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THE ROLE AND USE OF URBAN OPEN SPACE: HYPOTHETICAL ALTERNATIVES AND THE STATUS-QUO

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ABSTRACT

Although many cities have guidelines as to the quantity of green open space that should accompany residential development, there is less guidance on the type or quality of these spaces. The study uses a choice experiment approach to determine whether green space can be valued on the basis of its constituent characteristics and, if so, what characteristics are preferred. The results indicate that preferences vary depending on whether the green space in question is a small local park or a larger regional park. However, where a base alternative of usual park destination in included in the analysis, the results are affected by collinearity and the actual availability of relevant green space attributes in these destinations. A mixed logit approach is used to tease out this effect from the underlying preference values.

INTRODUCTION

Green open spaces (parks, country parks, nature reserves and landscaped public open space) provide an important contribution to quality of life. Such spaces act as recreational resources, peaceful retreats from the city, attractive backdrops to urban development, safe and exciting play areas for children and reserves for urban wildlife. Nevertheless, like many public goods, green space can be taken for granted. Although there are examples of successful participation of local people in green space management, the design and provision of green space is typically the preserve of municipal parks departments and landscape architects. Typically, local residents only become actively involved in park management when issues of public safety arise, when maintenance has greatly deteriorated, or when a green space is threatened by redevelopment. Furthermore, as the public authorities do not receive any significant income from green space, they must budget for its maintenance along with other municipal responsibilities such as education or roads. Much green space is therefore sustained by low maintenance regimes or continues to exist in a form that risks becoming less relevant to modern lifestyles.

The current study

The study set out to determine what types of urban green space people most prefer. Dublin was selected as a case study, although we would argue that the findings and methodology have relevance to other locations even though underlying preferences are likely to be specific to individual cities or cultures. A choice experiment was applied to examine whether these spaces can be valued in terms of their component attributes. This method can also be used to determine if these values can be converted into a monetary measure for the purposes of a cost benefit analysis. For the study to be manageable, it focused on the *use* of green space rather than the indirect benefits of green space supplies such as wildlife habitat, flood management or noise/ pollution mitigation.

In addition, the study sought information on whether people value variety, whether they would value different types of green space to that with which they are currently familiar, and whether these values are held uniformly within the population. A further issue, given development pressure within Dublin, is whether the remaining quality of green space can compensate for the loss of quantity of open spaces to new higher density residential development.

Context

The Irish Government has no specific policy in relation to the composition of green space and parks. Instead, guidelines have been issued over the years on the amount of green space that should be provided with any new development. These guidelines do not extend to the design or character of a green space.

From the mid 1990s, Ireland has been experiencing a period of rapid economic growth that has allowed living standards to catch up with those of other EU member states. This has brought about a changing social context that has included higher living standards, increased in-migration, greater ethnic diversity and more female participation in the workforce.

Hours worked are now amongst the highest in Europe (ILO, 2003). Consequently, a greater premium has been placed on leisure time than before and many people are becoming engaged in active pursuits such as walking, cycling, jogging and water sports, in addition to the more traditional field sports that have been accommodated by guidelines in relation to park size and user catchments. In this context it is not surprising that the impression obtained from newspaper

articles and letters is that green space is highly valued by Dubliners. However, this remains only an "impression" as no detailed published survey has ever been carried out.

In addition, Dublin has experienced a considerable amount of residential expansion, particularly in its outer suburbs. Although designated parks are safe from development, much privately owned green space and other undeveloped land has a considerable opportunity cost value which has attracted the attention of developers. An accompanying issue within planning circles, is that government guidelines require too much open space to be set aside with any new development. The subsequent maintenance obligations then place a strain on local authority resources. Lack of resources is one reason that there are rather few facilities such as toilets, cafes or quality tennis courts and, at least until recently, few quality play areas for children. Arguably, the historic absence of quality facilities contributes to a public lack of awareness of what could be provided. It may also contribute to a corresponding low level of use of green spaces by many people which appears to justify some planners' arguments that there is too much open space. The research questions are therefore, a) how do Dubliners value their existing open spaces relative to alternative provision, and b) whether they values these spaces above fewer higher quality open spaces?

Approach

In the current study, people were asked if they would value additional features that could be regarded as providing additional quality. The question therefore arises of how "quality" is to be defined? One might anticipate that people's valuation of improved green space might attract less interest or lower values than a potential loss of green space could evoke. Indeed, psychologists, for example Thaler (1992), have left their mark on environmental valuation by countering economic theory with empirical evidence that people value losses more than they value gains.

