Using Choice Modelling to Investigate Equity Preferences*

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Abstract

Benefit cost analysis (BCA) is a widely used method of assessing environmental policies. One of the limitations of BCA is the incorporation of equity considerations into an analysis. While this is theoretically possible through the application of distributional weights, this practice has not been generally adopted due to difficulties in determining appropriate weights. This paper suggests that one way of addressing the equity issue is through the application of a stated preference technique to the estimation of equity preferences. It is demonstrated that using choice modelling enables respondents' equity preferences to be elicited and distributional weights suitable for application in BCA to be estimated.

Keywords: Distributional weights, Benefit cost analysis, Choice modelling

* Paper presented at AARES 48th Annual Conference, 11-13 February 2004, Melbourne, Victoria

1. Introduction

Within the sphere of environmental economics, Benefit Cost Analysis (BCA) is one of the most widely accepted methods of comparing policy options. With foundations in the theory of welfare economics, a project is deemed worthwhile if it benefits outweigh its costs. However, while BCA provides a comprehensive analysis in terms of efficiency, resource management decisions influence not only the output of the economy but also the allocation of resources between groups within the community. In order to assess the full impact of a policy decision it is necessary to consider the equity impacts resulting from policy options as well as their efficiency consequences.

It is possible to weight costs and benefits in order to incorporate equity considerations into an analysis. For example, if a poorer or disadvantaged group within the community will enjoy a benefit, that benefit can receive higher weighting in a BCA assessment. In reality, policy makers are frequently faced with this issue and implicit weights are imposed. Theoretically, the weights being applied are incorporated in a Social Welfare Function (SWF) reflecting a ranking of social states. In this case, it is the SWF of the policy maker that is being utilised. In general, the form of the SWF is determined by each individual's preferences over different social distributions and incorporates distributional weights which the individual is applying to the utility of different groups within society. While the relevant SWF is often assumed to be that of the government, policy maker or environment agency (Mäler 1985), each individual has different preferences and therefore the SWF will vary depending on the individual or group.

Alternatively, if no weights are applied, each $1 of benefits and costs is treated equally, regardless of who bears the cost or reaps the benefit. In effect, the assumption that the marginal social value of income is equal for all individuals is being applied. This assumption has two aspects: firstly, that an extra $1 of income will provide equal additional utility to all groups within the community, and secondly that the utility of all groups within the community is treated equally in each individual's assessment of social welfare.

The unrealistic nature of this assumption has led to debate about the appropriateness of weighting costs and benefits when using BCA to evaluate policy changes. Despite being theoretically possible there has been reluctance by economists to adopt this approach for a number of reasons. There is debate about whether it is within the role of economic analysis, due to the value judgements involved. Even if it is accepted that weights should be applied, the difficulty is determining how to estimate the weights and whose SWF should be reflected in the weights. Furthermore, determining what factors contributing to welfare should be included in the weighting process is problematic. The ignoring of distributional concerns still implies the application of a particular set of weights. Dissatisfaction with this outcome is evidenced through the environmental social justice movement which emphasises the distributional implications of environmental change and policy.[1] It is also reflected in the fact that policy makers only use BCA results as an ingredient in their decisions in

[1] For example see Agyeman, Bullard et. al (2003).

acknowledgement that there are more than efficiency concerns involved in decision making.

The research outlined in this paper contributes to this debate by proposing the use of a stated preference technique to elicit the equity preferences of respondents. It is shown that distributional weights applicable to BCA can be estimated using choice modelling, a particular stated preference technique.

The paper is structured in the following manner. Section 2 outlines the welfare economic theory underpinning the distributional question and identifies the technical components of the distributional weight. Section 3 provides the background to choice modelling, the stated preference technique applied to elicit equity preferences. Section 4 brings these two components together illustrating how distributional weights can be derived from the outputs of the choice model. Section 5 provides discussion of this method of determining social justice preferences, including advantages and limitations of the approach. A brief conclusion is provided in Section 6.

2. The distributional weight

BCA has strong welfare economic theoretical foundations. Without pursuing this background in detail there are a number of areas which are particularly relevant for this research.

2.1 Market outcomes

The problem addressed by BCA is one of ranking different resource allocations in order to maximize social welfare. Well established theory indicates that in a two person economy, a competitive market will exhaust all of the gains from trade and an equilibrium allocation will be achieved that is Pareto optimal.[2] However, this outcome, known as the First Welfare Theorem, says nothing about the distribution of utility. Whilst it provides insight into the efficiency of an outcome, the equity of the outcome is difficult to measure. As the outcome depends on the original distribution of endowments, if this is changed, a new equilibrium and a new Pareto optimum is reached. Hence, one of the fundamental problems faced in assessing policy options is the comparison of welfare levels within the community. The competitive market provides a number of efficient outcomes that are Pareto optimal, but it does not provide a solution to the question of choosing between alternative distributions. Pareto optimality does not embody a concept of justice or an ordering of social states and is limited in its usefulness as few if any changes in the real world generate no losers.

2.2 Social welfare functions

These limitations have led to reliance on social welfare functions (SWF) (Bergson 1938; Samuelson 1947). Technically, a social welfare ordering ranks social states or projects in terms of their impact on the welfare of the population. If the social welfare ordering is continuous it can be translated into a social welfare function. It is assumed that every individual is capable of making distributional judgements and that these

[2] See intermediate microeconomics texts such as Varian (1999).

judgements can be represented by a social welfare function which may differ between individuals.

