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Money, who needs it?
Natural Resource Damage Assessment

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A new natural resource damage assessment paradigm has been suggested that emphasizes direct analysis of compensatory restoration rather than analysis of compensating variation for damages. We consider whether money can be avoided in damage assessment. Our analysis of compensatory restoration leads us to conclude that money should be considered when measuring preferences. Failure to consider money leaves trustees unable to judge the adequacy of compensatory restoration. The problem stems from heterogeneity over restoration scale. Since environmental quality levels are public, even potential redistribution is precluded. We also find that service to service restoration does not generally meet standard welfare criteria.

1 Introduction

Several authors (Mazzotta et al. (1994), Unsworth and Bishop (1994), Jones and Pease (1997), Unsworth et al. (1999)) have discussed or suggested a shift of emphasis in natural resource damage assessment away from the monetary assessment of damages to direct analysis of compensatory restoration. Rather than first assess the monetary damages of the natural resource injuries and then use the money for restoration, trustees would instead focus on the scale of restoration projects that would make the public whole.

There are two primary justifications given in support of this new paradigm. First, Federal natural resource damage assessment statues explicitly require that recoveries be used for the purpose of enhancing or creating natural resources (Jones and Pease (1997), Mazzotta, Opaluch et al. (1994)).[1] Estimating preferences for both injured and replacement resources may result in a more efficient use of recoveries. Second, directly assessing compensatory restoration may avoid some of the controversy that has been associated with the monetary assessment of damages (Jones and Pease (1997), Randall (1997)). Much of the controversy over monetary damage assessment stems from the measurement of passive use values where small individual household damages can easily aggregate into the billions of dollars. For example, passive use value damages from the Exxon Valdez oil spill damage assessment were estimated at $2.8 billion (Carson et al. (1992)). Direct measurement of compensatory restoration may provide responsible parties relief from the problem of aggregating monetary compensation over millions of

[1]From an economic perspective, one can separate the problem of the amount of money necessary to compensate for loss and a requirement that restricts spending on specific public goods. Unless the specified public goods are under-supplied, a constraint on how the compensation is spent will only make the public worse off.

households since public goods are used to replace public goods. In accordance with this new shift of emphasis in natural resource damage assessment, recent damage assessments plans in Texas (Texas General Land Office et al. (1999)) and Wisconsin (Wisconsin Department of Natural Resource Services (1999)) were developed with an emphasis on compensatory restoration. It is safe to say that the paradigm shift has already happened.

We consider the question of whether or not money can be altogether avoided in damage assessment. We provide an analysis of the restoration methods that have recently been advanced. The use of pure compensatory restoration will result in some losers and some gainers relative to pre-injury utility levels due simply to the public goods nature of the compensatory goods. As the case with monetary compensation, a rigorous standard is necessary to meaningfully evaluate provides both the economic and legal standard for damage assessment. In the case of natural resource damage assessment, the goal is to determine monetary compensation or restoration projects that could, in principle, make the public whole. For those individuals who suffer a loss from the natural resource injury, willingness to accept (compensating variation), by definition, exactly satisfies the requirement that an individual can be returned to their pre-injury level of utility. Trustees could in principle provide each individual his or her willingness to accept compensation and exactly return the affected individuals to their pre-injury utility levels. Even though the actual remedy may not provide each individual his or her willingness to accept, economic principles provide a clear goal in monetary assessment of damages: estimate aggregate willingness to accept compensation.

Prior to the paradigm shift discussed above, the estimation of aggregate willingness to pay was the goal of damage assessment. The application of recoveries was, for practical and economic purposes, secondary. A great deal of emphasis was placed on accurately estimating aggregate willingness to accept compensation while little or no effort was placed on understanding the most economically efficient application of these recoveries to the compensatory restoration required under law. The reality of the former method that focused on monetary assessment of damages is that at least conceptually, trustees could make the public whole from the first stage of recoveries from the monetary assessment. Whether or not the public was actually made whole from a welfare economic standard was an open question.

It simply does not follow that such emphasis should be placed on the first phase of monetary damage assessment while the application of recoveries is overlooked. The thrust of the new paradigm is to measure losses, after primary restoration, in terms of compensatory restoration. Conceptually this new approach facilitates measuring the losses while measuring the necessary scale of restoration. This new approach has the potential for a real improvement over the old way of conducting damage assessment and the ensuing restoration.

