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Benefits Transfer

Procedures, Problems, And Research Needs

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Benefits Transfer: Procedures, Problems, and Research Needs

1992 Association of Environmental and Resource Economists Workshop

Snowbird, Utah

June 3 - 5, 1992

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FOREWORD

The 1992 Association of Environmental and Resource Economists (AERE) Workshop was the third in a series of important recent activities related to benefits transfer. In November 1992 the National Oceanic and Atmospheric Administration (NOAA) hosted a workshop directed toward developing databases to support benefits transfers. The U. S. Environmental Protection Agency (EPA) has taken a key first step in this development by compiling a bibliography of their environmental benefits studies (see Appendix A). In March 1992 a special section of *Water Resources Research* was dedicated to papers addressing issues related to benefits transfer. The AERE workshop sought to expand on this base by addressing questions related to the adequacy of existing methods and valuation studies for performing benefits transfer and by identifying the research needed to enhance benefits transfers.

Appreciation is extended to the workshop sponsors-EPA, NOAA, and U.S. Department of Agriculture’s Economic Research Service-for their continuing support of the workshop series and for this workshop in particular.

“Benefits transfer" is the use of information from existing nonmarket valuation studies to develop value estimates for another valuation problem. It can reduce both the calendar time and resources needed to develop original estimates of values for environmental commodities. These estimates are used to evaluate the attractiveness of potential governmental policies, to assess the value of policies implemented in the past, and to identify the compensation required under CERCLA when toxic substances, such as oil or PCBs, are released to the environment.

Benefits transfer is not new. In any ex ante studies of policy options, researchers must transfer information from other times and places to the present question. The policy researcher straddles two points in time-the past and the future-attempting to apply experience from the past to a future situation. For example, the economist evaluating the likely effects of a possible minimum wage increase on employment must draw on previously conducted research to forecast the effects of the specific policy under consideration. This research may have analyzed a “natural experiment" in a past setting. From this research the economist may conclude that a 10 percent increase in the minimum wage above the equilibrium wage caused employment to fall 5 percent in the affected labor markets. The economist offering advice on the specific policy under consideration may use this information to forecast that the same (a lesser or greater) effect is expected this time because the present situation is like (unlike) the past

For hypothesis testing purposes, frequently only the sign of the variable(s) of interest is critical for supporting a theory. But for policy analyses the magnitude of the effect is critical

Indeed in formal benefit-cost analysis, quantification is virtually the sine non qua. Benefits transfer provides a means of economically obtaining these magnitudes. However, the process of benefits transfer is complex, and a “science“ of benefits transfer does not now exist. One purpose of the workshop was to increase our awareness of the types of decisions involved in performing benefits transfer and the research needed to close some of the gaps in our knowledge.

The workshop consisted of three formal papers, six benefits transfer case study protocols. the concluding remarks of three discussants, and an after-dinner speaker who outlined the utility of an information system to support benefits transfers. The case study protocols were selected to provide a forum for evaluating the potential for conducting benefits transfer in specific applications and to identify research needs. The case study groups comprised workshop participants and a leader(s) who provided the initial case study materials to the members of the group, presented the results of the group’s discussions to the entire workshop, and wrote the final case studies presented herein.

David Brookshire in his opening remarks to the workshop observed that the question we face is not whether benefits transfers will be done but rather how. The imperative for such studies is simply too strong to resist. He highlights the complementary relationship between many of the issues the researcher must address in benefits transfer and in original nonmarket valuation studies. Furthermore, he raises questions regarding the adequacy of the existing research base to support benefits transfer applications.

Leland Deck and Lauraine Chestnut consider how good benefits estimates must be for transfer purposes. Taking a value of information approach, they look at the “market” for benefits estimates and the costs of developing them. They identify several stages in the development process, each of which represents a possible stopping point in developing benefits estimates.

Edward Morey investigates the relationship between consumer’s surplus and consumer’s surplus for a day of recreational use. Estimates of consumer’s surplus for a day of use are commonly used for benefits transfers. He shows that compensating variation per day of use is a well-defined concept for a change in the price of visiting a recreational site but is not, in general, well-defined for a change in the characteristics of a site. He identifies sufficient conditions for when it is well-defined for characteristics changes and uses simulations to demonstrate the biases from using approximations for the compensating variation.,

In the first case study, John Bergstrom and Kevin Boyle develop a protocol for estimating the value of protecting groundwater in a rural area dependent on it for its water supply. They identify several studies that provide information for their benefits transfer problem, provide a catalogue of the characteristics of these studies, and present a benefits value from the transfer process. An actual policy site study serves as a validity check on the estimates they derive through the benefits transfer process. That study supports their benefits transfer value.

