent publications include evidence on the value of woodlands (Tyrväinen and Miettinen, 2000; Mansfield et al., 2005), air quality improvements (Chay and Greenstone, 2005), traffic-related noise (Day et al., 2007), as well as the presence of open spaces, parks and water bodies (Irwin, 2002; Morancho, 2003; Cho et al., 2006). In the context of regeneration initiatives, a recent study by Dolan and Metcalfe (2008) uses a quasi-experimental setting to study the impact of a regeneration scheme on house prices and a self-reported measure of well-being. Comparing changes in well-being measures in the area subject to regeneration relative to a similar neighborhood that did not benefit from regeneration, the authors find significant benefits associated with the regeneration scheme. In contrast however, they find little evidence of price differentials when comparing changes in dwelling prices in the treated and control neighborhoods.

In this paper, our aim is to examine preferences for six local environmental amenities brought about by regeneration initiatives:

- 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 paths dedicated to cycling and walking.

Given the nature of these amenities, practical application of the hedonic pricing approach can be problematic. As Dolan and Metcalfe (2008) note, property prices might not reflect the environmental amenity improvements due to information asymmetry, since individuals outside the area do not directly observe improvements. In turn, potential buyers might interpret the regeneration process as a signal for the existence of disamenity (see also Messer et al., 2006). In addition, improvements are typically small scale, primarily benefiting the immediate residential population of the recipient area. Consequently, the number of property market transactions is small, making robust estimation of the hedonic model difficult. More generally, data on environmental amenities is typically limited to broadly defined goods, such as area of park and distance from property, and the extensive data requirement of the hedonic price function can induce collinearity problems (Freeman, 2003). This makes identification of preferences for more nuanced attributes of the local environment difficult, and can lead to omitted variable bias (e.g. Leggett and Bockstael, 2000).[1]

As an alternative, we use the stated discrete choice experiment (DCE) methodology (Louviere et al., 2000) and describe the outcome of a regeneration policy in terms of improved local environmental amenity (the 'attributes'). Survey respondents participate in a hypothetical market in which improvements in amenity can be traded-off against their income. By choosing their most preferred combinations of attribute levels out of a set of pre-specified bundles (the 'alternatives'), they reveal the relative valuation of each attribute. Using a structural representation of preferences, the demand schedule and willingness to pay (WTP) can be inferred for marginal changes in the provision of each amenity. While the main advantage of this approach is the ability to value individual environmental amenity attributes, analyzing survey-based choices has its own caveats, notably due to the hypothetical nature of the exercise (see e.g. Munro and Hanley, 2000; 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 randomization procedures to mitigate potential biases. More fundamentally, the policy improvements we consider take place in the day-to-day environment of the respondents, implying that they are familiar with the goods proposed, and a hypothetical market can be credibly specified. The DCE approach has previously

[1] Other issues with the use of the hedonic pricing approach include the assumption that markets are in equilibrium (Greenwood et al., 1991) as well as inefficiencies on the supply side of the market, notably because of state regulation (Glaeser et al., 2005).

been used to provide evidence on the preferences for local environmental amenity, including urban green space (Bullock, 2006), improvements to city centers (Alberini et al., 2003) and urban river quality (Hanley et al., 2007a). However, no studies to date have specifically considered a broader range of attributes in the context of local regeneration schemes.[2]

By construction the DCE approach embeds a scope test for the level of provision of each attribute (Hanley et al., 1998). We exploit this feature by making the trade-off between space and other attributes explicit and investigating preferences for a particular aspect of the spatial scope of the policy change. Specifically, we assess whether respondents prefer regeneration initiatives that are spatially 'focused' or spatially 'diffuse', and weather respondents are willing to contribute to regeneration improvements in more distant areas. This result is of interest to public policy since decision-makers often face prioritization issues 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. This also contributes to the growing literature on the spatial dimension of environmental policy in preference elicitation, including spatial representations of policy outcomes (Johnston et al., 2002; Bateman et al., 2009), distance to the site and decay of welfare measures (Bateman et al., 2006; Campbell et al., 2009), and the existence of substitute sites in neighboring areas (Brouwer et al., 2010).[3]

Formally, preferences for the spatial scope of the policy are estimated by interacting the spatial scope of improvements and the environmental amenity attributes. We select the experimental design to efficiently estimate the first order interaction effects based on the D-efficiency criteria (see e.g. Street and Burgess, 2007). As the spatial attribute is undefined if no improvement takes place (i.e. the status quo), the experimental design is selected such that some improvement in environmental amenity takes place in all alternatives. The resulting constrained efficient experimental design allows us to rely on a relatively small sample size, and permits resources to be focused on conducting face-to-face interviews carried-out by a professional interviewers, where the information flow and attention given to the exercise can be actively monitored.

Stated choices are analyzed within the random utility framework and we use a panel mixed-logit model to quantify preference heterogeneity among respondents. Based on a representative

[2] Two other studies should be mentioned. First, Earnhart (2001) complements market transaction data for a hedonic pricing model with data generated by a DCE exercise to obtain a continuum of environmental amenities and dwelling characteristics. As in the traditional hedonic methodology, this approach provides evidence on preferences for non-marginal changes and broadly defined environmental amenities. Second, Dolan and Metcalfe (2008) also report results from a contingent valuation question for a specific regeneration policy, but do not consider the valuation of marginal changes.

[3] Numerous hedonic studies also use information from a Geographical Information System to study the relationship between the preferences for and the location of environmental amenities. See for example Lake et al. (2000); Paterson and Boyle (2002); Brasington and Hite (2005).

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. This effect is both of statistical and economic significance. Generally, as the spatial scope of the policy increases, the value of improvements at the average of the sample declines, but preference heterogeneity increases. For some attributes, respondents display negative surplus for the provision of improvements in other locations, which signals competition among urban agglomerations for the appropriations of rival benefits. In addition, our data suggest that a small but significant fraction of respondents are price insensitive, which prevents identification of their WTP. For inference about mean WTP to remain valid in this setting, we propose an approximation based on a second order Taylor approximation for the expectation of the ratio of two random variables. A set of validity tests provide evidence about the internal consistency of the responses and robustness of the results with respect to protest motives, attribute non-attendance, and ordering effects.

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, experimental design, and WTP estimation. Section 4 provides the sample description, estimation results and validity tests. Our conclusions are presented in Section 5.

2 Survey design

2.1 Local regeneration initiatives: Attributes and levels

The stated preference survey was designed to be administered in Seaham, a coastal town in the North East of England. Seaham is a small-sized town (population approximately 21,000) located in a former coalfield area. In the early 1980s there were four collieries (Seaham/Vane Tempest, Murton, Dawdon and Hawthorn) and one coking works (Hawthorn) which provided 65% of all employment in the area (82% of male employment). By the mid-1990s all collieries and the coking works had closed. Seaham and neighboring Murton have been subject to physical regeneration activity with projects including transport link improvements, new housing, and commercial development on reclaimed coalfield land along with some environmental and public realm improvements particularly on the seafront.