The challenge was to solicit values for enhancements of green space compared with what exists already. For green space, much of the existing international economic research has been in the form of hedonic pricing studies which have inferred the value of green space from local property values. However, the benefits that tend to be identified in these studies are not use related, but are rather ones that have a structural link with property values, such as views, neighbourhood character or protection from further development (see Crompton 2001).

Use values are difficult to pin down. Different people value park use for different reasons. In addition, the same people value parks for different reasons at different times. Context is important. People visiting a park with children will obviously have different motivations for using a park compared with occasions when they visit on their own. There are also socio-economic factors. People living in more disadvantaged parts of a town may have different preferences and needs to those living in more affluent suburbs. Indeed, perceptions of the attributes of parks often depend on the characteristics of their surroundings. What could be a pleasant wooded park in an affluent part of town, becomes a more threatening place if located in a more marginalized neighbourhood.

The principal methodology selected for the study was choice modelling or choice experiments. This method relies on a stated preference questionnaire in which people are confronted with alternative products that are described by their respective characteristics or attributes. They are then requested to *choose* a single alternative by mentally trading off these attributes. Each alternative's constituent attributes are varied substantially on the basis of an orthogonal statistical design so as to allow a subsequent estimation of an independent marginal value free of the

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collinearity between attributes that can occur in reality. Collectively, questionnaire responses supply an indication of the odds of selecting a composite alternative based on a particular attribute level.

In principle, attributes can be packaged into particular products, for instance to provide a value for different types of parks. It is also possible to investigate the interactions that exist between attributes and between type of user and type of park. In this way, choice experiments can be used to explore some of the values and motivations of different subsets of people, including, for instance, interactions between perceived levels of personal security, naturalness and the built environment.

Despite the versatility of choice experiments, it is an open question as to whether people can disaggregate the value they attach to environmental goods to the level of their component attributes. It might be true of recreation scenarios where choice experiments have previously been used (Adamowicz, Louviere, & Williams 1994; Hauber & Parsons 2000). However, it is less clear that people value green space in this fashion. Certainly, users of green space will have certain expectations such as the presence of attributes like play facilities, paths or seating. On the other hand, green space may be valued in its entirety or for subtle reasons that cannot be easily captured by attributes. Green space might be valued for personal recollections and memories, or in relation to vicarious values associated with the needs of the wider community.

Choice experiments do, though, have the merit of replicating many real-life situations in which people can only choose to consume one product or another. Trade-offs are an inevitable fact of life. The relative value of attributes which emerges from these trade-offs supplies practical information of preferences to park managers and administrators faced with managing specific elements within a limited budget. The fact that the scenarios used in the questionnaires are not restricted to the current environment, means that they can also be used to assess public reactions to potential attributes that are not currently available.

In the current study, other approaches were used to complement the choice methodology and to provide additional data through which to interpret the results. Focus groups were used at the outset of the survey to collect qualitative data in relation to the values people hold for parks and for the purpose of refining the attribute definitions to be used in the choice experiment. A factor analysis survey of 200 park users was also used both for attribute selection and to examine the perceived benefits of a much wider range of attributes than could feasibly be included in choice experiment.

Methodology

The choice experiment method provides considerably more data than would typically be available to a researcher using hedonic pricing or applying a travel cost approach to a single site. The method also has advantages over the main alternative stated preference approach of contingent valuation in that the risk of strategic or hypothetical bias, while not eliminated, is reduced (Bristow & Wardman 2004). It is also arguably easier for a respondent to choose an alternative than to overtly express a willingness-to-pay, especially for environmental goods. In common with contingent valuation, however, there is still the challenge of finding a meaningful payment vehicle if values are to be quantified in monetary terms, particularly the more divorced the good is from the market.

An assumption of continuity of preferences is fundamental. This allows us to assume substitutability whereby consumers are able to make trade-offs between goods (Freeman 1993). Although green space is a discrete good, rather than continuous good, it is still comprised of attributes between which continuous substitution is technically possible. On the basis of a change in the level of any one attribute, an individual can switch from visiting one green space to another. This decision can be represented by a value of 1 or 0 depending on whether the good is selected or not.   However, because maximisation of utility take a 'corner solution', no demand curve can be estimated (Ben-Akiva & Lerman 1985).