Bill Desvousges and his coauthors examine the use of benefits transfer to value use damages from the Arthur Kill oil spill. Their group evaluated the adequacy of existing studies for several categories of water and wetlands use. They identify several important gaps in the data, one of the more important of which is in wetlands values-especially nonuse values for wetlands preservation/restoration.

Carol Jones describes the Department of Interior's Type A oil spill model and evaluates its adequacy for estimating the value of recreational fishing losses in a natural resources damages context. The Type A model, which provides a computerized approach to predicting the fate and effects of spills and to valuing injuries, is the major benefits transfer model for natural resource damage assessments. Her paper identifies some of the improvements to the model, especially the valuation component, that the case study participants thought would make the results more valid.

Susan Kask examines the potential for transferring health benefits estimates to a study site involving health risks from surface water contamination. She describes a theoretical model and identifies a number of factors that may influence the value estimate. She finds that a major problem with health benefits valuation is the absence of studies addressing both morbidity and mortality in a comprehensive fashion.

Mary Jo Kealy and her coauthors develop a protocol for estimating the recreational fishing benefits of reductions in acid deposition. This is an ex ante analysis because it examines the expected benefits from implementing the Clean Air Amendments of 1990 (CAAA). They base their protocol on the Deck and Chestnut staged process: each stage represents a decision point at which the researcher asks if the expected value of the benefits of the information gained from proceeding with the next stage exceeds its costs:

Lauraine Chestnut and Robert Rowe also conduct an ex ante study of the CAAA. They examine the potential to transfer previous studies of the value of visibility improvements to a study of the value of the expected reduction in regional haze in the Eastern United States. They argue for a protocol that incorporates all available information, properly weighted, and assesses the uncertainty of the results. Their group was relatively comfortable with the availability of information for their benefits transfer problem; however, they all felt the contingent valuation method could be significantly improved.

Trudy Cameron's remarks draw from the literature and from experiences outside environmental and resource economics to suggest both technical and institutional changes that would improve benefits transfers. She shows that the benefits transfer issue is not an activity unique to us; it has much in common with other efforts to develop more rigorous procedures for combining information. She addresses the issue of sample bias that may be present in original studies when applied to a policy site and suggests a procedure for reweighting the original data based on the policy site variables. She also describes a way to develop estimates from pooled data using prior information that has potential application for benefits transfer. Finally, she proposes some institutional changes that would result in improved archiving and sharing of original data sets for others to use in their research.

Alan Krupnick discusses the demand for benefits transfer studies, in particular their use for developing estimates of the external costs of electric power. He considers several types of benefits and offers his opinions on those for which the research base is strong enough to support their transfer to other contexts. He also raises some important issues regarding the value of standard protocols for documenting the choices benefits transfer practitioners make so that their choices and reasoning are clear to readers. He concludes his remarks with a suggestion for research that would improve the quality of benefits transfers.

Jim Opaluch's and Marisa Mazzotta's concluding remarks argue that a valid and reliable research base of original studies is complementary to benefits transfers. They also identify the need to provide empirical tests of benefits transfers and to develop better methods for transferring benefits estimates.

Martin David points out in his remarks that, once collected, data have many of the characteristics of a public good. A system for archiving and sharing data would promote good science, learning, and better policy analysis. He provides some suggestions for an information system based on his experience with other complex data sets.

The papers, case studies, and discussants' remarks highlighted several concerns researchers have about performing benefits transfers. The workshop participants' concerns and suggestions for a research program and some of my own are provided below.

Because benefits transfer begins with original studies many of the issues raised applied as well to them. Specifically, workshop participants were concerned that both the scope of the studies and the reporting of data, methods, and findings in both the published literature and in reports are not complete enough to perform good benefits transfers

More original studies are needed that address the human health effects of the environment. The available information on morbidity and mortality values is very limited and tends to focus on adult health and life expectancy. Additional research is also needed on the value of reducing infant and children's morbidity and mortality, including the value of reducing the risks of reduced IQ and physical effects from both the pregnant mother's exposure to environmental pollutants and the infant's or child's subsequent direct exposure. Both parents and prospective parents would probably place a high value on risk reductions in this area, but the literature provides virtually no estimates of these values.