The survey is constructed around six local environmental amenity attributes that would be impacted by proposed regeneration initiatives. These are summarized in Table 1. Detailed definitions and description of the attributes presented to survey respondents are provided in Appendix

1. Two attributes are concerned with disamenity caused by 'derelict properties' and 'street cleanliness' respectively. 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.[4]

The 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', is a form of infrastructure with the primary purpose of providing access links for the local population. This type of infrastructure enhances recreation opportunities and also facilitates healthier lifestyle choices (e.g. cycling).[5]

Specification of the attribute levels is based on data concerning their current provision (e.g. the number of hectares of open space currently available) and the scale of improvements. All local environmental amenity attributes except 'improved public areas' are described in terms of three levels: the status quo, which represents the existing level of provision (Level 0) and two improved levels (Levels 1 and 2). These attributes are defined in quantitative terms, which we treat as a continuum. Improvements to public areas are more complex to quantify and we specify this attribute with just one qualitative improvement level.

For local residents, all these attributes have features of public goods. However the benefits of improvements are partly excludable, since the extent to which respondents can appropriate these benefits hinges upon their relative distance to the improvements. More specifically, for improvements to areas of open space, restoration of derelict properties, as well as the provision of community facilities and green routes, an increase of the spatial scope of the policy implies that a larger population can potentially benefit from improvements. However, if non-use values

[4] 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.

[5] The terminology 'green routes' contrasts with green or blue corridors which are typically ecology (e.g. the connectivity of habitats) or riparian (e.g. accommodation space for river flooding) focused environmental infrastructure.

Table 1: Discrete choice experiment attributes and levels

Attribute	Level 0 (Status quo)	Level 1	Level 2	Level 3	Level 4	Level 5
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	–	–	–
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	–	–	–
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	–	–	–
Location of improvements	–	Improvements spread across all of East Durham area	Improvements spread across the wider local area	All improvements in Seaham	–	–
Cost (£per year)	£0	£5	£10	£20	£30	£50

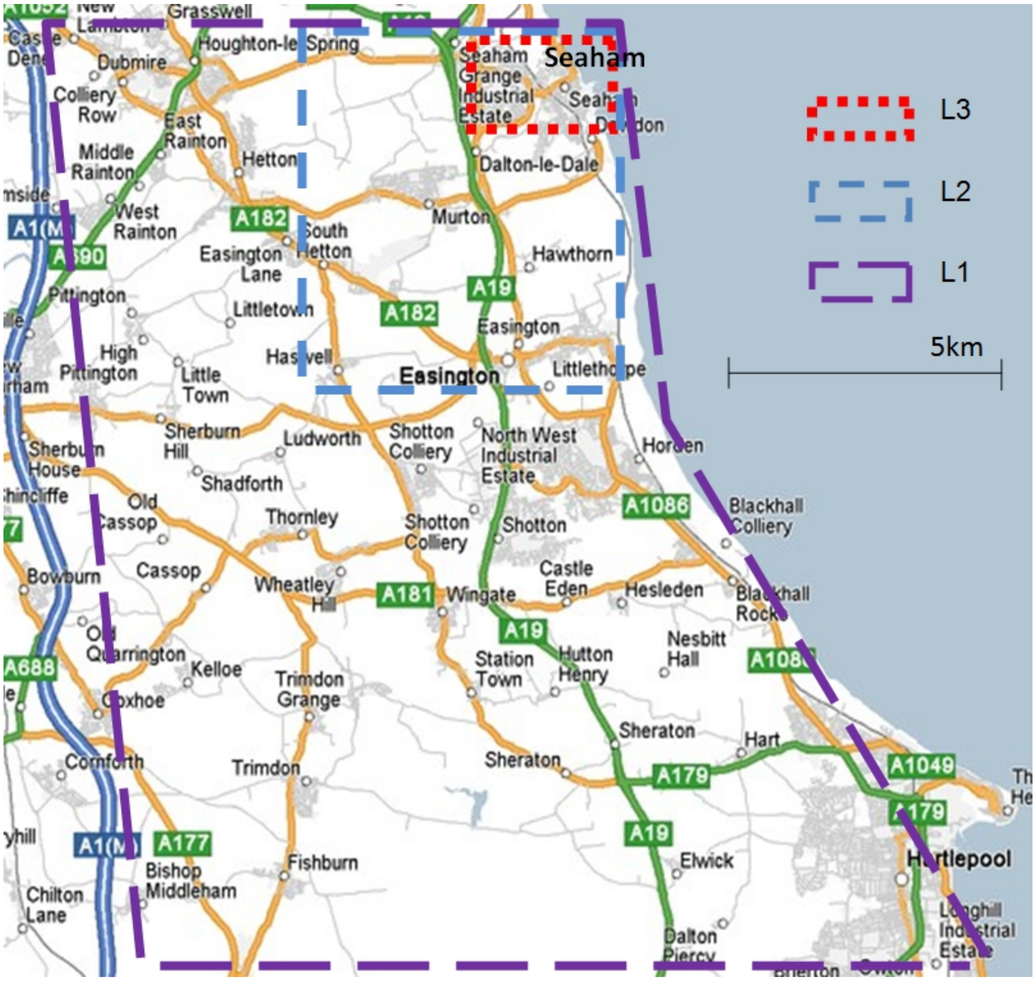
are small and based on altruistic motives, the value of improvements will mainly reflect benefits to the immediate residential population of the recipient area. Thus increasing the spatial scope of the policy implies a reduction of the provision of improvements on a per person or per km^2 basis, reducing the expected benefits of individual respondents. In contrast, the provision of improvements to public areas and to street cleanliness increases with the spatial scope of the policy since, as defined in Table 1, improvements are applied uniformly across the policy area. Thus from the standpoint of Seaham residents, the benefits of larger the spatial coverage hinges upon the perception of improvements for residents in other areas ('non-locals') relative to local residents.

In order to control for expectations about the appropriation of benefits, we explicitly specify the spatial scope of improvements as an attribute. The geographical coverage of the spatial attribute is mapped in Figure 1. The largest area over which improvements could be spread (L1) is the East Durham area, which has a population of over 100,000 residents and spans approximately 280 km^2. This area includes urban agglomerations that are larger than Seaham, notably other coastal towns Peterlee and Hartlepool. At Level 2, improvements are spread across Seaham and the wider local area (L2), with a population of around 31,000 and a spatial area of approximately 30 km^2. In this area, Seaham is the largest urban area, and all the neighboring settlements (Murton, Easington) are part of the same jurisdiction. Level 3 concentrates all improvements in the town of Seaham (L3), with 21,000 residents and an area of approximately 6 km^2. Level 0 corresponds to the status quo, which is left undefined since no improvements take place in any locations.

In the DCE hypothetical market, improvements in local environmental amenity are traded off against a cost ('price') attribute, which we define 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 and the tax base depends on the value of the residential property. Revenues are collected at the Local Government level and contribute to publicly funded services, including the provision of improvements in local environmental amenity, and hence provides a credible payment vehicle for the hypothetical market.[6] 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

[6] 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.

FIGURE 1: SPECIFICATION OF THE SPATIAL SCOPE OF IMPROVEMENTS (SOURCE: http://maps.google.com)



the price tag transparent, we specify the increase in local taxes in absolute terms. Six levels of the price attribute are defined, ranging from no change to the current household bill (Level 0) to an increase of £50 per year (Level 5). At the time of the survey, a £50 increase in council tax was approximately a 4-5% increase in the average household bill.