The algebra behind the choice decision has been presented on numerous occasions elsewhere in the literature (for example Alpizar et al. 2002). In short, the individual makes only a single discrete choice where the indirect utility provided by one good exceeds that of another, namely

$$V_i(x_i, y\text{-}p_i x_i) > V_j(x_j, y\text{-}p_j x_j) \qquad \forall_{i \neq j}$$

where x_i represents a single alternative represented by profile i of generic and alternative specific attributes, x_j is the vector of alternative goods, and p_j is the price associated with each complete profile.

The equation forms the basis for the model of discrete choice and the calculation of economic welfare estimates. To become a predictive model, however, an allowance must be made for random utility. Stated preferences can still differ from those that are made in reality, depending, for example, on the mix of objective attributes, but also perceptual attributes. Other opportunities for error to creep into the model include heterogeneity of preferences, measurement error, specification error and unobservable factors such as relevant attributes that have not been included in the choice experiment. The analyst cannot control for all of these factors, so utility is taken to be a random function comprised of a deterministic part and a stochastic part. As the error cannot be observed, it is instead necessary to make assumptions about its probability distribution. The usual decision is to select a linear additive functional form in which

$$U_i = V_i + e_i$$

The equation presents utility as consisting of one part that is common to all individuals and another that is individual specific. This facilitates a workable model which can combine the probability of an outcome with a function that relates the utility of each alternative to the attributes of which it is comprised (Louviere et al. 2000).   This framework for linking the deterministic model with a statistical model of behaviour is provided by the random utility model.

$$P(i) = P\{V_i(x_i) + e_i > V_j(x,) + e_j\} \text{ all } j \ \forall_{i \neq j}$$

Although e_i and e_j cannot be observed, the odds of choice are estimated on the probability (P) that this difference is less than the probability that $[V_i(x_i) - V_j(x_j)]$.

Multinomial logit (MNL) is typically applied to estimate the probability. This approach does, however, rely on restrictive assumptions, namely that the random elements of each alternative are each independently and identically distributed (IID). The assumption of constant error variance has the further implication that it leads directly to the property of independence of irrelevant alternatives (IIA) which requires that the odds of choosing between any two alternatives are unaffected by the presence of any third alternative in the choice set.

Study Design

The selection of attributes and the decision of how many attributes and choice sets to include in the survey is a compromise between the number and relevance of each attribute, the complexity of the choice experiments for respondents, and design complexity. In the event 500 people were interviewed, each of whom were presented with eight separate choice sets. To facilitate the exercise, respondents were asked about parks as most of the accessible green space in Dublin is represented by public parks.

An interest in attribute interactions restricted the design to eight park attributes represented at between two and four levels of provision. Some researchers, e.g. Kanninen (1993), have recommended the use of just two attribute levels. However, in the context of green space, it was felt that to have restricted the experiment to just two attribute levels would have misled respondents by failing to describe the range of attributes typically found in parks. It would also have provided insufficient information for park managers as well as making it more difficult to identify interactions. In the event, the experiment was restricted to the following attributes and levels (in parentheses) which the preceding focus groups and factor analysis had indicated to have most influence on park use. Each attribute was described in detail in advance of the choice exercise.

Size (2) = small local park, large regional park
Maintain (2) = light maintenance, intensive maintenance
Trees (3) = few trees, scattered trees, woods and meadows
Water (3) = shallow pond with paved banks, natural-looking pond/lake, riverside
Play Facilities (3) = no playground, small playground, adventure play facilities
Walking Facilities (3) = few paths and seating, plenty surfaced paths and seating, … nature trails
People (3) = typically few people around, mixture of quiet and busy areas, tends to be busy
Journey Time (4) = 5 min walk/2mins by car, 15 min walk/10 mins by car, 45 min walk/20 mins
                    by car, 1 hour by car.

A challenge with all environmental valuation is to find a price attribute through which the coefficients on attributes can be transformed into monetary values. In this case, no meaningful price attribute exists in that parks are generally funded as an unattributed part of central government grants to local authorities. Instead, journey time was used for this purpose as previous local authority surveys have shown that this factor exerts most influence on visitation. Time, including leisure time, has an opportunity cost that must be traded off in relation to the utility that is provided by the park attributes.

Each attribute was given a reference level. This has the advantage of linking parameter estimates to a meaningful base level for the purpose of estimating utility. Parameter coefficients represent the odds of choosing one attribute level over the base level. They also indicate the relative utility provided by each attribute level. In a linear model, marginal rates of substitution between attributes can be estimated simply by dividing one parameter value by another.