More work is needed on specific services provided by the environment and the characterization of how the value of these services is affected by changes in the quality of the environment. Workshop participants specifically identified the need for additional studies of water resource use, including boating and beach use and wetlands values. Also the link between injury to the environment and damages needs to be clearer in both the original and benefits transfer studies. Achieving this clarity may require an expanded role for economists in the modeling of physical systems and their relationship to human activity.

Only one case study at the workshop touched on nonuse values, yet they are the most controversial component of benefits studies. Part of the reason for interest in nonuse values is clear-even a small value when multiplied by a large number of affected individuals can result in a number large enough to dwarf use values. The nonuse issue begins by asking when nonuse values are relevant and extends to both technical and policy issues. Both the values elicitation process and the extent of the "market" for nonuse values are controversial issues. More research is needed on the way nonuse values enter individuals' utility functions and on the values elicitation process.

Systematic implementation of improved benefits transfers is probably impossible without better access to well-documented data. AERE should develop a standardized protocol for documenting survey procedures used in original studies. For example, the protocol would provide information on sample sizes and selection, data coding and checking, response rates and steps taken to minimize nonresponse bias, and the treatment of outliers in the estimation phase. A completed protocol could be required for all *Journal of Environmental Economics and Management* papers submitted for review. The completed form could be attached as an appendix to papers accepted for publication; the journal editor could keep copies of the completed form, or the authors could be required to express their willingness to provide them to other researchers when so requested.

Related to the issues of documentation for both original and policy studies is the importance of providing clear definitions of the baseline quantities of resource services, of reporting value functions not just means, and of employing sensitivity analysis for key parameters when performing benefits transfers.

Many participants discussed the lack of incentives to share original data such as survey information. This problem will be hard to solve. One approach that may result in lower costs of sharing and may promote communication is to develop a standardized approach to managing survey data. Again AERE could play an important role: it could design a universal information system to provide a standard format for electronic data files for benefits studies. The system would have to be flexible enough to meet a wide range of researcher interests yet structured enough so that users unfamiliar with the details could still find their way through the data with little need to involve the original researchers. Such a system would not solve the proprietary interest that developers of the data may have, but, given their willingness to share their data, it would lower their and the recipient’s cost of that sharing.

We should consider the value of studies that replicate the work of others. Too often existing editorial policies are opposed to replication; then when the “right” signs are found, the opportunity for publishing papers confirming the results of others is very limited. But the parameter estimates are at best just that-estimates. The estimates are conditional on the institutional context and constraints impinging on the individual decision makers. A broader base of empirical studies is needed to support benefits transfer. Further research may help to develop the preponderance of evidence needed for theories to have broad acceptance.

A benefits transfer must assess the extent to which the following are “similar" between the study and policy site contexts: affected resource(s), damage(s), substitutes, and affected population. Studies will be similar in some features, different in others. How should we weight studies for use in benefits transfer, and how should we communicate those weights to our audience? Can this weighting be done objectively? Quantitatively? Meta-analysis and some of the literature cited by Trudy Cameron may be useful in addressing these questions.

Most benefits estimates have been developed in the United States and to a lesser extent in Europe. More research is needed to evaluate the extent to which these estimates are transferrable across societies where preferences, constraints, and institutions differ. Similarly, more work is needed to identify the circumstances for which intergenerational benefits transfers are appropriate and the procedures that should be used to modify current estimates to express the values and constraints appropriate for future societies.

Changes in environmental quality are likely to affect both the intensity and quality of resource use. For example, a beach with oil on it may experience reduced visits by beachgoers; however, some people may still frequent it. In both original and policy studies we should explicitly value the losses in utility for the foregone visits as well as the reduction in the value of the remaining visits.

Benefits transfers will not have the elegance of pure theory or the rigor of hypothesis testing. This method seems likely to emerge as a different science, one that uses the results from original research but is based on interpreting economic history and applying it to current problems. It can provide useful input to policy issues that directly affect resource allocation and to compensation questions that may indirectly change resource allocation as liability rules are internalized into future choices.

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CONTENTS

ISSUES REGARDING BENEFITS TRANSFER

David S. Brookshire*

ABSTRACT

Although benefits transfers are not new, many issues remain unresolved. In this paper I make three arguments: most, if not all, of the issues regarding nonmarket valuation are also relevant to developing protocols for benefits transfer; considering the required level of accuracy for different uses of nonmarket values is central to the benefits transfer process; the existing set of nonmarket studies does not form an adequate base for benefits transfer.