2.2 Questionnaire structure and administration

The questionnaire and DCE exercise follow the typical structure for a stated preference survey (Bateman et al., 2002).[7] The design and development of the survey was aided by a set of focus groups and cognitive interviews to pre-test and pilot the survey material. Findings were

[7] A copy of the survey questionnaire can be obtained from the authors upon request.

used to refine definitions of local environmental amenity attributes and pre-code responses for individuals perceptions of improvements and motivations for responses to various questions. The questionnaire was administered by professional interviewers via one-to-one (in-home) computer aided interviews. This allows controlling the provision of information to respondents and ensuring adequate attention is given to the DCE exercises.

We used a set of initial quota questions to ensure the construction of a random sample representative in terms of gender, age and socio-economics status, and a screening question to retain only respondents that were either responsible or jointly responsible for paying the household's bills. Following introductory questions focusing on the perceptions of local environmental amenity and priorities for improvement, respondents were introduced to the choice tasks and attributes of the DCEs. In order to ease the cognitive burden of trading-off the eight attributes detailed in Table 1, a block design was employed (Willis et al., 2005), and the six environmental amenity attributes were grouped into three blocks (see Appendix 1). The assignment of attributes to blocks was based on initial qualitative research carried out during focus groups and aims at mitigating the potential complementarities between attributes within each block. The three separate DCEs each comprised four attributes in total: two local environmental amenity attributes, the spatial scope attribute and the price attribute.

In each choice task, respondents were required to select their preferred option out of the current situation (the status quo) and two alternative options with varying levels of the attributes.[8] We elicited the preferences of each respondent for all three blocks of attributes. For the interview length to remain reasonable and to avoid potential fatigue effects, we follow results reported in Caussade et al. (2005) and set the total number of choice tasks to 12, leaving four choice tasks per block for each respondent. Respondents were aware of the repeated nature of the exercise, although the choice tasks were presented in sequential manner with no prior knowledge of forthcoming tasks. Since the order in which the choice tasks are presented can influence observed choices (Day and Pinto Prades, 2010), we limit potential influence of ordering effects on the results by using a randomization procedure both on the attributes' blocks and on the choice tasks. Hence the order in which the blocks were presented was randomized, and within each DCE block the sequence of choice cards was also randomized.

[8] On the one hand, a large number of options in each task increases the efficiency of the estimation, and given the repeated nature of the exercise, it mitigates potential starting point bias. Moreover, presenting several alternative lessens the incentives for strategic behavior that can arise with 'one off' policy proposals (Earnhart, 2001). On the other hand, multiple options increases the complexity of the choice exercise, and could induce respondents to use simple heuristic for making choices, such as always retaining the status quo option. Caussade et al. (2005) provide evidence that three-options choices tasks is a reasonable compromise.

The local environmental amenity improvements offered to respondents relate to familiar facets of their day-to-day surroundings. Accordingly, the context and the type of improvements can be expected to be well-known, a fact borne out by the testing phase. Nevertheless verbal description of each attribute was accompanied by illustrations, including a set of maps for describing the spatial scope attribute. In addition, along with on-screen information, a number of showcards were read-out by the interviewer and presented to the respondents, with the aim of increasing the evaluability of the choice tasks (Bateman et al., 2009). Furthermore, in order to mitigate the hypothetical bias, and following findings reported in Cummings and Taylor (1999), List (2001), and Landry and List (2007), we include a number of cheap talk entreaties to remind respondents of consequences of their choices and income constraints.[9]

After completing each DCE block, respondents were asked to report the attention given to each attribute when making their choices. This allows an assessment of attribute non-attendance, which is shown to be of importance by Scarpa et al. (2010). After the three DCE exercises were completed, a series of follow-up questions focused on respondent motivation for choices and feedback on how easy or difficult they found the choice questions. The questionnaire ended with standard questions on socio-economic characteristics of the respondent and their household, and by an evaluation from the interviewer about the attention and interest taken by the respondents in answering to the questions.

3 Discrete choice experiment

3.1 Econometric models

The objective of the econometric analysis is to estimate the relative value given to each attribute based on the respondents choices. We follow the standard random utility model (RUM), where an individual i chooses a policy bundle or alternative j over j' if the utility of j is greater than

[9] 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."

the utility of j'. We write the utility of respondent i associated alternative j as:

$$U_{ij} = V_{ij} + \varepsilon_{ij}\,, \quad i = 1, \ldots, N\,, \quad j = 1, \ldots, J\,,$$

where V_{ij} is the deterministic part of the utility function, and ε_{ij} 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:

$$P(U_{ij} > U_{ij'}\,, \quad \forall j \neq j') \quad = \quad P(\varepsilon_{ij'} < \varepsilon_{ij} + V_{ij} - V_{ij'}\,, \quad \forall j \neq j')$$

which is the cumulative distribution of $\varepsilon_{ij'}$ conditional on ε_{ij}, V_{ij} and $V_{ij'}$. 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:

$$P(U_{ij} > U_{ij'}\,, \quad \forall j \neq j') = \frac{\exp V_{ij}}{\exp V_{ij} + \sum_{j'} \exp V_{ij'}}\,.$$

Further, we impose structure on V_{ij} and assume it is a linear function of the attribute levels in alternative j.[10] In our setting, each alternative includes two local environmental amenity attributes, the spatial scope attribute and the price attribute. In order to allow tastes for improvements to vary with the location of attributes, we use a set of dummy variables to indicate the spatial scope of option j, which we denote $\{L_{lj}\}_{l=\{\text{L1,L2,L3}\}}$, and we estimate interactions between the regeneration and the spatial attributes. Formally, V_{ij} is specified as:

$$V_{ij} = \sum_k \sum_l \beta_{kl} X_{kj} L_{lj} + \gamma P_j$$

where the β's measure the marginal utility (or tastes) for improvements undertaken in area l, X_{kj} are levels of improvement specified in alternative j, γ is the marginal utility of money, and P_j is the price of j. Since it is possible that individuals may perceive the status quo alternative differently from the two other alternatives (Hess and Rose, 2009), we control for this effect by including a status quo alternative specific constant (ASC).

[10] Non-linearities in the utility function are potentially important (Lanz et al., 2010; Masiero and Hensher, 2010). In the present context, however, model specification statistics from a dummy-coded model suggests that a linear representation of preferences should be preferred.

Given the iid assumption about the error term, the log-likelihood function can be written as:

$$lnL = \sum_i \sum_j y_{ij} lnP_{ij}(X_{ij}, L_{lj}, P_j; \theta) \quad (1)$$

where $\theta = (\beta, \gamma)^T$ is the vector of parameters to be estimated from the data and y_{ij} is an indicator variable which is equal to one if i chooses j, zero otherwise. This structure is known as the multinomial logit (MNL) choice model.

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 (see Bhat et al., 2008, for example). To overcome the limitations of the MNL model, we exploit the panel data structure with a 'mixed logit' (MXL) model (Revelt and Train, 1998), which accommodates unobserved preference heterogeneity by treating individual tastes as random variables and imposing structure on the distribution of tastes among individuals. In the empirical analysis, we control for unobserved taste heterogeneity in all attributes as well as for the cost variable and status quo ASC, and assume that the taste parameters are normally distributed ($\theta_i \sim N(\overline{\theta}, \Sigma)$).