Focus group interviews had suggested that the attribute *Size* provided a cue as to the type of facilities likely to be found in such a park. Separate designs were therefore selected for a) two pairs of choice sets which presented a choice between two 'small local parks', b) two choice sets of 'large regional parks', and four choice sets presenting a mixture of both local and regional parks. In order to free subsequent parameter estimates of interactions, a large proportion of the full factorial set of potential attribute combinations was selected. The full set of possible profiles

was reduced by strategies that including eliminating aliases and the use of Latin Squares. This left 978 unique individual profiles in the case of small and large parks, and 1,296 profiles in the case of the mixed combination.[1] Attribute levels were independent of one another with the exception of *Size* and *Journey Time* where an interaction naturally exists in that regional parks are typically located at greater distance from most users.

Two choice questions were asked at the foot of each choice set. The first of these asked respondents to choose between the two hypothetical parks and a base of "not go/do something else". The second question asked respondents to rank the hypothetical alternatives in relation to their usual park destination (the status-quo). The attribute mix of each respondent's usual park had been defined through an earlier question in which respondents had been asked to describe their usual park in terms of the same attributes used in the choice experiment. That respondents should be asked to describe the existing alternative in terms of their perception is an approach that has been recommended by Hoehn and Randall (1987). For both questions, respondents were asked to consider that all non-represented attributes were the same as in their usual park.

Results

Common trends are apparent through each analysis of the local parks, large parks, mixed sizes, and combined datasets. In each of these, children's *Play Facilities* attract high significant coefficients, generally followed by the attribute *Walking Facilities* and *Maintenance* and the attribute level *mixture of quiet and busy areas*. In each model, *Journey Time* has a negative coefficient as would be expected.

First choice question

In the case of the choice between local parks, quality appears to be represented by higher levels of *Play Facilities* and *mixture of quiet and busy areas*. These attribute levels have significant positive coefficients, whereas *woods and meadows* and *natural-looking ponds* attract negative coefficients. By comparison, in the case of the choice between large regional parks, *adventure play facilities* and the higher level of *Walking Facilities* that includes trails, attract much higher significant coefficients. For regional parks, though, *woods and meadows* and *natural-looking lakes* attract small positive coefficients while *Journey Time* assumes a smaller negative coefficient.

It interpreting these values, it is possible to imagine a situation in which adventure play facilities, trails, natural lakes and woods would be more familiar constituents of larger parks, whereas the presence of a natural-looking pond in a local park could imply a potential danger to children. In addition, it would appear that where the choice is between one large regional park and another, users are less discouraged by journey time than they might be for a local park. Perhaps users accept that a journey to a large regional park is a dedicated expedition that they might usually be performed at weekends, whereas local parks are expected to be conveniently nearby.

An alternative model is available for the second group of four choice set. In the 'mixed' dataset respondents were asked to compare both local and regional parks. In this model, the higher level of *Walking Facilities* attracts the highest coefficient. Firm negative coefficients apply to *park can be quite busy* and *woods and meadows*. Size now becomes an attribute in itself, but *large size* attracts a negative value due to the association between large park and greater *journey time*. This

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[1] Thanks are due to Dr. David Elston of BioSS, Aberdeen, for his assistance with the factorial design.

latter effect cannot be removed by including a specific *Size/Journey Time* interaction, but rather through the effects coding of the four levels of *Journey Time*. In this case, journey times in excess of 15 minutes attract increasingly large significant negative coefficients, demonstrating the substantial influence that journey time has on decision to visit.

Second choice question

The second question following the choice sets asked respondents to rank the two hypothetical parks compared with their usual park. The question can be analysed both as a rank or first choice response. The distinction of the second choice question is the inclusion of the usual park alternative. On the one hand, this provides a more meaningful alternative than that of 'not go/do something else' (which was selected by few respondents in choice question 1). On the other hand, this third alternative is not comprised of orthogonal attribute combinations. Consequently, there can be a degree of collinearity in the existence of some attributes within particular park types. For example, regional parks may contain a mix of higher quality facilities for a larger catchment population. There is also be a problem of restricted attribute availability in that desirable park facilities are often not available in smaller parks even though such a park may be the respondent's usual destination.

In the case of this second choice question, model fit is much improved for local, regional and mixed local/regional parks. Significant positive coefficients apply to the main attributes, including here *Large size*. *Natural ponds/lakes* and *wooded areas* now attract negative coefficients.

