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NON-COMPENSATORY PREFERENCE STRUCTURES IN NON-MARKET VALUATION OF NATURAL AREA POLICY

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Non-compensatory preferences may form a significant component of individuals' values for non-market goods such as natural areas, especially in the context of a reduction in environmental quality. The widespread neglect of such preferences can result in erroneous estimates of changes in economic welfare. Non-market valuation using techniques such as contingent valuation therefore need to take into account the possibility that some individuals hold non-compensatory preferences. The formal structure of the lexicographic non-compensatory ordering is described, and the theoretical implications of an individual holding such preferences over some region of goods space is examined. A method for the empirical identification of non-compensatory preference orderings is outlined.

Introduction

There are a number of methods employed by economists to measure the non-market economic values of natural areas for use in benefit cost analyses. Direct estimation methods such as contingent valuation (CV) are based on responses to hypothetical valuation questions. Indirect methods based on actual behaviour include the travel cost method, hedonic pricing and voting in a referendum. Indirect hypothetical methods infer values from hypothetical questions concerning behaviour, as in the contingent ranking method (Freeman 1993). This paper addresses an issue of value identification which may effect the hypothetical methods, as well as a method such as referendum voting which uses discrete choice and random utility models to infer values. While I will concentrate on CV, because of its widespread use and ability to encompass all components of non-market economic value, similar arguments apply to the other hypothetical methods and to referendum voting.

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CV requires that the values expressed by participants can be meaningfully encompassed by economic welfare theory. Specifically, CV should produce Hicksian measures of changes in economic welfare. These measures are grounded in the existence of a continuous utility function which is itself dependent on an individual's preferences satisfying a number of structural conditions. The neoclassical economic notion of value depends on the existence of exchange relations between valuable goods. Preferences satisfying the axioms of completeness, reflexivity, transitivity, nonsatiation, continuity and strict convexity can be represented by a function which allocates a real number to each good to indicate its rank order. A consequence of the continuity condition is that any change in one good can be compensated for by a change in another good. This implies that for any quantity of one good there will always be a quantity of another good such that an individual is indifferent between them. A preference ordering which satisfies these conditions can be represented by a utility function which allocates a real number to each bundle to indicate its rank order, so that all bundles in the same indifference set have the same number, and bundles in the preferred indifference sets have higher numbers. I will use the term exchange preferences to describe such a preference structure.

In general, utility can be considered as a function of market goods $\mathbf{x}$ and public goods $\mathbf{q}$, so that an individual is assumed to maximise $u = u(\mathbf{x},\mathbf{q})$ subject to a budget constraint W. The expenditure function $e(\mathbf{p},u)$ relates the minimum expenditure necessary to achieve a specified utility level to vectors of prices $\mathbf{p}$ and public goods $\mathbf{q}$ faced by the consumer. The expenditure function can be used to derive Hicksian welfare measures. For example, the compensating surplus (CS) associated with an increase in the provision of a particular public good q_i from q' to q'', which is expressed by willingness to pay (WTP), is given by:

$$CS = WTP = -\int_{q'}^{q''} e(p,q_i,u')dq$$

where u' indicates the level of utility before the change.

Such welfare measures require the existence of a continuous utility function. While 'kinks' in the utility function (so that the nonconvexity assumption does not hold) are an integral part of environmental economic theory, a complete break in the function (ie., its nonexistence for specified levels of q_i), is a more fundamental type of discontinuity. Such a fundamental discontinuity may arise if some people are not willing, over a given range of q_i, to make tradeoffs between natural areas and other goods and services.

Etzioni (1986) argued that the qualitative differences between moral and utilitarian preferences may imply they cannot be traded off or substituted for each other. Furthermore, essential social and biological functions may be irreducible, so that the notion of indifference does

not apply (Georgescu-Roegen 1954). Moral and essential goods and services may therefore, under certain conditions or limitations, be associated with non-compensatory preference structures (Edwards 1986).

Natural areas may be regarded as having moral content if they have intrinsic value. Although, as far as I am aware, there have been no surveys specifically documenting the extent to which people consider natural areas to have value in their own right, it is evident from the activities of animal rights and conservation groups that some people believe that humans have obligations in relation to the natural world which arise from the intrinsic value of animals, plants and even collective entities such as ecosystems. One way people can express such beliefs is through non-compensatory preferences. For example, below a certain level of provision, some goods become essential to support life. Where this life is considered to be intrinsically valuable, such essential goods do not have any substitutes, and it makes no sense to trade them. Some people attach such values to certain plants, animals, natural areas, and of course to themselves and other people.