We note that the normal distribution is parsimonious and numerically well behaved, and hence widely used in practice. However, a caveat to this is that the support of the normal distribution is not bounded, and hence marginal utility estimates can have the 'wrong sign'. Of particular contention is the price variable, since a positive coefficient would indicate a negative marginal utility of money. This issue motivates the use of bounded mixing distributions, such as the log-normal and triangular distributions, or the use of a fixed coefficient for the cost variable. In our sample, however, the scrutiny of verbatim responses for individuals motives reveals that a small but significant fraction of respondents did not consider the cost of improvements when stating their choice (see Section 4.3). Thus these respondents can be seen as displaying price inelastic preferences.[11] This signals that non-compensatory trade-offs took place, which could be due to very strong preferences for improvements, strategic motives (e.g. freeriding), because the price levels were too small or because these respondents were not engaging with hypothetical market (e.g. protest response). Since our main purpose is to provide a good account of observed

[11] Evidence from a mixed logit model with discrete taste distribution, or latent class model (Greene and Hensher, 2003), also suggests that a small group of respondents are best described with a negative marginal utility of income.

choices at the mean of the sample, we refrain from setting arbitrary bounds to the support of the distribution. We thus interpret preferences with the 'wrong sign' as capturing a systematic deviation from narrowly defined utility maximization assumptions underlying the RUM, and reflecting unobserved characteristics of the respondents or alternative decision-making rules that are not explicitly controlled for.[12]

Estimates from the MXL model are interpreted as the mean and standard-deviation of the distribution of tastes. The estimation of the MXL model is also based on log-likelihood (1), but with unconditional choice probabilities defined as:

$$P(U_{ij} > U_{ij'}, \quad \forall j \neq j') = \int \frac{\exp(V_{ij})}{\sum_{j'} \exp V_{ij'}} \phi(\theta \mid \overline{\theta}, \Sigma) d\theta$$

where $\phi(\cdot)$ is the multivariate normal density. Since this expression has no closed-form, we approximate the integral numerically using 500 Halton draws, estimating the parameters of the model with simulated maximum likelihood (Train, 2003).

3.2 Experimental design

Based on the set of feasible outcomes for each attribute (Table 1), the experimental design specifies the bundles (or combinations of attribute levels) offered to the respondents in a given choice task. The specification of the choice tasks can significantly affect the statistical precision of estimation (Lusk and Norwood, 2005). In choosing the experimental design, our aim is to minimize the sample requirements yet achieve a 'reasonable' statistical precision for our estimates.[13] This amounts to maximizing the information generated by the covariates X_{ij}, L_{lj}, P_j on respondents' preferences parameters θ.

With no prior information on the parameters value, results reported in Ferrini and Scarpa (2007) suggest basing the design on minimizing the D-error. Hence we specify the experimental design so as to minimize the determinant of the asymptotic variance-covariance (AVC) matrix scaled by the number of parameters to be estimated. The AVC is equal to the inverse of the

[12] For a detailed discussion about preference heterogeneity for the price variable, see Campbell et al. (2010). For a different line of argument favoring the use of bounded mixing distribution, and arguing that deviations from the RUM assumptions should be explained by individual characteristics, see Hess et al. (2005).

[13] An alternative approach, which we did not consider at the time of the study design, is to model choices directly in WTP-space by scaling the utility function with the marginal utility of income (Train and Weeks, 2005), and derive the design to efficiently estimate WTP values (Thiene and Scarpa, 2009). We follow the more traditional approach and we model the choice probabilities in utility space.

second derivative of the log-likelihood function, and thus we minimize:

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

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 $\sum_k (X_{kj} - X^0_{kj}) > 0$, where X^0 represent the status quo level.

As two of the three DCE blocks have an identical structure in terms of attribute levels, and we have no prior on preferences parameters, 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. This approach to the allocation of choice cards ensures that each respondent saw each attribute level approximately the same number of times.

3.3 Willingness to pay estimation

Mean WTP for changes in the provision of attributes is the key information provided by DCEs for resource allocation decisions. It measures the monetary value of a marginal change in each attribute for a representative individual. In the context of MNL models based on linear-in-variables utility functions, WTP evaluated at the sample average is simply the ratio of the marginal utility of an attribute to the marginal utility of money (McFadden, 1984). Hence the marginal WTP for attribute k and location l is:

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

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

At the individual level, estimation of the WTP from MXL model follows the same logic. However, the MXL model treats individual taste parameters as random variables, and the formula for the MNL model evaluated at the mean of the taste distribution will provide biased estimates of the mean WTP since the expected value of a ratio is generally not equal to the ratio of expectations. The usual approach is to compute the mean 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. Since our distributional assumption for tastes allows for the existence of price insensitive respondents, draws with γ in the neighborhood of zero will give rise to implausible WTP values.[14] Although the occurrence of these extreme draws is small, they heavily influence average WTP. It follows that the particular sequence of random draws considered will unduly influence the simulations, even if using a trimmed estimator for the mean.

Given that the fundamental issue is 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.[15] Since a truncated cost distribution with ε small can still be problematic for the purpose of simulation, and choosing a numerical value for ε is arbitrary, we avoid this issue by approximating the mean WTP based on the second order Taylor series expansion for a ratio of random variables (see Paolella, 2007). Specifically, we 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:

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

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:

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

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:

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

[14] 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 (Daly et al., 2011).

[15] This assumption is also implicit for the analysis of stated choices in the WTP space (Train and Weeks, 2005), since the presence of price insensitive respondents would require scaling the individual utility by zero, making the choice primitives undefined.

This expression shows that the bias implied by simply taking the ratio of expectation, which corresponds to a first order Taylor expansion, will generally be positive.

4 Results

4.1 Sample summary and descriptive statistics

The survey fieldwork took place in January 2010 in the town of Seaham and a total of 106 interviews were completed. The average interview length was less than 30 minutes. The sample is representative of the gender, age, socio-economic and household income characteristics of the population of North-East England (see Appendix 2). 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 willingness to cooperate and consideration given to their responses, a 100% response rate was achieved on the household income question.

Table 2 summarizes the data from the introductory questions focused on the respondent's perception of current level of local environmental amenity and priorities for improvement. The list of amenities differs slightly from the attributes considered in the DCEs, by breaking down the community facilities attribute ('facilities for children and teenagers', and other 'outdoor facilities') and including local nature reserves ('nature areas').[16] Overall, the low rate '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'

[16] 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 the survey initially was to provide comprehensive coverage of the features of the local environment in Seaham.