Table 1 Mixed data set: Second choice question with usual park as a third alternative

	CHOICE ANALYSIS		RANK	
Parameter	Coefficient	Significance	Coefficient	Significance
Large Size	.283**	.0000	.282**	.0000
Higher maintenance	.184**	.0000	.197**	.0000
Woods & meadows	-.050	.4804	-.065	.1909
Scattered trees	.183**	.0007	.159**	.0000
Riversides	.042	.4344	-.004	.9155
Natural-looking pond/lake	-.147**	.0187	-.172**	.0000
Adventure play park	.306**	.0000	.240**	.0000
Conventional playground	-.034	.5295	.019	.6384
Paths, seating & nature trails	.008	.9160	.041	.4134
Paths and seating only	.210**	.0001	.113**	.0031
Park can be quite busy	.042**	.4634	.019	.6739
Mix of quiet and busier areas	.226**	.0000	.250**	.0000
Journey Time	-.035**	.0000	-.034**	.0000
Size*journey time interaction	-.015**		-.011**	.0000
Log-likelihood (1)	-1460.81		-1565.89	
Log-likelihood (0)	-2001.67		-1973.11	
ρ^2 (adjusted)	.267		.211	

A further advance is model fit is achieved by including alternative specific constants. This captures the effect of non-represented attributes, reducing their influence on the coefficients for those attributes included in the model. However, their inclusion does not reflect the value of a

clear alternative in that, for the sample as a whole, usual park choices are comprised of many different actual destinations. In this case, the negative value for the hypothetical alternatives A and B indicates an overall preference for the status-quo. Indeed, a majority of respondents (60%) preferred their usual park destination to the hypothetical alternatives.

An alternative rank model of the second choice question can be analysed through the transformation of the responses into sequential choice data for analysis by MNL. Although it has been argued that ranks may provide inconsistent estimates of utility in that respondents could apply different decision protocols to each rank level (Ben-Akiva et al. 1992), there is less risk of such in this case in that the number of ranks is limited to just three levels. The ranks also provide additional information on the value of the discarded alternatives (Hensher 1994). Indeed, this additional data reduces the effect of collinearity arising from the usual park alternative.

Table 1 shows that the same attributes in both the choice and rank models are significant. The negative coefficients on *woods and meadows* are less than for the former models without the usual park alternative, possibly because woods are a feature of the larger Dublin parks that form many respondents' usual destinations. Probably for the same reason, the attribute level *park can be quite busy* attracts a positive coefficient, while *riversides* attract a low or negative coefficient because there are currently few parks with such a setting.

The effect of the usual park alternative

The inclusion of a status-quo choice is often recommended in that it provides a more meaningful choice comparison in that most real decisions have a status-quo alternative. However, it does introduce collinearity and issues of actual attribute availability into the model. It is also unclear whether the status-quo choice is genuine or a reflection of the some respondents ignoring the request to treat non-represented attributes in the hypothetical profiles as being the same as their usual park. In addition, respondents may have simply found it less demanding to select usual park over alternatives A or B in response to a demanding exercise (Ritov & Baron 1992; Samuelson & Zeckhauser 19).

Given the prevalence of the choice of usual park, it is possibly not surprising that a model based exclusively on revealed preference is unsatisfactory. Earlier in the questionnaire, respondents had been asked to indicate their first, second and third actual park preferences. In principle, it might be expected that a revealed preference model could perform well given that it is based on real choices. A rank model appears to perform reasonably well, though it is evident that there is a high degree of collinearity between attributes given that similar park types contain similar attributes. Low variability in the data also means that ρ^2 appears misleading good, but that parameter values are difficult to interpret. Estimation of a joint revealed/stated preference model is possible too by equalising the difference in scale between the two datasets (Ben-akiva & Morikawa 1990; Hnsher & Bradley 1993), but the result is poor due to the absence of meaningful alternative specific constants and the varying decision contexts.

As an alternative, it is interesting to examine the nature of respondents who were most likely to choose the status-quo alternative in the stated preference exercise. For instance, over 25% of regular park users chose the status-quo alternative in all eight choice sets, whereas irregular users were as likely to choose the hypothetical alternatives as the third alternative. Individuals from more affluent social classes were also more likely to choose the status-quo alternative as were people in older age groups. However, there is no clear evidence of lexicographic preferences in relation to any one attribute.