Benefits transfer has been a widely used methodology in policy analysis and natural resources decision making for decades. The process involves

> focus[ing] on measuring (in dollars) how much the people affected by some policy will gain from it. They are not forecasts, and they usually do not attempt to predict other exogenous influences on people's behavior. Instead, a predefined set of conditions is assumed to characterize the nonpolicy variables. Then benefit estimates are derived by focusing on the effects of the conditions assumed to be changed by the policy. (Smith, 1992, p. 686)

Viewed simplistically, the benefits transfer process applies a data set that was developed for a unique purpose to an application for a different purpose.

The use of benefits transfer has increased recently and is thus receiving renewed attention. The renewed interest stems from various sources, including recent court decisions (State of Ohio, 1989), increased federal agency interest, and financial pressures due to increased costs and limited funding for primary studies. As recently as fall 1991, an environmental database workshop held in Washington, DC, assessed the availability of existing nonmarket valuation studies and considered means to enhance the availability of these studies for purposes of benefits transfer.[1]

My renewed interest in benefits transfer was rekindled by two papers on the topic that I received approximately two years ago for possible publication in *Water Resources Research* (Luken, Johnson, and Kibler, 1992; Desvousges, Naughton, and Parsons, 1992). The review process raised a relatively unique problem for an editor. The reviews ranged from "publish this paper, it is great, timely etc." to "you cannot do this, benefits transfer make no sense." The distribution of recommendations was so highly bimodal that I decided to edit a special issue of

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[1] The workshop was funded by the EPA, USDA Forest Service, USDA Economic Research Service, and NOAA.

Water Resources Research to directly address the benefits transfer process. I believed the Luken and Desvousges papers were controversial and represented a challenging contribution to the literature. Too often controversial papers never make it into the literature because they are, in fact, controversial. Further, after reflecting about the notion of benefits transfer, I believed we had already become committed to this method: the issue was not whether, but how benefits transfer should be conducted. We needed a forum for discussing possible issues and protocols for benefits transfer. Hopefully, the special *Water Resources Research* section was a step in that direction.[2]

This paper builds on the issues already identified in the extant literature (see, for instance, Smith and Kaoru, 1990; Walsh, 1992) and those brought forth in the special *Water Resources Research* section,[3] and raises additional issues regarding the benefits transfer process. I argue that

- most, if not all, of the issues regarding nonmarket valuation are also relevant to developing protocols for benefits transfer;
- a consideration of the required level of accuracy for different uses of nonmarket values is central to the benefits transfer process; and
- the existing set of nonmarket studies does not form an adequate base for benefits transfer protocols;

PROTOCOLS FOR BENEFITS TRANSFER[4]

Innumerable benefits transfer studies and guidelines have assigned values through using expert opinion as well as results from observed behavior and direct elicitation models.[5] Why attempt to develop benefits transfer protocols? Why not just conduct a primary study? Two reasons justify developing these protocols: primary studies can be time consuming and costly.

Studies based on original data require developing survey instruments, selecting and drawing a sample, administering the instrument, and analyzing the data collected, for example. In some cases the calendar time required is simply not available. For instance, both

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[2]Thanks to the efforts of many contributors and reviewers, the special section was published in the March 1992 issue of *Water Resources Research.*

[3]See Atkinson Crocker, and Shogren (1992); Brookshire and Neill (1992); Boyle and Bergstrom (1992); Desvousges, Naughton, and Parsons (1992); Loomis (1992); Luken, Johnson, and Kibler 1992); McConnell (1992); Smith (1992); and Walsh, Johnson, and McKean (1992), *Water Resources Research,* Vol 28, March 1992.

[4]The Brookshire and Neill (1992), Loomis (1992) and McConnell (1992) papers explore the issues in this section.

[5]Consider as a case in point the U.S.Water Resources Council guidelines on recreation (U.S. Water Resources Council, 1983).

governmental policy makers and litigants in damage assessment cases do not always have the time to conduct primary studies.

Financial resources are also limited. Recognizing this, the U.S. Environmental Protection Agency (EPA), National Oceanic and Atmospheric Administration (NOAA), and the U.S. Forest Service (USFS) are actively addressing data and protocols for benefits transfer.

Local and state governments also have a growing need for nonmarket valuation information. Many environmental matters are addressed at the state level, yet financial resources are very limited. For instance, New Mexico has a large natural resource portfolio with many competing needs. Developing countries, including eastern Europe, also lack the financial resources for primary studies. Mexico is a case in point: it has a great need to obtain an understanding of the overall environmental problems (McIntosh, 1991). In general, applying nonmarket valuations across differing national economies is a relatively unexplored area. An obvious place to start would be with benefits transfer rather than costly primary studies.