TABLE 2: PERCEPTION OF LOCAL ENVIRONMENT AMENITY PROVISION (N = 106)

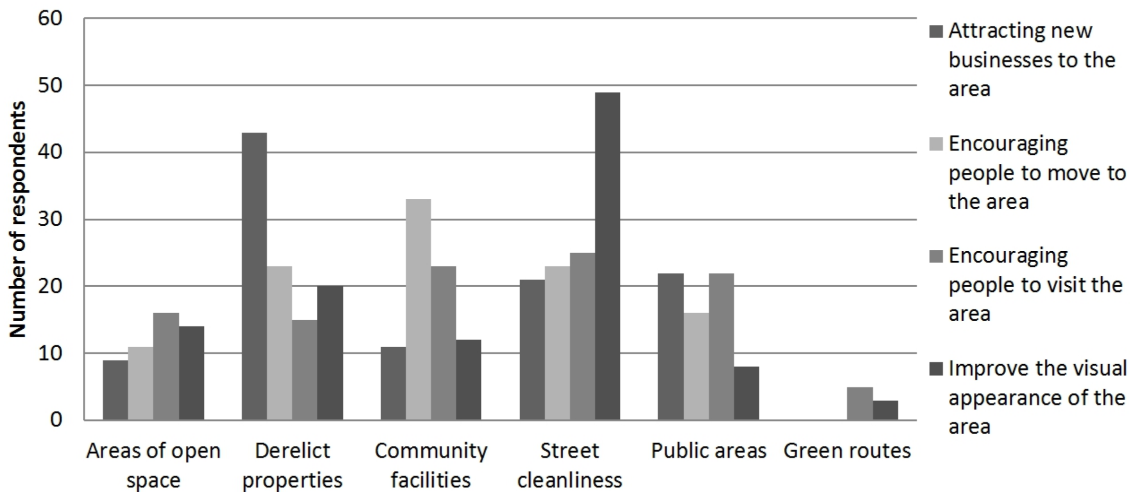
Local amenity	Perception of current provision			Ranking[a]
	Needs improvement	Does not need improvement	Don't know	Priority for improvement
Amount and quality of facilities for children and teenagers	79.2	10.1	10.7	34.2
Street cleanliness (litter and graffiti)	74.7	25.3	0.0	31.7
Quality of public areas (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

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

were stated to need improvement by only 43% and 49% of survey respondents respectively and gathered a very small number of votes in the prioritization 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 Figure 2. The attribute 'street cleanliness' was stated to have the highest effect on the 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 most effective action for encouraging people to move to the local area. Generally, respondents did not believe that 'green routes' and 'improvements to open space' would have much effect on the

Figure 2: Significance of local environmental amenity to improving aspects of the local area (%)



stated outcomes.

4.2 Estimation results

In this section, we report results from the analysis of the data generated from the DCEs and derive mean WTP estimates. We use both MNL and MXL models to estimate taste parameters in the sample of respondents. As discussed above, the enjoyment of environmental amenity is related to the proximity to improvements, and we interact local environmental amenity attributes with the ‘location of improvements’ attribute. We use a set of dummy variables for the location of improvements and estimate three coefficients for each local environmental amenity attribute 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.[17] We expect positive coefficient estimates for all local environmental amenity attributes. For ‘street cleanliness’ and ‘public areas’, increasing the spatial scope of the policy does not reduce the provision of improvements in the Seaham only (L3) area, whereas for all other attributes, spreading the improvements over a larger area would decrease the expected appropriation of improvements. The cost attribute is expected to have a negative impact on the choice probabilities, with increases in council tax reducing respondents’ utility. The status quo ASC reflects the perception

[17] Since we include dummy variables for all the levels of the spatial attribute, we do not estimate the effect of individual attributes separately.

of the currently experienced situation and will thus vary over individual respondents.

Estimation results for the three DCE blocks are reported in Table 3. For both the MNL and MXL models, all coefficients have the expected sign. The MNL model suggests that improvements spread over the largest area (L1) have a small and mostly statistically insignificant impact on choices, and that the status quo alternative is not perceived differently from the other options. However, the goodness of fit measure for the MNL models is low. In contrast, controlling for unobserved heterogeneity in preferences with a MXL specification dramatically improves the explanatory power of the estimation, and all R^2 statistics are at 30% and above. In light of this finding, we focus on the results from the MXL models.

In Block 1, improvements to areas of open space are given no significant utility value if spread over the largest area (L1). We observe significant heterogeneity in preferences for a more focused (L2) provision, so that that at least some respondents would value such improvements undertaken in the wider local area. For local improvements (L3), preferences are statistically highly significant and homogeneous. The 'Derelict properties' attribute is highly valued, and preferences are relatively similar across locations. However, the standard-deviation estimate measuring preference heterogeneity is only statistically significant for the L1 area ($p<5\%$).

In Block 2, improvements to community facilities are valued when proposed in the local (L2 and L3) area, whereas there is little evidence about the value of more diffuse improvement. The largest preference coefficient is the local (L3) interaction, with no statistically significant preference heterogeneity. However, preference heterogeneity is statistically significant ($p<10\%$) for the L2 area. For the 'street cleanliness' attribute, the L1 interaction is not statistically significant at conventional levels, which suggests that some respondents are reluctant for improvements to take place in the larger area that includes other urban agglomerations. However, preference heterogeneity for the L1 interaction is quantitatively large and statistically significant at the 10% level. Preferences for improvements in L2 and L3 areas are highly statistically significant, while the standard-deviation estimates are not.

In Block 3, the value of improvements to public areas is statistically significant for all three locations, and declines as the spatial scope increases. Preference heterogeneity for this attribute is statistically significant for both L1 and L3 levels. However, on average respondents were reluctant to contribute to the provision of improvements outside the Seaham only area (L3). The 'green route' attribute was given the highest value if provided in the L3 area. The L2 interaction is also statistically significant ($p<10\%$), and significant heterogeneity is observed. Finally, the mean coefficient for the provision of green routes spread over the entire East Durham area is not statistically significant, but there is significant preference heterogeneity.

TABLE 3: MNL AND MXL MODEL ESTIMATES (N = 106 RESPONDENTS, T = 4 CHOICES)

Attribute*Location		MNL model Coeff.	(std-err.)	MXL model Mean coef.	(std-err.)	Std-dev.	(std-err.)
Block 1							
Areas of open space	*L1	0.01	(0.02)	0.01	(0.04)	0.01	(0.05)
	*L2	0.04**	(0.02)	0.05	(0.05)	0.21**	(0.10)
	*L3	0.06***	(0.02)	0.14***	(0.05)	0.16	(0.10)
Derelict properties	*L1	0.09***	(0.03)	0.20**	(0.09)	0.36**	(0.16)
	*L2	0.13***	(0.03)	0.37***	(0.10)	0.02	(0.09)
	*L3	0.09***	(0.03)	0.26***	(0.08)	0.02	(0.15)
Cost		-0.03***	(0.01)	-0.15***	(0.04)	0.14***	(0.04)
Status quo ASC		0.12	(0.22)	-3.01**	(1.34)	8.71***	(2.68)
Log-likelihood		-432.0		-296.6			
Pseudo R^2		9.2		36.2			
Block 2							
Community facilities	*L1	0.17	(0.13)	0.50	(0.32)	0.69	(0.81)
	*L2	0.51***	(0.13)	1.02***	(0.39)	1.15*	(0.69)
	*L3	0.44***	(0.13)	1.18***	(0.36)	0.45	(0.63)
Street cleanliness	*L1	0.27*	(0.14)	0.44	(0.36)	1.21*	(0.70)
	*L2	0.34**	(0.14)	1.42***	(0.44)	0.17	(0.49)
	*L3	0.45***	(0.13)	1.25***	(0.38)	1.05	(0.90)
Cost		-0.03***	(0.01)	-0.14***	(0.04)	0.14***	(0.04)
Status quo ASC		-0.10	(0.23)	-4.13**	(1.62)	8.78***	(2.46)
Log-likelihood		-420.6		-292.7			
Pseudo R^2		9.7		37.2			
Block 3							
Public areas	*L1	0.51**	(0.23)	0.80*	(0.47)	1.87**	(0.93)
	*L2	0.69***	(0.22)	1.57***	(0.52)	0.05	(1.27)
	*L3	0.89***	(0.24)	1.98***	(0.59)	1.70*	(0.88)
Green routes	*L1	0.06	(0.07)	0.15	(0.14)	0.43*	(0.27)
	*L2	0.13*	(0.07)	0.27*	(0.14)	0.43*	(0.25)
	*L3	0.12	(0.08)	0.34**	(0.16)	0.18	(0.34)
Cost		-0.05***	(0.01)	-0.14***	(0.03)	0.12***	(0.03)
Status quo ASC		-0.42	(0.23)	-2.54***	(0.75)	4.19***	(0.95)
Log-likelihood		-414.5		-327.2			
Pseudo R^2		11.0		29.8			