Adopting the notation of previous work (Brekke et al. 1996; Nyborg 2000):

$$W^j = V^j(w_1^j,....,w_n^j) \qquad \text{for all } j \in \mathrm{N} \qquad (1)$$

where $N=\{1,.....,n\}$ is the set of all individuals in society. W^j denotes social welfare according to person *j*'s social preferences, which she applies whenever she perceives herself to be in the role of an observer, trying to judge matters from society's point of view. The social welfare functions are assumed to be transitive, continuous and increasing with respect to individual utility.[3]

A degree of cardinal and interpersonally comparability of utility is assumed[4] (Sen 1977; Roberts 1980a; Roberts 1980b). Although there is no commonly accepted way to measure such a utility comparing concept, in everyday life, people nevertheless make intuitive judgements about each other's well-being. Hence, it is assumed that given information on individual *i*'s income, her access to public goods, and her characteristics, any person *j* is able to arrive at a subjective judgement of *i*' s utility:

$$w_i^j = v^j(y_i, x; c_i) \qquad \text{for all } i, j \in \mathrm{N} \qquad (2)$$

where y_i is *i*'s net disposable income (after taxes), which is assumed to be exogenous to *i*, *x* is a physical quantity (or quality) indicator for provision of a pure public good, and c_i is a vector describing *i'*s individual characteristics. Characteristics are assumed to be fixed and observable, not subject to individual judgement by *j*. Individual *j*'s personal preferences can be described by the situation where *i=j*.

Hence, people are requested to apply their social preferences when expressing their view of the relative social justice of policy options. That is, consideration of what is best for society from the perspective of an observer.

2.3 Distributive justice

The properties of the SWF reflect the social justice principles of the observer. For example, the most common form of the SWF is the utilitarian where the utilities of individuals, *1…n,* are summed and the aim is to maximise the sum of the utilities, that is:

$$W(V_{1.....}V_n) = \sum_{i=1}^{n} V_i \qquad (3)$$

This is known as the classical utilitarian SWF, developed by Bentham (1789) and championed by economists such as Mill (1861), Edgeworth (1881), Marshall (1890) and Pigou (1920). Utilitarianism has been, in many ways, the "official" theory of traditional welfare economics (Sen 2000). There are two particular limitations of

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[3] Brekke et.al and others use the term "well being" instead of utility.

[4] This overcomes the limitations exposed by Arrow's impossibility theorem (Arrow 1963).

utilitarianism as a theory of social welfare which are relevant. Firstly, the process of aggregation can lead to an inability to distinguish between any two distributions that yield the same total utility. Hence, on its own it cannot be used to address the equity question. Secondly, the assumption is standardly made that each individual gets the same utility from the same commodity basket and the same level of income (Sen, 2000). [5]

The maximisation of a SWF is invariably adopted as the objective of policy in public economics (Myles 1995). Importantly, the SWF emphasises that society is concerned with the distribution of utility rather than the distribution of income. Each SWF represents one person's view of the allocation of utility across individuals in society. The research reported in this paper provides one means of eliciting the social welfare preferences of the community.

2.4 *Measuring welfare changes*

The estimation of welfare changes in going from one resource allocation to another involves calculating the utility of each individual in each state and aggregating the utilities to the SWF. The following is adapted from Johansson (1993). Assume an economy with *i* individuals each demanding *n* goods and supplying *k* factors traded in markets, demanding an unpriced environmental asset denoted "environmental quality", and each individual with a fixed lump sum income. The indirect utility function of individual *i* is written as:

$$V_i = v_i(p, w, y_i, z) \qquad (4)$$

Where V_i is the utility level attained, $p=[p_1,..,p_n]$ is a vector of prices of private goods, $w=[w_1,...,w_k]$ is a vector of wage rates, y^i is a lump-sum income including profit income but less any taxes, and z denotes environmental quality. It is assumed that the indirect utility function is decreasing in prices, and increasing in wage rate and lump sum income and the quality of the environment.[6]

The problem facing the individual can be viewed as either a constrained maximisation problem, in terms of maximising utility within a budget constraint, or a constrained minimisation problem in terms of minimising expenditure while maintaining a particular level of utility. Hence, the measurement of utility can also be expressed as an expenditure function that is:

$$E_i = e_i(p, w, u_i, z) \qquad (5)$$

As both the expenditure function and the indirect utility function are used in later equations, the relationship between the two is specified as:

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[5] Mueller (1989) provides the proof that the impartial utilitarian chooses a distribution of income such that the marginal utility of income across all individuals is equal.

[6] For further elaboration of the properties of this function see Johansson (1993), p42. Other useful references include Boadway and Bruce (1984), Dreze and Stern (1987), and Johansson (1987; Johansson 1993).

$$v_i(p,w,y_i,z) = V_i \Leftrightarrow e_i(p,w,u_i,z) = E_i \qquad (6)$$

By aggregating the indirect utility functions the SWF may be written as :

$$W = w(V_1,...V_n) = W[v_1(p,w_, y_{1,} z),...v_n(p,w,y_n,z)] \qquad (7)$$

This is a useful manipulation as the measurement of social welfare can be approached by an aggregation of the money metric measure of utilities rather than the utilities themselves.