Discontinuous, non-compensatory preferences can be described by lexicographic structures, in which a good with a particular value or attribute is always preferred to any amount of another good. If lexicographic preferences can be motivated by, for example, moral concerns arising from the perceived intrinsic value of natural areas, it is likely that some people might hold such preferences for natural areas. Lexicographic preferences satisfy the axioms of completeness, transitivity, reflexivity and nonsatiation, but not continuity or strict convexity. For people who have lexicographic preferences attached to certain levels of provision of natural areas, indifference relationships between natural areas and other goods cannot be defined for these levels, so a continuous utility function does not exist, and any WTP is not equivalent to CS.

Evidence from the decision research literature suggests that the use of non-compensatory strategies is widespread, especially where decisions are complex and involve multiple attributes. Ford *et al.* (1989) reviewed 24 studies which indicated that non-compensatory strategies were more commonly used by decision makers than optimising or compensatory strategies. Compensatory strategies were used only when the number of alternatives and dimensions were small or as a secondary decision mode after a number of alternatives had been eliminated from consideration. Zakay & Tsal (1993) examined the use of compensatory multiattribute utility versus lexicographic strategies. Six problems each involving three alternative were designed to identify by the decision mode used by participants. A compensatory strategy would lead to a choice of the alternative with the highest utility, whereas the lexicographic approach would result in choice of the alternative which was rated best on the most important attribute. Of the 99 participants 32 had a strong tendency towards using a compensatory strategy, 37

had a strong tendency towards using a lexicographic strategy, and the other 30 had no stable decision mode.

This research has been primarily concerned with choice situations involving a clearly superior alternative which can be identified through some compensatory decision making process. The use of non-compensatory strategies is thus viewed as an inferior mode of decision making, and their adoption typically explained by cognitive or time limitations. Combining information from different dimensions is often problematic for survey participants, and the predictive power of non-compensatory models such as the disjunctive and lexicographic orderings is taken by Hershey *et al.* (1982) to indicate deficiencies in information processing. However, where comparisons are made between qualitatively different value components, non-compensatory decision processes can be rational. Lexicographically ordered preferences may be appropriate when a good is essential or is ascribed moral or some other irreducible form of value.

Goods such as natural areas which tend to be dominated by non-market values are likely to attract moral commitments, or be viewed as providing irreducible services. This is especially true for goods which are ascribed nonuse values. At present measurement of nonuse values requires the use of a hypothetical survey approach such as CV. Referendum voting methods and hypothetical non-market valuations, particularly CV, need to take into account the possibility that some individuals hold non-compensatory preferences for natural areas. This paper describes the formal structure of the lexicographic ordering, examines theoretical implications for measurement of economic welfare arising from an individual holding such preferences over some region of goods space, and outlines some possibilities for their empirical identification and aggregation.

Lexicographic Preference Structures

Following Gravelle & Rees (1981, p. 92), for a choice involving a pure public environmental good, say two levels of provision of old growth forest F, f^1 and f^2 ($f^1 > f^2$), and a bundle of private goods and services W which define the material wellbeing of the person ($w^1 > w^2$), then hierarchical lexicographic preferences over F and W are such that:

$$f^1 \succ f^2 \text{ implies } (f^1, W) \succ (f^2, W), \text{ and}$$

$$f^1 \sim f^2, \text{ and } w^1 \succ w^2 \text{ implies } (f^1, w^1) \succ (f^2, w^2),$$

where $\succ$ indicates 'is preferred to', $\sim$ indicates 'is indifferent to', and choice is primarily determined by the quantity (or quality) of F, and secondarily determined by the quantity of W. In practice, small differences must be disregarded, because at some point it will make no sense to require $f^1 \succ f^2$ if the difference in quantity (or quality) is negligible. This principle, called order by the first significant difference by

Fishburn (1974), says that one alternative is better than another if the first is better than the second on the most important criterion on which they differ. For example, in comparing areas of forest differences of 1 hectare may be regarded as significant, but differences of some fraction of a hectare regarded with indifference.

This version of the lexicographic model which is based on a fixed ranking of criteria has been of little interest to economists because it rules out all possibility of tradeoffs. Several more flexible variants of the basic model have been developed where people are assumed to set targets or have thresholds for attributes, as well as ranking them according to their priorities. A criterion may be satiated upon which it is demoted down the hierarchy (Georgescu-Roegen 1954; Encarnación 1964, 1990), or the ranking of criteria may be continuously varied by imposing continuity on each criterion's preference relation and on the criteria's ordering, which allows another criteria to apply without satiation with respect to a hitherto more important criterion (Moldau 1993).