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

In sum, the results reveal interesting patterns in taste variations over the spatial scope. Without exception, the coefficients for the largest geographical spread of improvements (L1) are the smallest in magnitude. The experimental design performs well to precisely estimate the attribute*location interactions that have a large impact on respondent choices, and all mean coefficients for improvements in Seaham (L3) are statistically significant at 5% or 1% level. We also observe a tendency for taste heterogeneity to be larger for improvements spread over the larger areas, which can be interpreted as variations in willingness to contribute to public goods outside the immediate local area and the perception of non-use benefits. Conversely, preferences for improvements in the local area feature a higher degree of homogeneity, and none of the standard-deviation coefficients for improvements in Seaham only area are statistically significant at the conventional levels.

Turning to the price variable, all MXL estimates of the mean coefficient are highly statistically significant. Moreover, estimates are of similar magnitude, suggesting comparable trade-offs took place across blocks. Results show significant heterogeneity in attitudes toward the price variable, with standard-deviation estimates highly statistically significant. These results imply that about 15% of the distribution has a negative marginal utility of money. While the existence of price-insensitive respondents is confirmed by verbatim motivations for choices (see Section 4.3 below), we note that if some respondents are very price elastic, the symmetry property of the normal distribution will give rise to a probability mass in the positive domain of the distribution. We also find that the mean estimates for the status quo ASC across the three DCE blocks are negative and significant at either the 5% or 1% level. This indicates that, on average, there is a demand for improved levels of environmental amenity in Seaham and the surrounding area, even at a cost.[18] Preference heterogeneity for the status quo is of both economic and statistical significance.

Given the relatively large standard-deviation for the price variables, the bias adjustment suggested by WTP approximation (3) is quantitatively important. Moreover, simulated WTP distributions feature a high kurtosis, and the occurrence of extreme WTP values makes the mean WTP sensitive to the particular sequence of draws and thus highly instable. In Table 4 we report mean WTP estimates based on the approximation provided in equation (3). Overall, improvements in local environmental amenity are of significant value to the local residents. Moreover, the WTP estimates are of reasonable magnitude, and the valuation of maximum improvements in each attribute is consistent with the prioritization exercise reported in Table 2.

[18] 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 not sensitive to the smallest price level, and preferred improvements over the status quo at this price level.

TABLE 4: AVERAGE MARGINAL WILLINGNESS TO PAY FROM MXL MODELS (£/HOUSEHOLD/UNIT/YEAR)

Attribute	Units	*Location of improvements*		
		East Durham (L1)	Wider Seaham area (L2)	Seaham only (L3)
Areas of open space	ha	0.11 (0.49)	0.59 (0.67)	1.76*** (0.69)
Derelict properties	property	2.54** (1.19)	4.76*** (1.54)	3.29*** (1.11)
Community facilities	additional facility	7.74 (5.51)	15.82** (7.01)	18.33*** (6.97)
Street cleanliness	grade	6.78 (6.19)	22.07*** (8.01)	19.51*** (7.02)
Public areas	–	9.70* (5.75)	19.00*** (6.01)	23.95*** (7.12)
Green routes	km	1.77 (1.66)	3.32** (1.68)	4.08** (1.84)

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

Marginal WTP for improvements spread over the larger East Durham area (L1) is systematically lower than for the proximate and smallest spatial area (L3), with estimated values differing by an order of magnitude. Generally, improvements focused in Seaham (L3) are also valued more than those that are spread within the wider local area (L2). In only two cases ('derelict properties' and 'street cleanliness') are improvements over the latter given a higher value than in 'Seaham only'.

In the largest (L1) area, WTP estimates for two attributes only are statistically significant at conventional levels. First, 'derelict properties' is given a relatively even value across locations. Second, WTP for the 'public areas' attribute is statistically significant at the 10% level for improvements spread across the East Durham area (L1). Since we could expect WTP to be higher than L2 and L3 (recalling that, from their definition, for these attributes the scope of amenity provision increases with spatial coverage of the policy), this implies that Seaham residents, on average, give a negative value to improvements outside the local area. This finding signals competitive motives towards other neighboring urban agglomerations for the appropriation of rival benefits. Finally, WTP estimates when improvements are concentrated in L2 and L3 are all statistically significant at 5%, with the exception of 'areas of open space' which is only statistically significant when implemented in the L3 area. This suggests the proximity to open space is a key driver of economic values, with little associated non-use value.

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 modeling 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 verbatim responses from survey participants as to the motivation for their choices, which are reported in the top part of Table 5. 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 third explicitly chose improvements that were targeted at the local area. Confirming the existence of price insensitive respondents, 7.5% of the sample reported choosing among alternatives "irrespective of their costs". Finally, only one respondent stated he did not understand the choice cards, and none acted based on paternalistic altruist motives.

As a second follow-up to the three DCEs, 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.[19] Around 70% of respondents gave a positive response to the payment principle question, indicating that the large majority of respondents were willing to participate in the hypothetical market. This is also 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 5. 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 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, so that their choices represent motives other than their valuation of local environmental amenities and are not directly relevant for the estimation of welfare measures. The remaining 12% of the sample appear not value the proposed changes at the proposed prices.

[19] 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?". This was then followed by a payment card contingent valuation question to elicit respondent's WTP for maximum improvement in all 6 attributes in the Seaham only (L3) area. Since our focus is the relationship between the spatial scope of the policy and WTP for marginal changes, we do not report results from this question.

TABLE 5: 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*	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*	1.9
Objected to the proposed improvements	0.9
The local council should pay for this*	0.9
The government should pay for this*	0.9
Do not believe these improvements would actually happen*	0.9
The environmental improvements are not important to me	0.9
The quality of the local environment is already good enough	0.9

Notes: *Invalid (protest) motivations in the payment principle question.

In order to assess the impact of these 'invalid' responses on our results, we present results from additional parametric validity tests. To simplify the exposition of the results, 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).[20] While this specification is more parsimonious, requiring the estimation of a smaller number of parameters, it imposes very strong restriction on preferences and it is only applied for the purpose of model comparison and validity testing.

The resulting MXL estimates are reported in Tables 6 to 8. For the baseline model, reported

[20] 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.

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 reported in Table 3. As expected, however, the explanatory power of this model is lower than the formulation using the discrete measure of location.