2.4.1 Compensating and equivalent variations.

Whilst the expenditure function can be used as a base to estimate indirect utility, it is estimates of changes in welfare that are required, in order to embody both equity and efficiency considerations into decision making. The compensating variation (CV) and equivalent variation (EV) are two measures which are based on the indirect utility function and the expenditure function and provide the first step towards estimating welfare changes. The compensating variation (CV) is defined as the minimum amount by which a consumer would have to be compensated after a price change in order to be as well off as before (Hicks 1939). Similarly, utility changes can be expressed in terms of an EV; this is the amount of money that must be given to, (or taken from), a household at initial prices and income to make the household as well off as it would be at final prices and income. It is argued that the CV and EV are the most appropriate measures for most problems of applied welfare economics (e.g. (Mohring 1971; Small and Rosen 1981). The CV can be applied following changes in environmental quality and is often interpreted as the willingness to pay (WTP) for an improvement (Johansson 1993). The CV, or compensating surplus in this case, is also used to measure the willingness to pay for a change in the quantity supplied of a public good. Concentrating on the CV for the moment, it can be expressed in terms of the expenditure function[7]:

$$CV_i = e_i(p_1,w,u_i,z) - e_i(p_2,w,u_i,z) + \Delta m \qquad (8)$$

Where Δm is the change in income resulting from a policy change.

The CV and EV give a measure of the utility change for an individual, the next step is determining an aggregate for measuring utility changes in the community.

2.5 Deriving the distributional weight

A change in policy which moves the economy from one equilibrium, denoted by a superscript 0, to another denoted by a superscript 1 will make everyone better off if:

$$v_i(p_1,w_1,y_{1i},z_1) > v_i(p_0,w_0,y_{0i},z_0) \qquad \forall i \qquad (9)$$

[7] See Boadway and Bruce (1984) p 202 for further detail

While this outcome will pass the Pareto test it is unrealistic, as most projects will make some individuals better off and others worse off. In this instance:

$$v_i(p_1, w_1, y_{1i}, z_1) > v_i(p_0, w_0, y_{0i}, z_0) \qquad \exists i \in \eta \qquad (10)$$
$$v_i(p_1, w_1, y_{1i}, z_1) < v_i(p_0, w_0, y_{0i}, z_0) \qquad \exists i \in \eta \qquad (11)$$

Where η is the set of individuals. Hence there is a need for a principle other than the Pareto principle in order to rank outcomes involving both winners and losers. This is provided by a SWF, (Eq. 7), which can be written as indicated earlier:

$$W = w(V_1,...V_n) = W[v_1(p, w, y_1, z),...v_n(p, w, y_n z)] \qquad (7)$$

The impact of a project on the social welfare is the change in welfare denoted by:

$$\begin{aligned}\Delta W &= w[v_1(p_1, w_1, y_{11}, z_1),...v_n(p_1, w_1, y_{1n} z_1)] \\ &- w[v_1(p_0, w_0, y_{01}, z_0),....v_n(p_0, w_0, y_{0n}, z_0)] \qquad (12)\end{aligned}$$

While the individual utility levels are unobservable, this problem is overcome by calculating money measures of individual utility changes as indicated in the expenditure function. In order to quantify this change in welfare the income compensated or Hicksian money measures of individual utility changes need to be considered. Thus,

$$v_i(p_1, w_1, y_{1i} - CV_i, z_1) = v_i(p_0, w_0, y_{01}, z_0) \qquad \forall i \qquad (13)$$

$$v_i(p_1, w_1, y_{1i}, z_1) = v_i(p_0, w_0, y_{01} + EV_i, z_0) \qquad \forall i \qquad (14)$$

Where CV_i denotes the compensating variation, (Eq.8) and EV_i the equivalent variation for individual *i*. Concentrating for the moment on the CV and substituting Eq. 13 into Eq. 12, the change in social welfare can be written as:

$$\begin{aligned}\Delta W &= w[v_1(p_1, w_1, y_{11}, z_1),...v_n(p_1, w_1, y_{1n}, z_1)] \\ &- w[v_1(p_1, w_1, y_{11} - CV_1, z_1),....v_n(p_1, w_1, y_{1n} - CV_n, z_1)] \qquad (15)\end{aligned}$$

$$= \sum_{i=1}^{n} \int_0^{CVi} W_i V_{iy} dCV_i = \sum_{i=1}^{n} (W_i V_{iy}) CV_i \qquad (16)$$

where $W_i = \partial W/\partial V_i$, $V_{iy} = \partial V_i/\partial y_i$. This indicates that for each individual the change in welfare resulting from a particular project can be measured by calculating the product of the individual's average social utility of income and his/her compensating variation. The community change in social welfare is determined by summing the resulting amount by all individuals. Hence, the change in welfare is a weighted aggregate of the compensating variations.

2.6 The distributional weight

The weighting term in this aggregation process, known as the marginal social utility of income (Johansson 1993), the welfare weight (Dreze and Stern 1987), or just the marginal social utility (Boadway and Bruce 1984) is denoted here by α_i and referred to as the *distributional weight*. This distributional weight is a product of two components; W_i (or $\partial W/\partial V_i$) which represents the change in social welfare if the utility of individual i increases marginally, and V_{iy} (or $\partial V_i/\partial y_i$) which is the marginal utility of income of individual i. [8]

Assumptions regarding the W_i component of the distributional weight reflect varying theories of social justice. For example, in a Benthamite society $W_i = 1$ for all individuals, so that changes in individual utility are added, while in a Rawlsian society, $W_i=0$ for all individuals except the worst-off.[9]

The distributional weight is dependent on the impact of money, (assuming this is the chosen numéraire) on the utility of the individual and the utility of the individual on society's total welfare. The greater the distributional weight, the greater is the social gain from an increase in i's real income, and redistributing \$1 from individual k to individual i raises social welfare if $\alpha_i > \alpha_k$.