Attribute-based stated choice methods (Swait et al. (1998)) are the logical class of analytical model to consider for restoration assessment since these models are capable of modeling preferences over multiple goods through choice experiments. Knowledge of preferences over both the injured resource and the compensatory resource is the key to the new approach. Following up on this possibility, the National Oceanic and Atmospheric Administration's guidance document for damage assessment under the Oil Pollution Act of 1990 notes in several places that losses and gains may be measured either in units of natural resources, natural resource services, or money (NOAA (1997)). At first glimpse, altogether avoiding money appears to eliminate the need to sum across all individuals' values. The big number problem, for responsible parties, is simply that while $2 compensating variation for a household is not very much, summing $2 per household across the U.S. quickly adds up to a considerable sum. The big numbers problem is undoubtedly one reason why responsible parties favor valuing losses in terms of compensatory restoration, rather valuing losses in monetary terms. While avoiding money may eliminate some political unpleasantries for trustees, pure compensatory restoration lacks a rigorous foundation for evaluating the adequacy of a proposed restoration alternatives. We now turn to a simple analysis of compensatory restoration using a random utility framework which is the basic model used in attribute-based stated choice methods.

3 Welfare Analysis of Valuation Scaling

Jones and Pease (1997) provide two approaches to resource compensation: the *service to* *service approach* and the *valuation scaling*. We begin with a discussion of valuation scaling. Within valuation scaling, Jones and Pease describe two approaches, value to value and the value to cost. The value to cost approach equates the scale of projects such that the present value of restoration costs equals the present value of losses due to injury which is basically the way that damage assessment was conducted prior to the move toward valuing losses in terms of compensatory restoration. In their discussion of value to cost, Jones and Pease note that “To apply this procedure, the trustees must judge that the valuation of the lost services is practicable, but valuation of the replacement natural resources and/or services cannot be performed within a reasonable time frame or at a reasonable cost.”

The value to value approach brings us to the heart of the proposed new paradigm in natural resource damage assessment. In principle, the value to value approach scales restoration such that the presented discounted gain from restoration, in monetary terms, equals the present discounted loss from the injury. Note that this new approach requires the cost-benefit analyst to simultaneously value the losses and the gains. As several authors (Jones and Pease (1997), Mazzotta, Opaluch et al. (1994)) have noted, attribute-based stated choice methods are ideally suited for this task. Attribute-based stated choice methods involve choice experiments that consist of choices or rankings of projects that involve different attributes such as amounts of compensatory resources, in-kind or out of kind.[2] While cost is a potential attribute, the NOAA guidance document (NOAA (1997)) stresses that some stated choice methods are capable of measuring damages in either monetary or physical restoration units. The key issue that interests

[2]Typically choice experiment participants are offered a series of choices. According to Carson et al. (1999), these choices fail to be incentive compatible, an issue we do not take up in this paper.

$$u_i(q_1^0,\ q_1^0,\ y_i)$$

[4]There are two notable exceptions. Trustees could insist on providing the maximum over the entire population of $\{\ !_c^{i*}\ \}$ or the minimum which would respectively result in a distribution of no losers or a distribution of no winners.

$$CV_i = \frac{"^i_2}{"^i_y} (!_c - !_c^{i*}$$

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simplest of random parameters model, randomness of $"_1$, there is no summary measure of the distribution of $!_c^{i*}$ that will automatically satisfy the compensation test. While homogeneity of the marginal utility of income provides justification for using the average $!_c^{i*}$, the researcher cannot know about the homogeneity of the marginal utility of income without including money in the model.

Moving onto randomness of $"_2$ or both $"_1$ and $"_2$, the complexity of a decision rule that satisfies (5) quickly increases. For the case of $"_2$ being random and homogeneity of the marginal utility of income , the welfare adequacy of using the average $!_c^{i*}$ breaks down to the relative sizes of the mean of $"_2$ and the mean of $1/"_2$.[6] If these two are equal, the decision rule that requires providing the average $!_c^{i*}$ would satisfy (5). When there is heterogeneity of the marginal utility of income, adequacy is determined by the relative sizes of the mean of $1/"_y$ and the product of the mean of $"_2/"_y$ by the mean of $1/"_2$. Regardless of whether or not there is homogeneity of the marginal utility of income, the decision rule for the level of compensatory restoration that satisfies (5) must be determined on a case by case basis. When both $"_1$ and $"_2$ are random and the marginal utility of income is homogeneous, the welfare adequacy of using the average $!_c^{i*}$ breaks down to the relative sizes of the mean of $"_1$ and the product of the mean of $"_2$

[6]We are assuming that the means of all of the random variables discussed exist.

mean or the median will provide for a adequate amount of compensation when using the compensation principle as the standard. We now turn away from random parameters to consider cases of systematic heterogeneity that depend on characteristics of the individuals.