We contrast those results 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 protest motives, we removed respondents that implicitly questioned the credibility of the exercise, reporting in a follow-up question that they thought it would 'very unlikely' that the proposed improvements would actually occur. A further small fraction of respondents who understood very little and/or did not give serious consideration to responses, 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 value of 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 set of 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 practice individuals could discard some of it. Hence attribute non-attendance can potentially lead to false inference about the importance of certain attributes in observed choices. We measured attribute non-attendance by asking respondents to state the consideration they gave to each attribute in a question at the end of each DCE block. This is termed serial non-attendance by Scarpa et al. (2010). 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 (including the cost) with an 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). We do not find a significant effect for the interaction terms, suggesting no systematic effect on the estimation. The only exception is the price coefficient in block 2, and respondents who did not pay attention to the cost of improvements were, on average, more likely to be price insensitive. Nevertheless, all the taste estimates remain stable when controlling for non-attendance.

Finally, we report two tests focusing on potential order effects. While our experimental design does not allow a complete assessment of the issue, as in Day and Pinto Prades (2010),

TABLE 6: PARAMETRIC VALIDITY TESTING FOR DCE BLOCK 1: MXL ESTIMATES

*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 coeff.	0.02**	0.01**	0.01**	0.01	0.02***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
*Not attended	–	–	0.01	–	–
			(0.03)		
*Order effect	–	–	–	0.01	-0.01
				(0.01)	(0.01)
Std-dev.	0.01	0.01	0.01	0.01	0.01
	(0.02)	(0.05)	(0.03)	(0.03)	(0.03)
Derelict properties					
Mean coeff.	0.05***	0.05***	0.05***	0.05***	0.04***
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
*Not attended	–	–	-0.01	–	–
			(0.07)		
*Order effect	–	–	–	-0.01	0.03
				(0.02)	(0.02)
Std-dev.	0.05**	0.06*	0.05**	0.05**	0.04*
	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)
Cost					
Mean coeff.	-0.10***	-0.10***	-0.10***	-0.09***	-0.10***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
*Not attended	–	–	0.10	–	–
			(0.07)		
*Order effect	–	–	–	-0.01	-0.02
				(0.03)	(0.02)
Std-dev.	0.10***	0.11***	0.10***	0.10***	0.10***
	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)
Status quo ASC					
Mean coeff.	-2.39***	-4.49***	-2.39***	-2.36***	-2.48***
	(0.87)	(1.21)	(0.92)	(0.91)	(0.95)
Std-dev.	6.27***	5.56***	6.07***	6.22***	6.15***
	(1.32)	(1.40)	(1.31)	(1.38)	(1.26)
Log-likelihood	-307.0	-222.0	-305.7	-306.4	-305.5
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

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

TABLE 7: PARAMETRIC VALIDITY TESTING FOR DCE BLOCK 2: MXL ESTIMATES

*Attribute**Interaction	Linear MXL model (I)	Valid choices (II)	Attribute attendance (III)	Block order effect (IV)	Task order effect (V)
Community facilities					
Mean coeff.	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)
Std-dev.	0.13	0.21**	0.14	0.13	0.10
	(0.10)	(0.10)	(0.10)	(0.11)	(10.26)
Street cleanliness					
Mean coeff.	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)
Std-dev.	0.11	0.19	0.12	0.09	0.11
	(0.10)	(0.12)	(0.11)	(0.12)	(0.11)
Cost					
Mean coeff.	-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)
Std-dev.	0.11***	0.12***	0.11***	0.11***	0.11***
	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)
Status quo ASC					
Mean coeff.	-3.48***	-4.82***	-3.64***	-3.66***	-3.55***
	(1.09)	(1.18)	(1.06)	(1.10)	(1.09)
Std-dev.	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
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

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

TABLE 8: PARAMETRIC VALIDITY TESTING FOR DCE BLOCK 3: MXL ESTIMATES

*Attribute**Interaction	Linear MXL model (I)	Valid choices (II)	Attribute attendance (III)	Block order effect (IV)	Task order effect (V)
Public areas					
Mean coeff.	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)
Std-dev.	0.30**	0.21	0.02**	0.32**	0.29**
	(0.14)	(0.17)	(0.09)	(0.14)	(0.14)
Green routes					
Mean coeff.	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)
Std-dev.	0.04	0.04	0.02	0.05	0.02
	(0.07)	(0.07)	(0.10)	(0.06)	(0.08)
Cost					
Mean coeff.	-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)
Std-dev.	0.10***	0.09***	0.10***	0.10***	0.10***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Status quo ASC					
Mean coeff.	-2.41***	-2.97***	-2.39***	-2.48***	-2.42***
	(0.56)	(0.59)	(0.54)	(0.57)	(0.55)
Std-dev.	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
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

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

we use a set of indicator variables to parametrically estimate potential differences in tastes at different stages of the exercise. For the first test of ordering effect, which assesses systematic differences in the mean taste estimates during the first DCE exercise, we identify respondents who saw each block as the first DCE exercise during the interview. We then interact each attribute with a dummy variable equal to one to if a particular choice was made as part of the first DCE exercise. Column (IV) reports estimates for the block order effect test. None of the interaction terms measuring systematic differences in the mean valuation are statistically significant at conventional levels. Generally, the mean taste coefficients remain relatively stable when controlling for the order effect, although there is a weak tendency for the mean preference for improvements to decline and the sensitivity to the price to increase once controlling for the order effect.

The second test of ordering effects focuses on the repeated choice tasks. For this purpose, we identify the first choice tasks presented to respondents among the four choice tasks, and interact a dummy variable for these choices with each attribute. Column (V) report results on the task order effect test. We find that the 'order effect' interaction terms have a statistically significant negative impact on the valuation of the 'derelict properties', and on the price attribute in 'Block 2', so that respondents were more averse to increases in the price. We also note a tendency for preferences inferred from the first choice of a sequence to be less pronounced for improvements and more sensitive to the cost attribute. But as for the block order effect, the mean preference coefficients are stable, and a consistent order effect is not evident, suggesting that our key qualitative conclusions are robust.

5 Concluding remarks

There exists a large body of evidence that local environmental amenity improvements are valuable to residents, although few studies have been undertaken in the context of regeneration initiatives. Given the nature of these benefits and the familiarity of resident with their local environment, we argue in favor of the use of carefully tailored stated preference surveys to quantify their monetary values. In this paper, we have assessed preferences for a set of local environmental amenity improvements using a series of the discrete choice experiments. Overall, the survey instrument was well received by the respondents and generated internally consistent choices. The validity tests undertaken provide evidence that a large majority of respondents engaged in the hypothetical markets and were consistently sensitive to the cost of improvements. The DCE approach thus provides a flexible tool to study the value of local environmental amenities that may not be identified within market transaction data.

Our results indicate significant benefits of improved local environmental amenity, but we find significant variations depending on the type and spatial scope of improvements. Over the range of improvement considered, restoration of derelict properties and improvement to street cleanliness were the most highly valued attributes. The analysis of follow-up questions suggests that these attributes are associated with improving 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 analysis also contributes to the growing literature on the spatial aspects of environmental policy by controlling for the spatial scope of improvements. As well documented in the literature, expected proximity to improvements is a key driver for observed choices, but we find significant heterogeneity in preferences for the provision of improvement over a larger spatial area. This suggests important variations in the importance of non-use (altruistic) motives in individuals' decision-making. Moreover, we find some degree of competitive behavior for the appropriation of environmental improvements, which can be explained by the prospects of attracting new businesses to the local area. From a resource allocation perspective, this implies that investments in local environmental infrastructure of distinct administrative units are strong complements rather than substitutes.