2.7 Incorporating Equity into Benefit Cost Analysis

One application of the theory of measuring welfare changes using the SWF is BCA. It is founded on the assumption that a policy is worthwhile for society as a whole if the benefits (B) exceed the costs (C). That is, the discounted net social benefit is greater than zero:

$$\sum_{t=1}^{T} (Bt - Ct)/(1+s)^t > 0 \qquad (17)$$

where, s is the social discount rate. Equity considerations can be incorporated into BCA by weighting the net benefits of individuals or groups. As indicated by Eq. (16) the change in social welfare can be written as;

$$\Delta W = \sum_{i=1}^{n} (W_i V_{iy}) NB_i \qquad (18)$$

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[8] Although the second component of the weight is generally referred to in terms of income, this does not necessarily need to be the case. For example, it could also be the marginal utility of an additional unit of an environmental good for individual i. In an analysis of seven contingent valuation studies, Medin, et.al.(2001) illustrate the sensitivity of BCA findings to the assumption of equality of marginal utility of income. By using the environmental good as the numéraire and instead assuming equality of the marginal utility of the environmental good, they find that aggregate monetary benefits are reduced by a factor of between 2 and 307.

[9] For more details see Johansson (1993) or Maler (1985).

where NB_i is the net benefit of individual i. The application of welfare weights acknowledges that the marginal social welfare of income may not be equal for all individuals. This may be due to inequality in the marginal utility of income and/or inequality in the change in social welfare resulting from a marginal increase in the income of a particular individual or group within society. However, in applied BCA, there are few examples where the individual compensating or equivalent variations have been weighted (Adler and Posner 1999).[10] If welfare weights are incorporated in a BCA analysis, then the distributional or equity effects of a project are considered along with efficiency considerations.

As an example, assume a project results in a \$200 gain to person A, who happens to be a high income earner and a \$100 cost to person B, a low-income earner. From an efficiency perspective, the project would be justifiable as the unweighted aggregate of the benefit of the project is positive (\$100). However, if equity issues are incorporated and weights as in Table 1 are included, the outcome changes.

Table 1

Person	NB_i	W_iV_{iy}
A (high income)	200	0.7
B (low income)	-100	1.5

Now, with the distributional considerations incorporated the change in welfare would be negative and the project rejected.

$$\Delta W = 0.7(200) + 1.5(-100) = 140 - 150 = -10 \qquad (19)$$

Without weights, aggregation is the sum of individual benefits of a policy change, that is the sum of the compensating variations but this is not a measure of the change in social welfare because of the underlying assumption that the distributional weight is equal for all individuals or groups. Pearce (1993) suggests that BCA requires two normative value judgements.

"The first states that preferences count, but requires careful consideration about whose preferences are to count. The second must say how the preferences are to be weighted".[11]

This research addresses these two questions.

2.8 Background to the application of distributional weights in BCA.

[10] One example is Blackorby and Donaldson (1987) who analyse a method for distributionally sensitive cost-benefit analysis that uses household welfare ratios (the ratio of household income to the appropriate poverty line) as an index of each household member's well-being. While this has a number of advantages, it is limited that in focusing on income it is not an accurate indicator of well-being.

[11] Pearce (1993) p 10

There has been and remains extensive debate between economists regarding the application of distributional weights to BCA. For example in BCA texts, Campbell and Brown (2003) include a chapter on weighting net benefits to account for income distribution and Harberger and Jenkins (2002) dismiss the application of distributional weights in their introduction and proceed based on the postulate that an unweighted aggregate of net benefits provides a measure of changes in social welfare.

The two main arguments of authors who consider that distribution should not be a part of BCA are the difficulty in determining the weights to be applied and the efficiency cost associated with incorporating distributional considerations (Harberger 1978; Mishan 1981; Mishan 1988; Harberger and Jenkins 2002)

A number of methods of determining welfare weights have been discussed in the literature. For example, “value sensitive analysis” refers to situations where the analyst determines the weights. (Nash et al. 1975) However, Mishan, (1988) expressed concern that if economists choose weights they are only one view of the appropriate weights, and this runs the risk of discrediting BCA as a technique.[12] This ignores the fact that in the absence of distributional analysis from economists, policy makers may be confronted with the need to apply their own implicit weights.[13]

Another alternative discussed by Mishan is that weights be determined from the political process, however, he proposes that the continual changes this would involve would create instability. A further concern is the possibility that political interventions would be difficult to limit and that these weights may simply reflect the power of specific vested interest groups rather than a reflection of society’s marginal social value of an additional dollar to different groups.

The "revisionist" school (Dasgupta et al. 1972; Little and Mirrlees 1974), refers to studies where weights are derived from the political system. Major applications have been in developing countries; however, experience has shown that this method of determining weights has been slow to develop.

Another suggestion has been that distributional weights be determined by the progressive tax schedule (Harberger 1978). This would ensure consistency in value judgements. However, consistency would require more tax scales and also transfer payment schedules. The limitation of this method of determining weights has been that income is not the only distributional issue. For example, it may be that the weighting is for employment in a regional area as opposed to an urban area, or for a particular cultural group within the community. In these instances, tax scales are of little relevance.

It may also be possible to estimate weights based on an analysis of past decisions. However, there is no theoretical argument to suggest that past decisions have

[12] However, the assumption of constant marginal social value of a dollar is a value judgement in itself.
[13] Haveman, (Haveman 1965) examined twenty-nine water resource projects out of 150 authorised in 1960 that received appropriations in the succeeding appropriation bill. He points out that if the budget of $133 million dollars that was committed to the twenty-nine projects was allocated most efficiently, no project having a benefit-cost ratio of less than 1.8 would be chosen. In fact, eleven projects with lower ratios, involving $69 million were chosen. Projects from particular geographic regions seemed to be selected in spite of relatively low measures of efficiency (Weisbrod 1972).

maximised welfare. This is summed up by Musgrave's question, "If past investment decisions may be assumed to have been correct, why is cost-benefit analysis needed to validate future decisions?"[14] Basu (1980) clearly elaborates the difficulties in using revealed preferences to determine governmental weights.

