

Deriving weights for the Index of Multiple Deprivation based on societal preferences: The application of a discrete choice experiment *

Verity Watson, *University of Aberdeen* †

Matt Sutton, *University of Manchester* ‡

Chris Dibben, *University of St. Andrews* §

Mandy Ryan, *University of Aberdeen* **

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† Health Economics Research Unit, University of Aberdeen, Polwarth Building, Aberdeen AB25 2ZD, United Kingdom.

‡ Health Methodology Research Group, School of Community Based Medicine, University of Manchester.

§ Department of Geography and Geosciences, University of St. Andrews.

** Health Economics Research Unit, University of Aberdeen, Polwarth Building, Aberdeen AB25 2ZD, United Kingdom.

Introduction

Governments have developed statistical indices to identify areas to be targeted for funding. In the UK, the Oxford Index of Multiple Deprivation (IMD) has been used to identify local authority districts eligible for Neighbourhood Renewal funds. These funds totalled 975m between 2001 and 2006. The IMD was used by the Inland Revenue to identify the most deprived 15% of neighbourhoods where, to stimulate the housing market, stamp duty was abolished on homes costing less than £150,000. The IMD was also used to classify areas as most deprived for the purpose of setting the target to reduce inequalities in life expectancy.

The Oxford IMD is based on the premise that multiple deprivation consists of individual components which can be measured separately but also combined to form an overall single index measure (Noble et al. 2000). The IMD identified seven domains of indicators that measure the different aspects of deprivation (Income; Employment; Health and disability; Education, skills and training; Barriers to housing and social services; Living environment; and Crime). Based on these indicators each geographically defined area is then given a score. The scores in each domain are standardised, and each domain is weighted. These weighted scores are combined to give a composite score (or index value) for each area. These composite scores have important policy implications when resource allocation decisions are based on them.

The domain weights for the IMD 2000 and 2004 were determined principally on the basis of theory, and value judgements, which took account of the reliability of the data used to score each domain. It was argued that existing literature suggested that low income and dislocation from the labour market were key drivers of other deprivations, such as poor health outcomes and educational attainment; therefore these indicators should carry greater weight than other domains (Noble et al. 2000). Thus, the Employment and Income domains were given weights of 22.5%; Health and disability, and Education training and skills domains were given weights of 13.5%; and Barriers to housing and social care, Living environment and Crime domains were given weights of 9.3%. However, the reliability of the IMD has been questioned; in particular the domain weights (Deas et al, 2003).

In this paper we illustrate the use of a stated preference method, discrete choice experiments, to derive domain weights for the IMD. To do this, respondents were asked to make a series of choices between two deprivation states. To ensure the realism of, and respondents' engagement with, the task, we refer to each state as a hypothetical person's circumstances. In each choice, we ask respondents to state

which person needs the most additional support from the government. We show that respondents place greater weight on housing and health, and less weight on employment, than the existing IMD.

Methods

DCEs were originally designed as a method of establishing the relative importance of different attributes (or dimensions) in the provision of a good or a service (Farrar and Ryan 2000). This method was based on Lancaster's theory of value and thus assumes that any service can be defined by set of attributes (Lancaster 1966). This method originating from marketing research has been applied to transportation research, and in environmental and health economics to elicit preferences for non-market goods (Louviere, Hensher & Swait 2000). While the method has predominantly been used to value services, the application to the derivation of indices' weights is a promising new application.

An advantage of using a DCE to obtain weights is that the method requires respondents to make tradeoffs between the dimensions presented. While it is reasonable to expect that a society would prefer none of its members to be deprived in any dimension, for our purposes we want to know which dimensions of deprivation are considered to be worse and how much worse. We can derive this by observing how respondents make tradeoffs when they are asked to choose between individuals experiencing different profiles of deprivation presented in a DCE.

The dimensions presented to respondents in the DCE are based on the domains of the IMD 2004. The corresponding levels are, where possible, based upon the indicators used for the domains in the IMD 2004. The authors discussed how each of the domains could be presented in a meaningful and realistic manner and adopted a hypothetical person perspective. Whilst the choices presented to respondents are hypothetical, the dimensions and their levels must be as realistic as possible to ensure task credibility. Table 1 lists the dimensions and their associated levels. The way in which we defined the levels means that a person is either deprived or not deprived with respect to a given dimension.

Based on the income deprivation domain and indicators from IMD 2004, the DCE included an income dimension. This is defined as the income in the hypothetical person's household 'available to cover housing costs, bills, grocery shopping etc'. The English Indices of Deprivation 2004 stated 'an ideal measure of income deprivation

might be the proportion of household below a particular low-income threshold'. The headline measure of this is income below 60% of median income. This is an abstract measure and respondents are unlikely to be able to compute this amount. Thus, we expressed income deprivation as two levels; a household having less than £100 per person per week or a household having more than £100 per person per week.