Georgescu-Roegen (1954), Encarnación (1964), and Keeney & Raiffa (1976) outlined threshold models based on some good for which there can be psychological or physical need and then satiation. For example, if good X is food and good F is forest then a person will operate in terms of X until satisfied at x^*, then assess bundles on the basis of F:

$$(x_1, f_1) \succ (x_2, f_2) \text{ if}$$

(a) $x_2 < x_1 < x^*$

(b) $x_2 = x_1 < x^*; f_2 < f_1$

(c) $x_2 < x^* < x_1$

(d) $x^* < x_1, x^* < x_2; f_2 < f_1$.

In the absence of a criterion such as F which can complete the hierarchical ordering, the points x_1 and x_2 may be indifferent when $x_1 > x^*$ and $x_2 > x^*$. A threshold can also be established for F, and multiple thresholds for the one good are also possible (Fishburn 1974, Keeney & Raiffa 1976, Edwards 1986). The line (x^*, F) in commodity space has some characteristics of an indifference curve, but all points on it are ordered. Encarnación's model requires that if options q and r are satisfactory on all criteria, or if q and r are both satisfactory on the first n–1 criteria and indifferent on the last criterion, then $q \sim r$. Fishburn (1974) noted that if q and r are satisfactory on all but is q better on the first criterion, then it is more reasonable to have $q \succ r$, and proposed the following modification. If there is any criterion by which q and r are not indifferent and at least one satisfactory, they are ordered according to preference on the most important criteria. If both are satisfactory on all criteria, q and r are ordered according to preference on the most important criterion on which they are not indifferent.

This model can be further developed by introducing more than one satisficing level for each criterion.

Welfare Implications of Lexicographic Preferences

A threshold model can be used to examine the implications of lexicographic preferences for welfare measures. Let f* be the level of provision of F for which, when $f_i \leq f^*$, lexicographic preferences apply for all W, while at $f_i > f^*$, exchange preferences apply, and f^a is the zero level of provision. Similarly, let w* denote the level of provision for W for which, at $w_i \leq w^*$, lexicographic preferences apply for all f_i, while at $w_i > w^*$ exchange preferences apply, and w^a is the zero level of provision. I assume exchange preferences are convex, but may allow generation of corner solutions to a utility maximisation problem (that is, indifference curves may intersect some hyperplane f^a, f*, w^a or w*).

In this decision space the budget constraint is specified by $y^0/\mathbf{p}$ where y^0 is the initial income level and $\mathbf{p}$ is a vector of prices corresponding to the various goods and services in bundle W. Since F is a pure public good, $d(y^0/\mathbf{p})/dF = 0$, and the budget constraint is equivalent to the expenditure function $e(\mathbf{p}, f^n, U^n)$ where n denotes some utility level. Where $f_i > f^*$ given $0 < f^* < \infty$, and $w_i > w^*$ given $0 < w^* < \infty$, then exchange preferences are indicated. That is, the axes defining the boundaries of conventional economic decisions have shifted from $\{(f_i,w^a), (f^a,w_i)\}$ to $\{(f_i, w^*), (f^*,w_i)\}$. Here lexicographic preferences are defined according to certain quantities of F and W. U^0 and U^1 are two indifference curves with $U^0 > U^1$ and U^1 defined as the lowest level of utility for which preferences are continuous (that is, have characteristics compatible with an exchange preference ordering). The domain of lexicographic preferences is thus actually larger than $\{(f_i|f_i \leq f^*), (w_i|w_i \leq w^*)\}$, and includes all points to the left of and below U^1.

If a reduction in provision of F from f^0 to f^1 is proposed, with $f^1 \geq f^*$, then exchange preferences apply and conventional economic analysis may be used. Under these conditions, a technique such as CV may in principle provide a legitimate measure of non-market economic values. For a reduction in F the appropriate Hicksian welfare measures are given by the compensating surplus CS, which is the minimum compensation that must be given to the person to leave her or him as well off as before the change, where:

$$(1) \quad CS = -WTA = [e(\mathbf{p},f^0,U^0) - e(\mathbf{p},f^1,U^0)],$$

or the equivalent surplus ES, which is the maximum amount that must be paid by the person to make her or him as well off as after the change, where:

$$(2) \quad ES = -WTP = [e(\mathbf{p},f^0,U^1) - e(\mathbf{p},f^1,U^1)].$$

CS and ES are negative for a reduction in F.