Hence, a primary difficulty with the inclusion of distributional weights to BCA has not been the theoretical underpinnings of the methodology, but rather the method of determining appropriate weights.

The second concern with the incorporation of distributional weights into BCA is the extent of the efficiency trade off to be made in exchange for equity considerations. The combination of both efficiency and equity criteria in a unified analysis is a challenge for economists. If it is assumed that the incorporation of weights into BCA is possible, the subsequent question is: with full knowledge of these equity issues, is society prepared to forfeit efficiency in the quest for increased equity? (Harberger 1978; Harberger and Jenkins 2002)

However, if weighted benefits exceed weighted costs, social welfare is improved with the project. In effect, the weights reflect the trade-off between efficiency and distribution which is central to public policy. As it is not realistic to expect that policies will be both efficient and distributionally fair, by specifying the weights value judgements regarding the priority of objectives becomes explicit (Brent 1996).

The inclusion of distributional weights in BCA addresses a need to incorporate both efficiency and equity criteria into decision making. The issue then becomes whether the weights are implicit or explicit. This research reported here proposes an explicit approach.

3. Choice modelling (CM)

This research outlines a solution to the dilemma facing policy makers regarding the determination of appropriate distributional weights for applied BCA. It is premised on the assumption that policies are chosen with the aim of maximising social welfare. It proposes the use of choice modelling, a stated preference technique, to elicit the distributional weights of the community.

3.1 Introduction to Stated Choice Methods

Stated choice methods encompass a range of stated preference techniques that take a similar approach to estimating values for changes in non-market good supply. While they have only relatively recently been used in environmental valuation exercises (Adamowicz et al. 1994; Roe et al. 1996), stated choice methods have been employed by psychologists since the 1960s, and in transportation and marketing research since the early 1970s (Garrad and Willis 1999).

Stated choice methods include: choice experiments, contingent ranking, contingent rating and paired comparisons. This research focuses on choice modelling (CM). The origins of CM are in conjoint analysis (derived from the two words "considered

[14] Quoted in Basu (1980), p 107.

jointly") and contingent valuation methods in the environmental and health literatures. Hence, CM has evolved through advances in a variety of disciplines where the "common goal has been the development of methods to explain individual and aggregate choice behaviour" (Louviere et al. 2000).[15]

The focus of CM research in an environmental context has been to estimate non-market values.[16] Stated preference techniques rely on eliciting consumer preferences through some form of questionnaire approach, while revealed preference methods obtain value estimations based on the actual behaviour of consumers. Debate has arisen over the application of stated preference methods of valuation due to the scepticism associated with relying on what consumers say they will do compared with how they actually behave. However, there are many situations in which one has little alternative but to take consumers at their word or do nothing (Louviere et al. 2000).

In conventional applications, CM is used to identify the utility that individuals have for the attributes of goods or services by examining the trade-offs implicit in choices. This provides the flexibility to predict behavioural responses to changing opportunities. By varying the levels of the scenario attributes, it is possible to understand respondents' preferences and gain insight into the trade-offs respondents make between attributes. This allows the estimation of a variety of opportunity costs and willingness to pay. One of the strengths of this methodology is that it forces respondents to consider substitution possibilities. Hence the method is useful not only as a value estimation technique but also for assessing policy options.[17] This involves presenting respondents with a description of alternative policy options and seeking an indication of the single preferred option.

This research focuses on the development of a choice model to be used to explain the equity preferences of respondents by asking them to choose between policy options where the distributional outcomes vary. From this analysis distributional weights applicable to benefit-cost analysis may be derived.

3.2 Theoretical foundations.

CM derives from two theoretical foundations. First, it is based on the notion that utility is derived not from goods *per se* but rather from the characteristics which goods possess (Lancaster 1966; Lancaster 1971).[18] This approach allows the demand for or value of a particular attribute to be determined. The approach assumes that a particular consumption service can be described by a set of attributes.

Second, random utility theory is used to estimate the probability of choice (Thurstone 1927). The probability that a decision-maker will choose a particular alternative from a set of alternatives, given data observed by the researcher, can be calculated. In most

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[15] Louviere, et.al.(2000), Haab and McConnell (2001) and Bennett and Blamey (2001) provide valuable summaries of the methodology and application of choice models.

[16] Contingent valuation is possibly the more well known stated preference method of non market valuation. Morrison et.al (1996) provides a comparison of contingent valuation and CM.

[17] For example, in a study of water supply policy alternatives, Blamey, Gordon et. al. (1999) illustrate how CM can be used to provide both value estimates corresponding to policy changes involving one or more attributes, and community rankings of multiple policy options.

[18] Rosen (1974) further developed the model for the case in which goods are indivisible.

applications, respondents are presented with a set of alternatives, each fully characterised by levels of attributes and a cost. There are two sources of uncertainty in the estimation of values based on attributes. Firstly, it is very difficult to completely describe anything in terms of its attributes, and secondly, respondents' subjective views on attributes will vary. The random utility model (RUM) is the basic model for analysing choice modelling responses. The econometric analysis is based on McFadden's conditional logit model (McFadden 1974), and was further developed by Hanemann (1984).