The employment deprivation domain of IMD 2004 measures 'involuntary exclusion of the working age population from the world of work'. Based on this definition the DCE included an employment dimension with two levels; unemployed (not in paid employment) or not unemployed (employed, retired, looking after home/family).

The health deprivation and disability domain of IMD 2004 identifies deprivation as 'high rates of people dying prematurely' or 'whose quality of life is impaired by poor health or who are disabled' to capture this the index uses the 'comparative illness and disability ratio' (CIDR) as an indicator. This is highly correlated with the 2001 census question on limiting long-term illness. Thus in the DCE, the health dimension considered long-term illness or disability. The two levels presented were based in the Census 2001 question and described a person as having; limits on their daily work or activities due to long-term illness or no limits on their daily work or activities due to long-term illness.

In the education, skills and training deprivation domain indicators are divided into two sub-domains; one relates to lack of attainment among children and one relating to the lack of qualification in terms of skills. In the DCE, circumstances were defined from a hypothetical individual adult's perspective, thus we focus on the skills sub domain. The indicator used in the skills sub domain was working age adults with low or no qualifications. In the DCE, the education dimension took two levels; no educational qualifications or educational qualifications.

The barriers to housing and services domain in the IMD 2004 was split into two sub-domains; geographical barriers and wider barriers. In the DCE, the 'convenience of core services' dimension captured the wider barriers; convenience was defined as 'how handy local services, such as the shops, primary school, doctor's surgery are'. This dimension took two levels either core services were convenient (within a short walk, drive, or bus-ride) or inconvenient (not within a short walk, drive, or bus-ride).

The living environment deprivation domain in the IMD 2004 was split into two sub-domains; the indoors living environment and the outdoors living environment. In the DCE, the housing quality dimension captured the indoors living environment, based on the social and private housing condition indicator. To describe housing condition

the definition of decent housing in the poverty and social exclusion survey was used, where decent housing was defined as being ‘warm, damp free, and [having] reasonably modern facilities’. This dimension took two levels; decent and non-decent.

The crime domain of the IMD 2004 focuses on recorded crime for ‘four major crime themes - burglary, theft, criminal damage and violence.’ In the DCE, the crime dimension focused on the hypothetical person’s experience of crime in the past four years. This dimension took two levels the hypothetical person has been a victim of burglary or theft in the last four years or has not been a victim of burglary or theft in the past four years.

The combination of dimensions and levels results in 128 possible situations (2^7). These profiles were paired with a partner to create choice sets. For each situation, to create the partner the dimension levels were interchanged, this process is known as a foldover (Street, Burgess & Louviere 2005). These choices satisfied the properties of a good experimental design i.e. orthogonality, minimum overlap and level balance (Louviere, Hensher & Swait 2000). Note from Table 1, for each dimension the hypothetical person can be deprived with respect to this dimension or not deprived with respect to this dimension. Thus, for the dimensions where the person was deprived in the original profile they are not deprived in the choice set partner, likewise for the attributes where the person was not deprived in the original profile they are deprived in the choice set partner. This resulted in 128 choice sets: too many to present to one respondent. The 128 choice sets were randomly assigned to eight blocks, each block with 16 choice sets: thus there were eight versions of the questionnaire.

It is usual in DCEs to ask respondents to choose the alternative which they prefer. However, to incorporate the purpose for which the weights were being elicited, resource allocation, respondents were asked for each choice set they were presented with to state which hypothetical person needs the most additional support from the government. To avoid confounding the dimensions of deprivation with other aspects of the hypothetical individual they were individual adults. An example choice set is presented in figure 1.

Sample and Setting

A random sample of 1000 households in England was obtained using the Postcode Address File (PAF). The sample was randomly assigned to one of the eight questionnaire versions. Prior to the DCE questions, each domain was described to respondents

and the levels for that domain were presented. The choice task was explained to respondents and they were reminded there were no right or wrong answers. In addition to the DCE questions, the questionnaire collected the socioeconomic characteristics of respondents¹. Included alongside the questionnaire was a covering letter explaining the use of the Index of Deprivation and the relevance of this study, a prepaid return envelope was also included. Questionnaires were sent in August 2006. One week later a postcard was sent to whole sample, to thank those who had responded and to remind non-respondents to respond. A second questionnaire was sent to non-respondents three weeks after the initial mailing. This second mailing contained a revised covering letter urging those who had not yet responded to do so and another copy of the questionnaire.