For a change from f^0 to f^2, where $f^0 > f^1 \geq f^* > f^2$, the choice process will involve both lexicographic and exchange decision modes. Under these conditions, if a person was able to separate his or her exchange from lexicographic preferences, she or he would have the ability to make appropriate responses to a CV survey. Given the option, the respondent would simply choose the level f^* on a noneconomic basis. Thus f^* is effectively an expression of this participant's 'safe minimum standard' for F. Then she or he would express a willingness to accept compensation (WTA) for a reduction in provision of F, or a willingness to pay (WTP) for an increase in provision or for security of current provision (depending on the property rights assumption made).

Note that, where there a few substitutes for the good being valued, the disparity between WTP and WTA can be considerable (Hanemann 1991). Boyce et al. (1992) used the example that if participants were asked to accept monetary compensation from whalers to allow continued harvesting of blue whales, WTA may approach infinity. It is also likely that some participants would reject the notion of a tradeoff between whales and income, and would therefore refuse to answer the question. For these people, such WTA questions may involve a choice between a moral belief or an irreducible intrinsic value, and an increase in wealth. Non-compensatory lexicographic preferences may more accurately represent such choices than an exchange preference structure. On the other hand, the same participants may have a WTP for saving whales — they may be willing to buy intrinsic or moral values, but not sell them. Decisions which involve WTA property rights are thus more likely to attract lexicographic preferences than circumstances where WTP is the appropriate format, either for a good as a whole, or once the level of the good drops below some threshold of acceptability.

Current CV formats do not give respondents an opportunity to partition their decision making process into compensatory and non-compensatory components. There is also insufficient information in conventional CV data to determine whether the WTP or WTA is 'tainted' by a non-compensatory preference structure. It possible that a respondent with non-compensatory preferences over at least part of the range encompassed by the contingent market would either refuse to participate in the survey, offer a protest response, try to play the game by inflating their response in an attempt to introduce their non-compensatory value into the process, or offer a WTP which is not a Hicksian measure of welfare change. It is also possible (though highly unlikely) that, rather than lexicographic preferences being squeezed into the CV exchange preference framework, some participants CV surveys do distinguish between the two modes. In this case, the welfare measures actually apply to less resource than is usually assumed, leading to possible underestimation of unit values. In principle this might be checked by comparing CV measures and predicted

welfare changes inferred from a preference map constructed as described in the next section of this paper. Where appropriate distinction is being made between the preference modes, the two measures should of course be equal.

If rights to the future level of provision are assumed, below f* a respondent would be WTP any amount of W down to w* to secure f*. However, this sacrifice may not be regarded by the respondent as a transaction based on free exchange, but as the payment of a ransom for recovery of a valued item. Ransom demands cannot be considered as Hicksian measures of economic welfare, because the person can never be indifferent between the value of the ransom paid and the value of the ransomed entity. The magnitude of the ransom is independent of the value of the entity, so the same payment may be offered for different quantity changes even though each increment in provision is valued. If, on the other hand, the CV scenario assumed rights to the initial level of provision, WTA to allow a reduction in the public good would be undefined.

To assess the theoretical implications of a respondent 'playing the game' contrary to their true preference ordering, consider a pseudo indifference curve U_p which is located within the domain of lexicographic preferences — pseudo because although a purely neoclassical analysis would assume its existence, it is in fact within a region of the preference map where indifference between different bundles is not defined. This is the 'utility level' which is reached after a reduction in provision of F to f^2. A conventional analysis would predict welfare measures of a quantity determined pseudo CS and ES (denoted by ${}^{P}CS_q$ and ${}^{P}ES_q$ respectively):

$$(3) \quad {}^{P}CS_q = -{}^{P}WTA_q = [e(\mathbf{p},f^0,U^0) - e(\mathbf{p},f^2,U^0)], \text{ and}$$

$$(4) \quad {}^{P}ES_q = -{}^{P}WTP_q = [e(\mathbf{p},f^0,U_p) - e(\mathbf{p},f^2,U_p)].$$