The probability that individual, *i*, chooses good, *q,* among a particular set of *k* goods, *S*, can be expressed as:

$$P(q/S)\forall k \in S \tag{20}$$

It is assumed that individual, *i,* maximises utility and the indirect utility function can be separated into two parts: an observable element which describes the preferences of individual, *i* as a linear function of the goods attributes, X_q and a stochastic element, which represents those influences on individual choice which cannot be observed by the researcher. Hence, the indirect utility function for the *i*th individual of the *q* th alternative can be partitioned into two components, each a function of the characteristics of the alternative, X_q and the characteristics of the individual, c_i:

$$U_{qi} = V_{qi}(X_q, c_i) + \varepsilon_{qi}(X_q, c_i) \tag{21}$$

where U_{qi} is the unobservable overall utility, V_{qi} is the observable objective component of utility and ε_{qi} is the random component.

Different RUMs can be generated by allowing the random elements to enter the conditional indirect utility functions in different ways or by making different assumptions about their joint distribution. Consequently, two modelling decisions are needed: the functional form of V_{qi} and the distribution of ε_{q_i}. Most approaches begin by specifying the utility function as additively separable in deterministic and stochastic preferences (Haab and McConnell 2002). In this case, V_{qi} is a conditional indirect utility function that is generally assumed to be linear in form:

$$V_{qi} = \beta_1 + \beta_{2i}x_{q2i} + \beta_{3i}x_{q3i} + \ldots + \beta_{qi}x_{qai} \tag{22}$$

where x_{qai} are the attributes, *1-a* of the specific alternative, *q,* and the β_{qi} vector contains the marginal utility parameters. In Eq 22, β_1, is the alternative-specific constant (ASC) for 1.[19] Data analysis entails selection of the coefficient vector, β, which maximises the probability of obtaining the observed choice.

If the random error terms are distributed independently and identically (IID) and follow the Gumbel or type I extreme value distribution, the multinomial logit (MNL

[19] The ASC represents the mean of the difference between the unobserved factors in the error term of one alternative and that of a base case.

model is obtained and the probability of individual, *i,* choosing alternative, *q,* can be expressed as:

$$P_{qi} = \frac{\exp(\mu V_{qi})}{\sum_{k=1}^{K} \exp(\mu V_{ki})} \qquad (23)$$

As the V_{qi}'s are assumed to be linear additive functions in the attributes which determine the utility of the *qth* alternative, then V_{qi} can be written as

$$V_{qi} = \sum_{a=1}^{A} \mu \beta_{qi} X_{qai} \qquad (24)$$

An estimate of the utility parameter $\mu\beta_{qi}$, can be interpreted as an estimate of the weight of attribute, X_q, in the utility expression V_q of alternative *q*. In (24) μ is a scale parameter which is inversely proportional to the standard deviation of the error distribution. In a single data set this parameter cannot be separately identified and is therefore implicit in the terms estimated. The maximum likelihood procedure also allows testing for statistical significance of individual utility parameters, or $\hat{\beta}s$, through calculation of the asymptotic standard errors for the $\hat{\beta}s$ in the MNL model.

3.3 The outputs of choice models

CM provides two different types of value estimates. The first, known as *implicit prices,* are estimates of the value of a change in an environmental or social attribute. These are based on the marginal rate of substitution (MRS) between a cost or dollar value attribute and a non-monetary attribute. The second type of value estimates are compensating surpluses, which show respondents' willingness to pay for a bundle of changes. This may be different from the sum of the changes in the implicit prices if the value that respondents have for a bundle of changes is not simply the sum of the value of the individual changes. A significant advantage of the CM approach is that it is possible to estimate the willingness of the respondent to pay for more of an environmental attribute. Through these measures, which are analysed in more detail in Section 4.1, the random utility model represented by the MNL function provides a very useful way to assess the effects of a wide range of policies through estimating changes in utility.

4. Using choice modelling to estimate distributional weights.

In many CM studies the measurement of compensating and equivalent variations and implicit prices are classified as welfare measurements, yet, more correctly they are estimates of the change in utility expressed in dollar terms. The research reported in this paper explores a broader application of CM by addressing the question of the distributional effects of policies and the consequent social welfare outcomes of policy alternatives.

Rather than applying the RUM to the estimation of utility and value in a dollar measure, the RUM is applied to the estimation of the SWF of respondents. The choice between the current distribution associated with the status quo and a change in policy that will result in distributional change can be presented to respondents where the attributes of the policy options that are varied are the levels of utility of particular groups within society. In this instance the MRS or "implicit price" will reflect the willingness of respondents to trade-off a change in utility of one group for a change in utility of another group.[20]

4.1 Random Welfare Model

While the RUM usually presents problems in the context of a private choice with individuals maximising utility, in the context of social justice choices it is the maximisation of social welfare that is relevant.

Arrow (1963)[21] suggests people have two distinct personalities: their self-interested selves essentially disjoint from their ethical selves. Self-interested preferences guide day-to-day participation in the market economy while their ethical ones apply to participation in collective decision making. Nyborg (2000) formalises this distinction between "Homo economicus", the individual maximising utility, and "Homo politicus", the individual maximising their SWF. Focus on the behaviour of "homo politicus" allows for a sense of social justice which Musgrave and Musgrave (1989) argue is essential for the definition of a good society and the functioning of a democratic society. Broome (1995) describes this as a notion of communal good that is separate from the good of individuals.[22]

Here, it is assumed that respondents are able to make this distinction when determining their policy preferences. Therefore, decision-making is seen in a broader context of social structure rather than individuals engaged in maximising their self-interests in the market. Hence, each individual has a personal SWF based on their notion of what they consider to be a fair distribution, reflecting their individual perspective of social justice. These ethical judgements are reflected in every individual's SWF and can be expressed as in equation (2).