Analysis

From the questionnaire, we observe whether a respondent states that person A or B should be given more government support. Thus we have a binary dependent variable, which equals 1 when A is chosen and zero when B is chosen. Using a probit model we estimate the probability that an individual will choose A based on the difference between the dimension levels presented in the choice as

$$\begin{aligned} Pr(\text{choice} = A) = & \Phi\{\beta_0 + \beta_1(\text{Income}_A - \text{Income}_B) + \beta_2(\text{Employment}_A - \text{Employment}_B) \\ & + \beta_3(\text{Health}_A - \text{Health}_B) + \beta_4(\text{Education}_A - \text{Education}_B) \\ & + \beta_5(\text{CoreServices}_A - \text{CoreServices}_B) + \beta_6(\text{HouseQuality}_A - \text{HouseQuality}_B) \\ & + \beta_7(\text{Crime}_A - \text{Crime}_B)\} \end{aligned}$$

In essence we estimate the impact of each of the dimension on the probability of stating a person should be given extra support. The seven dimensions presented in Table 1 are represented by dummy variables. For each alternative the dummy variables equal 1 in the not deprived state and equal 0 in the deprived state. The probit was run in STATA 9.2. From these results it is possible to identify whether a particular dimension influences respondents' choice (as indicated by the significance) and the direction of the effect. To calculate the impact of that dimension on the probability that a state will be chosen we calculate the marginal effects.

¹ Respondents' socioeconomic characteristics will be compared with those of the general population in England. If the sample is not representative, sample weights will be applied.

$$M_{x_i} = \frac{\partial P}{\partial x_i}$$

The relative importance of the individual dimensions or the weights attached to the dimensions are calculated by transforming the marginal effects on to a 0-100 scale using the following formula:

$$Weight_{x_i} = \frac{M_{x_i}}{\sum_{i=1}^7 M_{x_i}} \times 100$$

Results

251 respondents returned the DCE questionnaire². The socioeconomic characteristics of the respondents are presented in table 2. From this is it clear that respondents are not representative of the population in England. Respondents under the age of 60 years are under represented. Further, respondents with no or 'O' level (or equivalent) educational qualifications are underrepresented. To correct for this responses are weighted for both age and education, based on population proportions in the census 2001. Respondents were grouped into 4 age categories³ with 5 education categories⁴ in each. Thus, people aged 18-39 with no qualifications are underrepresented and their responses receive a weight of 3.74; this is equivalent to each respondent aged 18-39 with no qualifications counting for 3.74 respondents. Similarly, people aged 40-59 with 'A' level education are overrepresented and their responses receive a weight of 0.52; this is equivalent to each respondent aged 40-59 with 'A' Level education counting for approximately half a respondent.

The results of the regression analysis for the unweighted and weighted samples are shown in Tables 3a and b below. The significance level indicates whether the dimension has an impact on choices. Overall we can see that most criteria are significant. The coefficient shows the change the probability of considering someone needs more support when moving from being deprived to not being deprived on the corresponding

²Of these 27 respondent did not complete the DCE, 2 respondents completed 1 choice, 2 respondents completed 3 choices, 1 respondents completed 4 choices, 2 respondents completed 6 choices, 3 respondents completed 7 choices, 1 respondent completed 11 choices, 4 respondents completed 12 choices, 3 respondents completed 14 choices, seven respondents completed 15 choices, and 199 respondents completed all 16 choices.

³Age 18-39 years, age 40-59 years, age 60-74 years and Over 75 years

⁴No qualifications, Level 1 and 2 ('O' levels, CSE, GCSE), Level 3 ('A' Levels) Level 4 and 5 (Degree or further education), and Other (including apprenticeships)

dimension. So, for example, in the unweighted model being income deprived (living in a household with less than 100 per person per week) increases the probability of choosing a person to receive extra support by 0.207, everything else equal. The effect of weighting the responses to correct how representative the sample is of the population is small. While the weight assigned to each domain changes slightly, this does not change the relative importance of the domains.

The DCE derived domain weights (rounded to the nearest integer) and the weights from the IMD are presented in table 4. Comparing the weights highlights that the weights for both the employment (markedly lower) and living environment (markedly higher) were quite different from the weights in the IMD (Table 4). The higher weight on the living and environment domain may have resulted from framing the choice in terms of decent housing and the emotiveness of this subject. The very low weight on unemployment reflects respondents' views that unemployment is not as significant a problem for individuals over and above the other domains of the index (i.e. that once you take into account poverty, then the extra negative impact of unemployment will be slight).