4.2 Individual Characteristics & Heterogeneity

Heterogeneity can be systematic in the sense that differences in $!_c^{i*}$ are driven entirely by individual characteristics as opposed to heterogeneity through different utility parameters. One characteristic that makes sense is income. If income enters the utility specification in a higher order through interaction with either resource, then there will exist heterogeneity in $!_c^{i*}$. The following two equations provide the utility specification and the expected level of adequate, individual compensatory restoration.

$$u(q_0,\ q_1,\ y_i) \ = \ "_1\ q_1^0 \ + \ "_2\ q_2^0 \ + \ "_y\ y_i \ + \ \$_1\ q_1\ y_i \ + \ \$_2\ q_2\ y_i \ + \ \#^i \qquad \textbf{(7)}$$

$$!_c^{*i} \ = \ \frac{"_1\ \ ! \ + \ \$_1\ y_i}{"_2 \ + \ \$_2\ y_i} \qquad \textbf{(8)}$$

Another characteristic that makes sense is individual distance from either the injured resource or the compensatory resource. Evidence for this hypothesis is statistically supported in a study by Loomis (2000). Distance is likely to matter greatly to resource users and cases where there are both users and non-users of the respective resources. In user demand models, distance is one of the key factors that determines the opportunity cost of trips. Omitting distance from the model may very well result in omitted variables bias of those parameter estimates included in the model. In order for distance to matter for heterogeneity in the linear specifications considered in this

replacement resource is a perfect substitute without any investigation of preferences, an impossible task. Finally there is the fundamental problem that providing the present value equivalent will not guarantee that individuals are left as well off as when no injury had occurred, even with perfect substitutability, a result that is easy to explain.

Consider the same set-up as presented earlier where the first resource is damaged and a second resource will be provided as compensation, the only difference being a time lag between injury and providing compensatory restoration. Perfect substitutability implies that utility in q_1 and q_2 takes the form $u(q_1,\ q_2,\ y)\ =\ u(q_1\ +\ q_2,\ y)$. Now suppose that good one is injured in the current period and we provide the present value equivalent, using our representative agent's value of time preference for discounting, in the next period as prescribed by the damage assessment guidelines.[7] If the marginal utility is diminishing in our perfectly substitutable good, then providing the present value equivalent in the second period will result in a present value utility loss. Adequate compensation through the present value equivalent only occurs when the marginal utility of the perfectly substitutable resources is constant, a fairly restrictive assumption.[8] Thus in the best of circumstances we generally fail to find that the service to service method provides adequate compensation.

Attribute-based stated choice methods can be used to explore all of the issues identified in this section in a reasonably cost-effective manner. Exploratory analysis of preferences can be

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[7]The form of utility for the two periods is given by $u(q_1^0\ +\ q_2^0,\ y^0)\ +\ \%\ u(q_1^1\ +\ q_2^1,\ y^1)$ where $\%$ is the discount factor. The superscripts denote the time period.

[8]In order for service to service to work, the non-discounted marginal utility of having more q_1 or q_2 must be equal in the two periods. If the level of either resource is changing from one period to the next without injury, this condition will generally be violated.

undertaken with a relatively small group of subjects since subjects are typically offered more than one choice scenario. For example Morey et al. (1999) successfully use groups to conduct choice experiments. Data from the exploratory analysis can be used to test perfect substitutability, diminishing marginal utility, and the effect of income on the marginal utility of the injured good.[9]

6 Practical Considerations

In addition to judging compensatory restoration by the usual standards of benefit-cost analysis, there are other practical reasons to include a money metric in damage assessment. First, there is the issue of benefits versus costs of compensatory restoration. Obviously responsible parties would like to obtain a legally satisfactory outcome at the least cost. It makes no sense to provide compensatory restoration projects for which the costs of the project greatly exceed the benefits, even if the responsible parties have to bear the cost. By avoiding money in the estimation of preferences, there is no way to judge whether costs are disproportionately high relative to benefits.

On the other hand, the costs to the responsible parties should not be the sole determinant of compensatory restoration i88 jud1.6(ceel.9(ray)29.2s)3.rhnd, the costs torhnd, theoft-cctoryec i88 jud1.6(ce0.9

[9]Of course if perfect substitutability is rejected, a more complete analysis should be undertaken.

sense that compensatory restoration benefits to group A are sufficiently high to make up for the net losses to group B. Project B mostly compensates group B, but is more expensive than project B. Should the responsible parties be allowed to implement A simply because it is the least cost? Welfare economics does not have much to offer on this account, but certainly redistributional effects are important to many people. By avoiding money in the damage assessment, some redistributional effects will be impossible to identify.

7 Further Discussion and Conclusions

The aim of the new paradigm in natural resource damage assessment is to improve the process of determining the economic damages to the public as well as improve the process by automatically satisfy the compensation test. Our analysis suggests that adequate compensatory must be determined on a case by case basis. In order to do so, there must be a monetary component included in the analysis. Putting aside welfare economic principles, there are still good reasons to consider money. Trustees need to consider the relative costs and benefits of potential compensatory restoration projects. Additionally trustees need to understand the potential redistributional impacts. In both cases, money is necessary.

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