Since $-[e(\mathbf{p},f^0,U^0) - e(\mathbf{p},f^2,U^0)] > -[e(\mathbf{p},f^0,U^0) - e(\mathbf{p},f^1,U^0)]$ and $-[e(\mathbf{p},f^0,U_p) - e(\mathbf{p},f^2,U_p)] > -[e(\mathbf{p},f^0,U^1) - e(\mathbf{p},f^1,U^1)]$, these measures overestimate the true change in economic welfare by:

$$(5) \quad -({}^{P}CS_q - CS) = -\{[e(\mathbf{p},f^0,U^0) - e(\mathbf{p},f^2,U^0)] - [e(\mathbf{p},f^0,U^0) - e(\mathbf{p},f^1,U^0)]\}$$

$$= [e(\mathbf{p},f^2,U^0)] - e(\mathbf{p},f^1,U^0), \text{ and}$$

$$(6) \quad -({}^{P}ES_q - ES) = -\{[e(\mathbf{p},f^0,U_p) - e(\mathbf{p},f^2,U_p)] - [e(\mathbf{p},f^0,U^1) - e(\mathbf{p},f^1,U^1)]\}.$$

If $w_i < w^*$, choices would be only directed at increasing the provision of W to the minimum essential level. As noted above, if some exchange is required to achieve w*, such exchange would be governed by lexicographic preferences in that any choice set will be judged on its effect on W regardless of its F content. This of course assumes W

is primary and F secondary. If F is primary then consideration will only be given to attaining w* after f* has been achieved.

A person may also have lexicographic preferences for a particular value component of the public good, regardless of its level of provision. Nonuse value is a likely candidate, given the predisposition of such value to be motivated by ethical concerns. In this case economic welfare measures may again be overestimates. Consider the situation where use and nonuse values associated with F are weakly complementary, use values can purchased at price p, and have a choke price of p* (so, unlike the previous case, F here is a mixed good). Following Freeman (1993), the economic value of a reduction in F from f^0 to f^1 is given by:

$$(7)\quad CS = CS_u + CS_n$$
$$= \{[e(p^*,f^1,U^0) - e(p,f^1,U^0) - e(p^*,f^0,U^0) + e(p,f^0,U^0)]$$
$$+ [e(p^*,f^0,U^0) - e(p^*,f^1,U^0)]\},$$

where CS_u is the compensating surplus arising from a change in use value and CS_n is the compensating surplus arising from a change in nonuse value. If some of the nonuse value is actually represented by lexicographic preferences, similar possibilities to the previous case apply. A respondent might attempt to represent their lexicographic preference for nonuse value within the economic format offered by a CV survey. Under such circumstances, WTA is inflated by up to:

$$(8)\quad -({}^{P}CS_c - CS) = e(p^*,f^0,U^0) - e(p^*,f^1,U^0),$$

where ${}^{P}CS_c$ is a component determined pseudo CS. Analogous problems may affect estimation of ES. Component determined lexicographic preferences for F would make the 'indifference' curves into behaviour curves along which all points are ordered by an existence value criterion.

Empirical Possibilities

There have at least two studies which have looked at the possibility of whether lexicographic preferences are evident in non-market valuation of natural areas. Stevens *et al.* (1991) concluded that their experiments could not rule out the possibility that some of their respondents had lexicographic preferences when valuing wildlife preservation. Respondents were asked to agree or disagree about the following trade-off statements:

(i) A long as I have enough money to live on, wildlife preservation is more important to me than having more money.

(ii) Wildlife preservation and money are both important to me; but decisions have to be made and more money could make up for the loss I would feel if there were less wildlife.

(iii) No matter how much money I have, having more money will always be more important to me than wildlife preservation.

The 24% of respondents who disagreed with (ii) and agreed with either (i) or (iii) may have lexicographic preferences for wildlife. However, the meaningfulness of questions which offer a few extreme options in which key components such as 'more money' are not defined is questionable. The inadequacy of such questions for revealing much about respondents' value structures is indicated by the fact that 70% of respondents gave answers which were inconsistent with both the compensatory and lexicographic preferences. In any case, such questions will not help identify the details of a respondent's preference structure when they employ mixed decision modes.

Spash & Hanley (1995) explored the possibility that some people may hold rights based beliefs which may motivate lexicographic preference structures. The rights they examined concerned the right to protection from harm for animals, all biota and ecosystems. Their experiment used two samples; a student sample of 125 and a general public sample of 198. Results were similar for the two samples. For the general public sample, 99.5% of respondents stated that animals, plants or ecosystems had a right to be protected, 74.7% at any cost. Of those who stated they believed in protection regardless of cost: (i) 68.9% had a positive WTP, and (ii) 31.1% did not state a WTP. Spash & Hanley (1995) considered group (ii) to be exhibiting lexicographic preferences. Group (i) appear to have offered inconsistent responses to the questions. However, as noted by Spash & Hanley (1995), there are several other explanations apart from inconsistency, including the possibility that these respondents may have lexicographic preferences for a standard of living with a threshold which is close to their current level of income. It is also possible that, as with the Stevens *et al.* (1991) experiment, the survey instrument did not create an institution which required respondents to seriously consider tradeoffs between their own wealth and changes in provision of biodiversity. The 'regardless of cost' question was framed in terms of costs to society, which may have elicited a quite different valuation response compared with the personal WTP question.