Discussion

The aim of this study was to illustrate the use of discrete choice experiments, to obtain a set of domain weights for the IMD that takes into account the opinion of the public. A random sample of the population of England was asked to complete a DCE, which described deprivation in terms of seven dimensions. These dimensions closely matched those used in the IMD 2004. Respondents were asked to consider two hypothetical persons' circumstances, and pick which one was most in need of additional government support. For most domains there was a degree of correspondence between the weights using in the IMD 2004 and the weights obtained from the DCE. The exceptions were the Employment domain and the Living Environment domain. In the IMD 2004, the employment domain has a weight of 22.5% (the same as the income domain and together these domains have the highest weights) in the DCE the employment domain has a weight of 2%; this is the least important domain to respondents. In the IMD 2004, the Living Environment domain has a weight of 9.3% (this is the lowest weight) in the DCE the Living Environment domain has a weight of 24%; this is the second most important domain to respondents.

The attributes and levels presented in the DCE place caveats on the results. The

attributes and levels were selected by the research team. Thus, we do not know if these criteria would have been chosen by the public as being most important when defining a person as being deprived. The definition of the attribute levels were equivalent to considering an individual as being deprived or not deprived. Thus, the weights are for a move out of deprivation. However, deprivation is likely to be a relative rather than absolute concept.

Consistent with the IMD, we do not consider interactions between the domains. However, it is possible that respondents considered interactions between the domains presented. In particular, the interaction between the income and employment domains. Due to the design of the study, we cannot test for interactions. An interesting extension to this project would be to consider if interactions between the domains are significant.

There are two recommendations for change that come out of this empirical analysis of the IMD weights. First that Employment should be given less weight. Second, that Living Environment should be given more weight.

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Figure 1: Example of choice presented to respondents

	Person A	Person B
Crime	Not a victim of crime in the last 4 years	A victim of crime in the last 4 years
Employment	Not employed	Employed, retired, or looking after home or family
Income	At least £100 per adult	Less than £100 per adult
Health	No limits on daily activity and work	Limits on daily activity and work
Housing quality	Decent	Non decent
Education	No educational qualifications	Educational qualifications
Convenience of Services	Inconvenient	Convenient

Table 1: Dimensions and levels in the discrete choice experiment

Dimension	Levels
Crime	0=Not been a victim of burglary or theft in the last 4 years 1=A victim of burglary or theft in the last 4 years
Employment	0=Employed, retired, or looking and after home or family 1=Not employed
Income	0=At least £100 per adult 1=Less than £100 per adult
Health	0=No limits on daily activity and work 1=Limits on daily activity and work
Housing quality	0=Decent 1=Non decent
Education	0= Educational qualifications 1=No educational qualifications
Convenience of Services	0=Convenient 1=inconvenient

Table 2: Socioeconomic characteristics of respondents

Characteristic	Level	Sample (%)	Population (%)
Age (years)	Range	18-91	
	Mean	54	
	Median	54	
Gender	Male	49.3	49.5 ¹
	Female	50.7	50.8
Highest educational qualification	None	20.6	28.9 ¹
	'O'Level	14.8	16.6
	'A'Level	12.1	27.7
	Apprentice	17.5	
	Degree	27.4	19.9
	Other	7.6	6.9
Employment status	Employed	47.5	54.3 ¹
	Seeking employment	1.8	3.5
	Retired	34.8	13.9
	Looking after home/family	2.71	6.7
	Student	0.90	2.7
	Self-employed	9.1	8.6
Gross annual household income	upto £5200 per year	4.3	2 ²
	5,200-10,300	13.3	12
	10,400-15,559	11.4	15
	15,600-20,799	4.8	12
	20,800-25,999	13.8	10
	26,000-31,199	12.9	8
	31,200-51,999	22.4	22
	52,000+	17.1	17

¹ based in the Census 2001 data.

² based on Family Resources Survey

Table 3a: Results (Unweighted)

Criteria	Marginal effect	Normalised Weight
Income	-0.217**	24.47
Employment	-0.021*	2.48
Health	-0.168**	19.82
Education	-0.097**	11.47
Core services	-0.076**	8.97
Housing Quality	-0.194**	22.95
Crime	-0.083**	9.84

Table 3b: Results (Weighted by age and education)

Criteria	Marginal effect	Normalised Weight
Income	-0.186**	24.22
Employment	-0.013	1.73
Health	-0.159**	20.76
Education	-0.092**	12.01
Core services	-0.069**	8.98
Housing Quality	-0.183**	23.79
Crime	-0.065**	8.49

Table 4: Current weights and DCE derived weights

IMD 2004 Domains	Current weight	DCE derived weight
Income deprivation	22.5%	24%
Employment deprivation	22.5%	2%
Health deprivation and disability	13.5%	21%
Education, skills and training deprivation	13.5%	12%
Barriers to housing and services deprivation	9.3%	9%
Living environment deprivation	9.3%	24%
Crime	9.3%	9%