An analysis of the subset of the data for regular users indicates that these respondents place a high value of good facilities and quieter areas. However, this again could be due to the influence of collinearity or actual attribute combinations. Instead, it is possible to examine a model only for those individuals who chose either alternative A or B. in this case, model fit is good and *natural-looking lakes* attracts a high coefficient.

Table 2 Model of those respondents who selected only alternative A or B

Parameter	Coefficient	Significance
Large Size	.139**	.0015
Higher maintenance	.338**	.0360
Woods & meadows	-.150**	.1050
Scattered trees	.192**	.0358
Riversides	.346*	.1003
Natural-looking lake	.852**	.0850
Adventure play park	.336**	.0000
Conventional playground	.327**	.0025
Paths, seating & nature trails	.115	.0001
Paths and seating only	-.231**	.0050
Park can be quite busy	.014**	.0156
Mix of quiet and busier areas	.123**	.0000
Journey Time	-.043**	.0000
Large size * journey time	-.001**	.0001
Log-lik (1)	-1135.95	
Log-lik (0)	-1579.80	
ρ^2 (adjusted)	.277	

Mixed logit analysis

A weakness of analysis based on MNL and its dependence on an assumption of independence of irrelevant alternatives (IIA) is that results only indicate average preferences. For example, in his valuation study of agricultural landscapes, Bergland (2001) finds that heterogeneous preferences are rather large and dominate other factors. It can be expected that green space preferences, and therefore choices, would differ substantially across the sampled population. Any failure to describe this variation would mean that the model would be providing a poor explanation of behaviour. Only by examining differences between population subsets, as above, can variations in preferences be observed. However, this reduces the size of the dataset and requires that the variation can be identified from population characteristics.

In addition to heterogeneous preferences, error can also arise due to factors that have only been partially observed by the researcehr, or which have been subject to measurement error or functional misrepresentation (Manski & Lerman 1977). This, in turn, can be reinforced through poor mental accounting, habit formation or motivational effects (Hensher et al. 1998).

A random parameters, or mixed logit, formulation is an alternative approach that can be used to account for varying tastes amongst respondents, including attitudes to the status-quo. Mixed logit adopts an extreme value distribution which relaxes IIA, effectively disengaging IIA from the IID distribution (Louviere et al. 2000). Examples are provided by Ben-Akiva and Bolduc (Ben-akiva & Bolduc 1996, Revelt and Train 1998) and Brownstone *et al.* (2000).

Formally, a description of the mixed logit model can begin with the familiar utility function below for individual n and alternatives j.

$$U_{nj} = \beta_n x_{nj} + e_{nj}$$

The parameter β represents the tastes of each individual and cannot be observed. Instead, it varies across the sampled population on the basis of a probability density function xxx where xx represents the parameters of the distribution which have to be estimated. The true error that remains is IID extreme value and independent of both β and x.

Conditional on β, the probability that individual n chooses alternative i is standard logit.

$$L_{ni} = \frac{e^{\beta n X n i}}{\sum_j e^{e^{\beta n X n j}}}$$

The unconditional probability, though, it the integral of the conditional probability, i.e. the logit formula L_{ni}, estimated for the various values of β_n (Revelt & Train 1998). This is weighted by the parameters of φ, namely the mean and covariance, i.e.

$$P_{ni} = \int L_{ni}(\beta_n) f(\beta_n | \varphi) \, d\beta_n$$

Where utility is of the form:

$$P_{ni} = \int \left(\frac{e^{\beta' x n i}}{\sum_j e^{\beta' x n j}} \right) f(\beta_n) d\beta_n$$

The two relevant sets of parameters are the varying tastes of the population, β, and those that describe the density of this distribution, φ. The "mixed" element of the function derives from the combination of the logit estimates for selected levels of β with the mixing distribution provided by $f(\beta | \varphi)$.

Among unobserved parameters will be those which are choice invariant due to characteristics such as social class or gender. These elements can now be identified in that they are correlated within the choice sets completed by individual respondents.