At best, the Stevens *et al.* (1991) and Spash & Hanley (1995) experiments suggest the possibility of lexicographic preferences. Convincing evidence for or against the existence of lexicographic preferences requires detailed information on the structure of an individuals preferences over relevant ranges of F and W, including regions where indifference relations apply and regions where non-compensatory structures are operative. Identification of indifference relations is an obvious starting point for such a mapping, but there have been few empirical attempts to estimate indifference curves. Wallis & Friedman (1949, cited in MacCrimmon & Toda 1969) considered that a satisfactory experiment was impossible to design because first, hypothetical choices do not elicit accurate preferences and second, to imitate real-

istic economic decisions, a context involving long periods of time and many different situations must be devised. Developments in non-market valuation over the past two decades, and in particular CV, have reduced the potency of such conclusions. Sinden & Wyckoff (1976) listed the reasons for a lack of reported studies as the time and interviewer skill required, the large number of choices involved, and the lack of well developed alternatives for many assessment contexts. Earl (1983) noted that the construction of an indifference map required considerable respondent introspection to be able to state preferences among all possible combinations of commodities, and asserted the impossibility of using questionnaire methods to do this. Mitchell & Carson (1989) criticised the expected utility based indifference mapping experiments of Sinden (1974), Sinden & Wyckoff (1976) and Findlater & Sinden (1982), which involved tradeoffs between recreation at two sites, on the grounds that the resulting maps gave no indication of whether respondents are interested in recreating in either park, and the potential for the method to elicit attitudes rather than behavioural intentions. Furthermore, the game-theoretic construction of indifference curves and utility functions under uncertainty (Hershey *et al.* 1982; Findlater & Sinden 1982) does not provide a realistic decision context for assessing welfare changes resulting from proposed certain changes in supply of natural areas.

More promising for present purposes is direct construction of a preference ordering. In the work of MacCrimmon & Toda (1969) and MacCrimmon & Wehrung (1977) alternative bundles were compared with a reference bundle, building up preferred and non-preferred spaces, resulting in eventual identification of a narrow region within which the respondent can trace an indifference curve. Incentive to reveal preferences was provided by a suitable pay-off procedure. This approach of simply comparing bundles of goods under certainty directly establishes indifference sets but the relative utility between each curve is unknown. However, direct determination of a preference ordering across bundles each comprising both a non-market good and income allows bounds to be established for 'indifference' sets. Assuming all participants have effectively no satiation level for money, ranking such bundles should overcome Mitchell & Carson's (1989) objections to the method.

The concerns regarding cognitive demands and incentive to reveal true preferences can be addressed to some extent by appropriate experimental design. Methods devised to address similar problems for the CV offer insights into ways of successfully constructing preference maps. For example, Fischhoff & Furby (1988) advocated the following requirements for an effective hypothetical valuation context: (i) substantive definition of the good in terms of its attributes, context, source of change in its provision; (ii) formal definition of the good in terms of reference and target levels, extent and timing of change, and certainty of provision; (iii) substantive definition of the value measure

including payment vehicle and relevant constituency; (iv) formal definition of the value measure including extent, timing and certainty of payment; and (v) description of the social context including other people involved, the resolution mechanism and other matters such as externalities, precedents, and legitimacy of the process.

Such features could be readily incorporated into a preference mapping exercise. In addition, for many respondents, participating in a preference mapping exercise would probably involve value construction, or at least value clarification, rather than simply uncovering existing well defined preferences (Gregory *et al.* 1993; Irwin *et al.* 1993). This suggests the desirability of using a process consisting of several stages and repetitions. Lazo *et al.* (1992) recommended that participants should have access to expert opinion and detailed information concerning the resource of interest so that their values can crystallise and become stable.