Based on the theoretical foundations of the RUM, a similar approach can be applied to the analysis of the question of welfare maximisation. There are two elements central to the model:

(i) a function that relates the probability of a distributional outcome to the welfare associated with each alternative; and,

(ii) a function that relates the welfare of each alternative to a set of attributes that together with estimated welfare parameters, determine the level of welfare of each alternative.

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[20] It is assumed that there are groups of individuals who have similar characteristics. Public debate is frequently framed in terms of concentrating on groups rather than individuals. (Rawls 1971) (Brekke et al. 1996)

[21] See (Boadway and Keen 2000) p680

[22] The terms "citizen" and "consumer" have deliberately not been used to avoid confusion with this debate; (Blamey et al. 1995; Rolfe and Bennett 1996). This discussion is centred on contingent valuation studies based on the assumption that respondents are maximising utility functions. A clear distinction needs to be drawn between utility maximisation and welfare maximisation hence the adoption of Nyborg's (2000) terminology.

The decision rule is based on welfare maximisation from a social justice point of view rather than an individual utility maximisation perspective. Use of this decision rule further requires that the decision makers are compensatory in their decisions, that is, willing to trade-off the utility between groups. Further discussion of these assumptions is provided in Section 4.3.

As for the RUM, in a *Random Welfare Model*, it is assumed that welfare is comprised of two components: an observed welfare function and an unobserved component. Thus, the social welfare function of individual *j,* for alternative *q,* can be expressed as

$$W_q^j = w_q^j + \varepsilon_{qj} \qquad (25)$$

where w_q^j is the deterministic part of the welfare function and ε_{qj}, the stochastic component. The error term acknowledges that it is difficult to describe welfare completely in terms of the utilities of groups and there may be some groups who contribute to an individual's SWF but have not been included in the analysis. It also allows for the fact that there may be mistakes made in the measurement of the contribution of identified groups to the SWF.

It is assumed that the SWF of respondent *j* is a linear function of the utility of groups *1…m.*

$$w_q^j = \beta_1 + \beta_2 v_{1q}^j + \beta_3 v_{2q}^j + \ldots + \beta_m v_{mq}^j \qquad (26)$$

where the attribute v_{mq}^j is an estimate by the respondent *j*, of the utility to group *1-m* from the specific alternative *q*. The utility of group *m* is assumed to be a function of income and access to public goods as denoted in equation (2).

When a respondent is asked to compare two alternatives, it is assumed that the respondent is comparing the welfare he or she thinks society attains from each alternative, and then selecting the highest social welfare option. The probability that any respondent (person *j*) prefers option *g* in the choice set to any alternative, option *h*, can be expressed as the probability that the welfare associated with option *g* exceeds that associated with all other options, that is:

$$P[(w_g^j + \varepsilon_{jg}) > (w_h^j + \varepsilon_{jh})] = P[(w_g^j - w_h^j) > (\varepsilon_{jh} - \varepsilon_{jg})] \qquad (27)$$

This indicates that respondent *j* will choose option *g* over option *h* if the difference in the deterministic parts of his/her welfare function exceeds the difference in the error parts. In order to derive an explicit expression for this probability, it is necessary to make an assumption about the distribution of the error terms (ε). Assuming a Gumbel distribution or double–exponential the distribution can be expressed as:

$$P(\varepsilon_q \le \varepsilon) = \exp(-\exp - \varepsilon) = e^{-e^{-\varepsilon}} \qquad (28)$$

From this foundation, the basic choice model can be applied within a welfare context. Assuming welfare maximisation, the probability of any particular alternative *q* being chosen as the most preferred can be expressed as:

$$P_q^j = \exp(\delta W_q^j) \Big/ \sum_{k=1}^{K} \exp(\delta W_k^j) \qquad (29)$$

Remembering that the W_q^j are assumed to be linear, additive functions in the attributes (in this case, utilities) which determine the welfare of the q*th* distribution, W_q^j can be written as

$$W_q^j = \sum_{m=1}^{M} \delta\beta_q^j \, V_{mq}^j \qquad (30)$$

The welfare parameter β_q^j provides an estimate of the weight of group, *m*, in the welfare expression of alternative *q*, from the perspective of respondent, *j*. The scalar parameter within the random welfare model is represented by δ.

4.2 Relating the Random Welfare Model to the Distributional Weight

The key output of the random welfare based choice model is the marginal rate of welfare substitution (MRWS), which is the ratio of the welfare parameters:

$$MRWS_{q1m}^j = \frac{\delta\beta_{q1}^j}{\delta\beta_{qm}^j} = \frac{\beta_{q1}^j}{\beta_{qm}^j} \qquad (31)$$

That is, the willingness of respondent, *j,* to trade the utility or well-being of group *1* for the utility of group *m* given alternative *q*. By focusing on the ratio of the welfare parameters, the problem of the scale parameter is overcome. In effect, the MRWS reflects a willingness to accept distributional change, which can be represented graphically by the slope of the SWF, assuming a constant level of welfare. This distribution reflects respondent *j*'s notion of social justice.