Practical use of mixed logit necessitates simulation which is used to approximate the probability by estimating the simulated log likelihood function for repeated draws of β on the basis of selected valued of φ. These simulated probabilities are then inserted into the likelihood function

$$\text{Sum } LL = \sum_{n=1}^{N} \sum_{j=1}^{J} d_{nj} \ln P_{nj}$$

Application of mixed logit to the survey data

A mixed logit analysis of the second choice question provides evidence of heterogeneity of preferences in relation to timing of visits and family composition on the attribute *Play Facilities*. Interestingly, mode of travel has the effect of reducing the significance of *Journey Time* which had been a highly significant variable in all previous models. This suggests that superior play facilities have an influence on people's readiness to visit (and travel further to) parks with these facilities at weekends. Heterogeneity might also have been expected in relation to other attributes, for example those suggesting naturalness. However, interest in naturalness is not restricted to any one socio-economic variable. A simultaneous latent class analysis, as applied by Boxall and Adamowicz (2002), might have a better prospect of revealing such a relationship.

Introducing a new variable (status-quo) to account for conservative preferences, i.e. the number of times each respondent chose the usual park alternative, leads to a significant improvement in both parameter significance and model fit. In this case, the influence of collinearity in the usual park alternative is still apparent, although interesting variations in prefers do emerge. For instance, a negative relationship between status-quo and *adventure play park* is now apparent suggesting, perhaps, that parents with dependent children are more variety seeking in terms of their green space destinations. There are also significant main effects for Wooded Areas and Playgrounds.

Table 3 Mixed Logit of Parks A, B and *Usual Park* with Status-quo as invariant variable (R=100)

Parameter	Coefficient	Significance
Size	.192**	.0000
Maintain	.489**	.0012
Trees3	-.088**	.1331
Trees2	.628**	.0005
Water3	.019	.6615
Water2	-.086	.1771
Play3	.672**	.0000
Play2	.306**	.0185
Facilities3	.017	.5412
Facilities2	.156**	.0197
People3	.001**	.0003
People2	.169**	.0000
Journey Time	-.038**	.0000
Size*Journey Time	-.014**	.0006
Heterogeneity		
Maintain	.168**	.0050
Trees2	.205**	.0560
Play3	-.121**	.0000
Play2	-.085**	.0002
Log-lik (1)	-.1128.51	
Log-lik (0)	-.2001.67	
ρ^2 (adjusted)	.433	

The analysis was taken further by using mixed logit to assist with a pooling of the stated preference data and the revealed preference data. Such an approach is used by Brownstone *et al.* (2000) who observe that pooled coefficients may be either be the same, vary by dataset, or be uniquely determined by one dataset or the other. By identifying respective sources of variability in the error term, mixed logit moderates the scaling differences between the two types of data and permits a sharper focus on the attributes themselves.

The earlier analysis of the revealed preference data had indicated that the two datasets were too disparate to allow a joint analysis. However, for this analysis, the "revealed" data is that represented by usual park choices. In principle, these should be more reliable in that responses are drawn from the same choice question even though the attributes of the usual park alternative are still not orthogonal.

Brownstone et al. note that there is a "limited amount of experience on the issue of which coefficients would be expected to pool and which would not". In the event, few parameters do pool and the retention of so many subset-specific attributes causes ρ^2 to rise suggesting model over-specification. Nevertheless, some individual parameter coefficients are interesting. For instance, the coefficient on the attribute Journey Time that is specific to the usual park alternative, is high relative to that for the hypothetical choices and may indicate that a greater pressure to make trade-offs applies in reality than in a hypothetical stated preference experiment.

Conclusion

The results from the choice experiment indicate that, for small local parks, quality is enhanced by the presence of play facilities and a mix of quiet and more busy areas. For larger regional parks, an *adventure play park* and good *walking/seating facilities* attract the highest coefficient values. In the context of regional parks, *natural lakes* and *woodlands* become positive factors, while the negative influence of *journey time* is reduced.

The analysis is extended through a further second choice question in which people are invited to choose between hypothetical parks and their usual park destination. *Adventure play parks* and *mixtures of quiet and more busy* areas again attract positive coefficients, as too does the attribute *Size*. However, while model fit is increased from the previous model, some coefficients appear to be affected by collinearity or the limited availability of some facilities within actual parks. This effect cannot be removed altogether as a high proportion of respondents had selected the third alternative. Nevertheless, it is interesting to examine the differences imposed on the model by these choices and how coefficients vary depending on an examination of subsets of the data represented by regular and irregular users or by those respondents who did not choose the status-quo alternative.

By comparison, mixed logit allows an analysis of the full sample. While the approach is still unable to remove the influence of status-quo choices, it does help to reveal the influence that quality play facilities, and to a lesser extent maintenance and tree cover , have on a willingness to select alternative parks.

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