These elements were incorporated into a pilot experiment in which five participants were asked to indicate their rank ordering of (F,W) bundles presented in a matrix showing 120 pairs (10 levels of W and 12 levels of F). Each bundle constituted a hypothetical state in which the participant was asked to locate themselves. The F component was a guarantee that the stated forest area would remain unlogged in perpetuity, with the balance being available to timber harvesting on the basis of 80 year rotations. The range of the W component was the participant's annual income w^0 to (w^0 – \$10,000). Both increases and decreases from f^0 were examined. Lexicographic preferences for F were considered to occur when more unlogged forest was preferred irrespective of income, within a certain income range and forest area range. Lexicographic preferences for W were considered to occur when more income was preferred irrespective of the area of reserved forest, again within a certain income and forest area ranges. Exchange preferences were considered to occur where an increase in income induced the participant to prefer less forest.

Two participants constructed maps which displayed exchange preferences throughout the F and W ranges. One participant had lexicographic preferences for W between w^0 – \$2,000 and w^0 – \$10,000, and two participants had thresholds under which they had lexicographic preferences for F. However, all participants remarked on the difficulty of the task. The method placed excessive cognitive demands on respondents and they took up to two and a half hours before being satisfied with their orderings (two participants), or becoming fatigued with the exercise so that they could not be bothered spending more time on it (three participants). While the pilot clearly showed the potential of direct preference map construction, significant modifications are required to reduce the time and complexity of the task.

A less demanding approach is suggested by the work of Peterson *et al.* (1994) who used a series of isolated paired comparisons over a

range of goods and dollar amounts to construct a preference ordering of non-market goods. The average time for each participant to complete 155 comparisons was 10 minutes. The occurrence of individual choice inconsistencies in relation to the dominant preference ordering was surprisingly low, given that each pair was assessed independently by the participant Inconsistencies result in circular triads in which preferences amongst three choice options are intransitive. In a total of 51,150 choices 3,804 (7.4%) were inconsistent, with 1542 of these being switched on retrial. Intransitivities in choice may be due to mistakes the respondent corrects under repetition (apparently about 40% came into this category in the Peterson *et al.* experiment), similarities that are so close as to result in fluctuations in choice, or an expression of genuine intransitivities in preferences. Retrials and follow-up questioning can identify which of these possibilities apply. In any case, the frequency of inconsistent choices did not, in this instance at least, significantly compromise the establishment of rationally supportable preference ordering.

The paired comparisons method can be adapted to use bundles rather than individual goods, with each bundle comprising a specified quantity of the non-market good of interest and a specified proportion of the respondents income. A series of comparisons of such bundles across varying quantities of the non-market good and levels of income (including amounts above the respondents current income to allow for WTA measures) could be made. Paired comparisons have the advantage of minimising the cognitive demand placed on participants for each individual comparison.

For **m** levels of W and **n** levels of F an ordinal ranking of **m** by **n** bundles requires comparison of $(\mathbf{mn})[(\mathbf{mn}) - 1]/2$ pairs. However, it can be assumed that (i) more W will always be preferred to less, so that bundles with the same F component can be pre-ordered according to the level of W they possess. This reduces the number of pairwise comparisons to $\mathbf{mn}(\mathbf{mn} - \mathbf{m})/2$ pairs. Similarly, it is reasonable to assume that (ii) for those participants who place a positive value on forests, more forest in reserves will be preferred to less for a given level of W, further reducing the number of comparisons required to $(\mathbf{m^2n^2} - \mathbf{mn^2} - \mathbf{m^2n} + \mathbf{mn})/4$. The same number of comparisons is required for participants who disapprove of increases in F (though they will have a different set of non-redundant pairs). To produce a complete rank ordering of the 120 bundles, as in the pilot experiment above, the initial 7140 pairwise comparisons reduces to 6600 under assumption (i), and 2970 under assumptions (i) and (ii). Clearly this number of comparisons is still impractical.

However, a useful preference ordering could be obtained from say eight levels of F and four levels of W. For example, assuming that at present 50% of forests are in reserves, participants could be presented with pairs involving F set at 0%, 1%, 20%, 21%, 40%, 41%, 49%, or 50% and W set at w^0+500, w^0+100, w^0+2000 or w^0+5000. Given

assumptions (i) and (ii), a complete preference ordering of (F,W) bundles made up of these values would require 168 decisions. Such a design would be practical in a survey context, and the 1% increments of F would enable lexicographic preferences to be identified with some confidence. For a given 1% change in F, participants who prefer more forest to less regardless of the level of W can be considered to have lexicographic preferences over this range of F.