In a three dimensional context, if the attributes of the choice model are the benefits which accrue to a particular group, and benefits are denoted in a common unit (eg dollars, represented by income, *(Y)* then the MRWS can be given as the ratio of the marginal welfares. That is:

$$MRWS_{q1m}^j = \frac{\partial W_{q1}^j}{\partial Y_{q1}} \Bigg/ \frac{\partial W_{qm}^j}{\partial Y_{qm}} = \frac{\partial W_{q1}^j}{\partial W_{qm}^j} \cdot \frac{\partial Y_{qm}}{\partial Y_{q1}} \qquad (32)$$

Recalling that the distributional weight when applied to a BCA setting is a product of two components; the change in social welfare if the utility of groups 1-*m* increases marginally, and the marginal utility of income of groups 1- *m*. The ratio of the weights can be given as:

$$\frac{\alpha_{q1}}{\alpha_{qm}} = \frac{\dfrac{\partial W^j_{q1}}{\partial U_{q1}} \cdot \dfrac{\partial U_{q1}}{\partial Y_{q1}}}{\dfrac{\partial W^j_{qm}}{\partial U_{qm}} \cdot \dfrac{\partial U_{qm}}{\partial Y_{qm}}} \tag{33}$$

$$\frac{\alpha_{q1}}{\alpha_{qm}} = \frac{\partial W^j_{q1}}{\partial W^j_{qm}} \cdot \frac{\partial Y_{qm}}{\partial Y_{q1}} \tag{34}$$

While the model yields the welfare parameters in terms of ratios, the setting of one parameter to unity as a base will yield a series of relative distributional weights.

4.3 Assumptions of the Random Welfare Model

There are a number of assumptions upon which this random welfare model is dependent.

A key assumption of this study is that respondents are able to remove their personal self interests and respond from the perspective of expressing their social justice preferences. The ability of respondents to view policy in this manner is supported in a study of the equity considerations of the burden of meeting the costs of environmental policy (Atkinson et al. 2000). The authors did not find strong support for the proposition that respondents significantly allowed their own position to influence their ranking of different options. Consequently, a degree of interpersonally comparable cardinal utility is assumed. It is also assumed that respondents have some knowledge of the well-being of groups within society under the status quo policy.

There is a trade-off between efficiency and equity considerations. Naturally the most efficient distribution may not be the most equitable. The inclusion of equity preferences is therefore likely to include an inherent efficiency loss. While this is an important consideration, it is deemed beyond the scope of this study. Hence, for the purposes of focusing on equity considerations, it will be assumed that there are no allocative efficiency effects and that choice is made purely on equity grounds.[23]

5. Advantages in using CM to estimate welfare changes.

Freeman (1998) defines a *social choice* as a decision made by society to move to a certain social state. Even doing nothing is a social choice as the alternative of doing something has been rejected. Social choice cannot be avoided. The use of CM to

[23] Atkinson, et. al. (2000) also make this assumption in a study of the equity considerations associated with the distribution of the cost burden of environmental policy.

address the distributional consequences of policy alternatives provides another means of eliciting the information required for informed social choice.

Two alternate forms of social choice procedure are voting on alternative social states or the delegation of authority to make social choices to a politically responsible agency, body or individual. In either case it is valuable to know if choices actually reflect the underlying preferences or welfare functions of individuals. Yet, neither form of social choice procedure, voting or representation, can in principle determine social orderings and make social choices that conform to the preferences of individuals (Freeman 1998). Musgrave and Musgrave (1989) argue that the state as a cooperative venture among individuals must reflect their interests and concerns. Individuals do not live in isolation but are members of groups and thereby have common concerns.

The application of a choice modelling approach to the question of social choice provides an alternate social choice mechanism. It provides the opportunity for social welfare orderings of the community at large to be voiced. The ability to disaggregate the sample of respondents allows for estimation of any variance in social preferences between representatives and the general population.

Furthermore, in some environmental policy contexts, beneficiaries of various programs and those with vested interests are more likely to be politically organised. They can thus influence political outcomes, whereas the interests of the unorganised general public are neglected (Persson and Tabellini 2000). Choice modelling can have a positive role in overcoming this potential policy bias.

Finally, CM is an appropriate preference elicitation method as it characterises the decision environment and it is able to align itself closely with realistic policy options (Bockstael and McConnell 1999).

5.1 Limitations

As with all research, and in particular attempts to build bridges between complex theoretical questions and the reality of policy environments in which decisions need to be made, there are a number of limitations to this research.

The cognitive difficulty associated with complex choices between bundles with many attributes and levels is a limitation of the methodology. Despite attempts to use language with which respondents are likely to be familiar, there is no doubt that the concepts being raised are difficult for respondents to consider.

While it is assumed that respondents have a level of information about the status quo level of welfare of the various groups, this level of knowledge is only a perception. However, it is this perception that will form the basis of their preferred distribution and social choice.

Even if the most appropriate distribution is determined in terms of policy outcomes, in many cases the issue will remain at to the most appropriate method to achieve a particular distribution. Thus, the focus of this research is on *distributive* justice, which concerns the final allocation of economic rewards and responsibilities, as opposed to *procedural* justice, which concerns just processes. While recognising the importance of procedural justice, it is deemed beyond the scope of this study.[24]

6. Conclusion

Given that the aim of BCA is to provide a ranking of policy proposals, the analysis of policy options requires two strands, addressing both the efficiency and the equity implications of policy alternatives. This paper addresses the equity issue by showing that it is possible to use the stated preference technique of choice modelling to derive distributional weights applicable for BCA. An advantage of this approach is that it takes the value judgement away from the policy maker and the economist and places it with the community. Policy interventions have to be sensitive to the gainers and losers, not only because that matters from a social justice point of view, but also because the political acceptability and effectiveness of the measures will depend on the distribution of the costs and benefits.

[24] For example, Syme, et.al. (1999) found procedural justice was an important aspect of equity considerations for respondents in a study of the allocation of water.

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