Methodologically, our results demonstrate that a carefully crafted experimental design can allow precise inference from a relatively small sample. We note however that a large number of individual observations would be required for a comprehensive investigation of the shape of preference distributions. In our setting taste heterogeneity is found to be important in relation to the spatial scope of improvements. The structure of heterogeneity is also crucial in the presence of price insensitive respondents which do not trade-off improvements against their costs. Given the RUM assumptions, these respondents are mechanically attributed an infinite WTP. We have argued in favor of the inclusion of these respondents in a utility-space analysis, and propose an analytical expression to approximate the mean WTP in the presence of preference heterogeneity. This avoids the problem of unstable WTP simulations, and thus improves the robustness of the mean WTP estimates. Importantly, the issue of price insensitivity and unidentified individual WTP also arises in the WTP-space analysis, since a non-zero price responsiveness is needed to scale the individual utility function. A more comprehensive analysis of this issue is left for future research.

Finally, our analysis suggests at least two additional directions for future research. First, our approach could be extended to provide further evidence on the importance of spatial considerations in economic values. This could be achieved, for example, by administering a similar survey at different locations, and comparing estimates derived from different sub-sample locations. The aim would be to quantify how the location of residence (e.g. densely populated urban areas versus smaller towns and rural settings) affects the perception of improvements implemented locally or over a wider area. Second, our results also suggest that further research should be conducted on ordering effects in DCEs. While we mitigate these through randomization procedures and 3-option choice tasks, our validity testing suggests that there is some dependency of choices across blocks and choice tasks. Thus although we find that the effects are of small statistical and economic significance, robustness of the estimates could be improved by a better understanding of the source of such discrepancies.

Appendix 1: Discrete choice experiment attribute descriptions

Improvements to areas of open space (DCE block 1)

Improvements to areas of open space such as parks and greens:

- These are areas of grass and open space that people can use for activities such as walking, dog-walking, picnics, sunbathing and informal games.
- Improvements include repair of paths and fences, etc., and more frequent removal of litter and upkeep of grass and planted areas (e.g. regular cutting).
- Open spaces in Seaham include parks in Dawdon, Deneside, Parkside and Seaham Town Park. In total these cover about 15 hectares. There are also other areas such as fields and greens around housing areas.

Derelict properties restored (DCE block 1)

Improvements to the local environment that restores derelict buildings and land to improve the visual appearance of built up areas:

- Derelict buildings include houses, business properties and other areas of land that are empty or abandoned and are not being looked after.
- Properties will be restored to their previous use, e.g. a house or shop.

Amount of outdoor community facilities (DCE block 2)

Improvements to the local environment that increase the amount of outdoor facilities available. These are areas that people use for certain activities, such as:

- Play areas for children and other facilities for young people such as skateboard parks. In Seaham there are 3 play areas.
- Sports pitches for activities such as football, rugby, etc. In Seaham there are 4 sites with sport pitches.
- Allotments and community gardens for growing vegetables and plants. In Seaham there are 9 allotment sites.

Street cleanliness (DCE block 2)

The amount of litter, fly-tipping, chewing gum and fallen leaves on streets, and the amount of graffiti and fly-posting on buildings. Street cleanliness is graded A to D:

- Grade A: very little litter etc.
- Grade B: mostly clear of litter etc.
- Grade C: some litter etc.
- Grade D: lots of litter etc.

Improvements to public areas (DCE Block 3)

Improvements to public areas such as town squares, pedestrian streets and promenades:

- These are open spaces in built up areas that are for the use of the general public.
- Improvements include new paved areas, benches and features such as fountains.
- Public areas in Seaham include the town centre and Church Street and the seafront promenade.

Green routes (DCE Block 3)

Improvements to the local environment that increase the amount of walking or cycling paths that avoid busy roads:

- Green routes provide access to other areas along paths that are bordered by trees and other plants (and are not alongside roads).

There are approximately 2.5 km (1.5 miles) of green routes in Seaham.

Location of improvements (All DCE blocks)

Improvements to the local environment may be made in:

- Seaham only: all improvements will be in Seaham.
- Seaham and the wider local area: improvements will be spread across the local area including places such as Murton and Easington.
- East Durham area: improvements will be spread across the entire East Durham area, including places such as Peterlee and Hartlepool.

Cost (All DCE blocks)

Improvements to the local environment will be paid for by council tax. Payments will ensure that the improvements are maintained and continue to be provided each year. Payments are additional – i.e. on top of – current council tax payments.

Appendix 2: Sample representativeness

The tables and figures below provide descriptive statistics on the socio-economic and demographic characteristics of the survey sample. Where possible comparable statistics are provided for the population of North-East England.

TABLE 2 1: SAMPLE AGE PROFILE

Age group (years)	Survey sample N	%	North-East Region (%)
18 to 24	11	10.4	12.0
25 to 44	39	36.8	31.9
45 to 59	22	20.8	25.1
60 and over	34	32.1	31.0

TABLE 2 2: LENGTH OF TIME RESPONDENT HAS LIVED IN SEAHAM

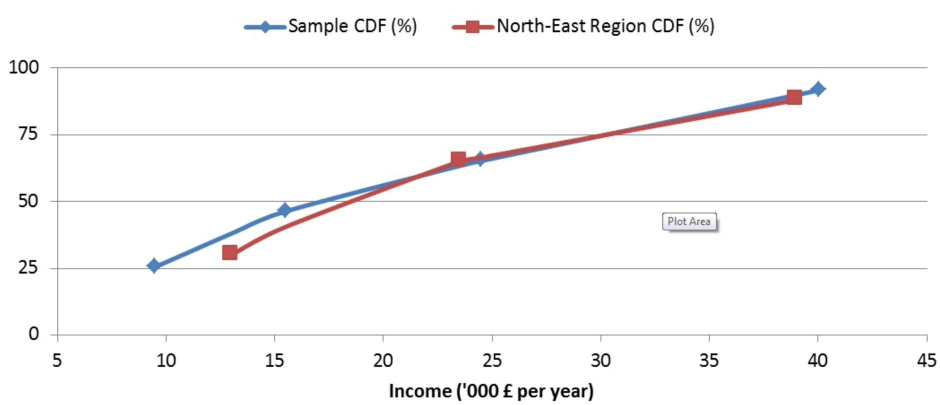
	N	%
Less than 1 year	2	1.9
1 – 2 years	3	2.8
2 – 5 years	6	5.7
5 – 10 years	4	3.8
10 – 20 years	6	5.7
20 – 30 years	24	22.6
More than 30 years	61	57.5

Table 2 3: Amount that the household pays in council tax

	n	%
Do not pay council tax	10	9.4
Less than £1000 per year	11	10.4
£1,000 – 1,250 per year	24	22.6
£1,250 – 1,500 per year	33	31.1
£1,500 – 1,750 per year	5	4.7
£1,750 – 2,000 per year	4	3.8
£2,000 – 2,500 per year	4	3.8
More than £2,500 per year	1	0.9
Don't know	14	13.2

Average council tax in the sample: £986
Average council tax in North-East of England: £1,036

Figure 2 1: Comparison of regional and sample annual household pre-tax income



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