Nonetheless, to recover a complete ranking of bundles, each participant must still make a large number of paired comparisons. Design of the decision context should be such that the danger of fatigue and boredom are minimised. Randomisation of the order in which bundles are compared is also required to minimise bias in the data.

Once individuals' preferences have been determined, some decision rules are required so that advice can be provided to decision makers on the outcomes of aggregating values. It is implausible, perhaps, that a large number of people would possess lexicographic preferences for environmental improvement. However, as discussed above, lexicographic preferences may be more prevalent with respect to a reduction in environmental quality. Consider a proposal to decrease the area of protected forest F by some specified amount. Assume all benefits associated with this proposal can be included in a benefit-cost analysis (BCA), and that the BCA uses the net present value (NPV) criterion. Those people who have a negative value for the proposal may express this either through lexicographic preferences or a WTA (counted as a cost). The proposal can be considered to be rejected if more than 50% of participants have a lexicographic preferences against it, regardless of the NPV result. If less than 50% of participants have lexicographic preferences and NPV < 0, then the proposal is also rejected. If less than 50% of participants have lexicographic preferences and NPV > 0, then the proposal is supported.

Though it may be implausible that 50% or more people hold lexicographic preferences for an increase in F by some specified amount, the existence of any level of lexicographic behaviour could give rise to an interesting aggregation problem. Assume all opportunity costs associated with the proposed increase in F can be included in a BCA. Those people who have a positive value for the proposal may express this either through lexicographic preferences or a WTP (counted as a benefit). In the unlikely event that more than 50% of participants have lexicographic preferences for the change, the proposal can be considered to be supported regardless of the NPV result. If less than 50% of participants have lexicographic preferences and NPV > 0, then the proposal is also supported. If less than 50% but more than zero participants have lexicographic preferences and NPV < 0, then an 'imputed' WTP for the lexicographic participants can be included and a revised NPV calculated. If this NPV > 0, then the proposal is supported. The imputed WTP for those people with lexicographic preferences is the difference between their current level of W and the

minimum W they require to support an acceptable lifestyle (that is, w*). While this WTP is not a Hicksian measure of change in economic welfare, this approach does enable inclusion of those individuals with lexicographic preferences into the assessment procedure.

The potential importance of imputing a WTP from lexicographic preferences is well illustrated by an example given by a referee, which I paraphrase here. Suppose that a particular constituency of N people is considering the preservation of a forest owned by a timber company who will sell the forest for $X. If the people comprising this constituency do not purchase the forest, the area will be logged by the timber company. N–1 individuals have positive exchange values which sum to $X – ε, so that NPV < 0. The Nth person has lexicographic preferences for F so long as $W > w^*$. The person would have a WTP of $W – w^*$, but this WTP is not a Hicksian measure of change in her or his economic welfare. However, it seems reasonable to include this person in the BCA, even though their preferences are not of the form required by theory. Not to do so would seem to miss a Pareto improving opportunity.

A further case of interest is when a development has already taken place, and some cost must be incurred to reverse the resulting environmental damage. The costs of remedying the problem can be justified up to the sum of each individual's $W – w^*$ for those who hold lexicographic preferences, plus the sum of individuals' WTP for those who hold exchange preferences.

Conclusions

Non-market valuation using techniques such as CV need to take into account the possibility that some individuals hold non-compensatory preferences for natural areas. Where preferences are constructed using information on minimum biological requirements for the maintenance of viable populations and ecosystem integrity, a lexicographically defined preference discontinuity is effectively a social construction of a minimum acceptable standard for environmental quality. Such preferences are mostly likely to occur in relation to policies which involve a reduction in environmental quality. If CV respondents are expressing preferences that are not exclusively founded on indifference relations between environmental values and marketed goods and services, then CV data cannot be interpreted simply or wholly as measures of economic value, and welfare estimations based on such data will be misleading.

Results of a pilot study show that some individuals do have complex preference maps which include regions of lexicographic preference for protection of native forests from logging. The method of paired comparisons can potentially be used to measure the extent of these lexicographic preferences. Constructing preference maps using paired comparisons potentially offers a means for distinguishing between exchange and

lexicographic preference modes, allowing improved estimates of economic welfare changes and better understanding of the structure of participants' values.

This paper also outlines some suggestions for aggregating data corresponding to exchange and lexicographic preference expressions. This integrated approach to value assessment is more inclusive than conventional BCA. While the notion of weighing up benefits and costs has been retained, a more comprehensive assessment of the value implications of a proposal can be undertaken, in which the actual structures of individuals' preferences are taken into account.

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