METHODS FOR ASSIGNING NONMARKET VALUES

An overview for benefits transfer must begin with a consideration of the methods available for initially assigning nonmarket values, the accuracy of the methods, the diversity of nonmarket commodities of interest, and the existing databases. Additional issues might include the existing form of research agendas, the availability of data, and the role of judgment.

Observed behavior methods (direct or indirect), such as the travel cost and hedonic methods, and/or hypothetical behavior, such as the contingent valuation approach, form the core of desirable methods. The literature reveals that many variants and much discussion of the robustness of each exist on nonmarket methods.[6]

The available, primary nonmarket valuation methods are not completely reliable or accurate. In my opinion, accuracy concerns preclude a cookbook approach to benefits transfer, as is true for nonmarket valuation efforts in general. Further, not all applications of nonmarket techniques are created equal. The more recent studies are not necessarily superior, more accurate, or more useful as some would seem to imply. We have not reached a consensus about the correct procedures with which to conduct all of our nonmarket valuation investigations, judgment issues not withstanding. Nor have we reached a consensus on valuing various types of component values. For instance, is the appropriate valuation framework a total value framework.

[6] See for example Cummings, Brookshire, and Schulze, (1986), and Mitchell and Carson (1989) for commentary on the contingent valuation method.

or are specific nonuse values the appropriate focus, or both? Thus, we should not expect all nonmarket valuation techniques to be equally useful in all cases of benefits transfer.

In addition to nonmarket valuation methods, the nature of the commodity is central to the reliability of the benefits transfer process. When researchers think of a study site (the primary study) and policy site (the site for which benefits are being transferred), they immediately must consider questions of uniqueness and substitute and complement availability. For example, if not all groundwater is just groundwater, then the specific nature of the commodity at the study and policy sites is important.

The quality of existing nonmarket data also is important. Given that primary studies are far from perfect, benefits transfer studies more than likely compound the accuracy problems of primary studies. The accuracy problems that exist in the primary studies do not disappear when the benefits transfer process is undertaken. This general theme has been with us for years (see Morgenstern 1973).

Although a large number of studies exist, the number available for specific nonmarket commodities might be limited. At best the current valuation database is a collection of studies that represent a serendipity of perceived needs. To some extent, funding agencies find coordinating research agendas difficult. Further, data have been lost through the process of changing affiliations of researchers as well as through changing computer technology. Perhaps not all of the raw data actually exist in our ever-expanding bibliography of studies.

Researchers should be concerned about extending the base of available studies. A systematic and coordinated research program is needed as well as a change in how we characterize productive research. Recently the legal community has become a significant source for the funding of new studies. In some sense the legal community is pacing our research efforts. This pacing and direction of efforts with specific agendas in mind may outstrip our actual abilities to assign sufficiently accurate values.[7] Further, replication is often viewed as not productive to journal editors and reviewers and thus not rewarded by the profession.

As the database expands and benefits transfer become more prevalent, another issue that will come to the fore more frequently is the issue of when primary data will be made available to other researchers. This issue has not been completely resolved. Should the database that an

[7] As pointed out by McConnell (1992), some of these studies will only see the light of day in the adversarial setting, otherwise not at all.

article directly reported on be made available, or should the complete data set be made available even if the authors intend further work?[8]

Finally, what is the role of judgment in the benefits transfer process, both in the original studies as well as in the process itself? Can we be judgment free and purely scientific?

ADEQUACY OF EXISTING SET OF STUDIES

A wide range of measurement issues is associated with all nonmarket valuation techniques. Consider the contingent valuation method, in part, because of the recent court rulings (State of Ohio, 1989). Let us ask a version of the question put forth by Burness, Cummings, and Ganderton (1991): “Which households place what value (or types of values) on which nonmarket goods?” (p. 432, emphasis added). We might add: Are households accurate in revealing their preferences and how do households form values and how should these values be elicited?

In light of the recent court rulings potentially leading to compensable damages as well as efforts to include externality costing for utilities, these issues are becoming increasingly important. These issues implicitly include the aggregation issue and the scope of the market question. To my knowledge we have never completely agreed on how to designate the market area nor agreed on appropriate aggregation procedures. This issue becomes especially difficult when we move from considering use values to existence values. For instance, what is the appropriate population to aggregate over for the Grand Canyon or El Morro National Monument? Further, one might include design concerns such as the level of specificity of the commodity that is described and issues of embedding.

In listening to the exchanges at the recent AERE 1992 sessions in New Orleans, I can only conclude that a serious debate continues over the accuracy levels that we can tolerate in primary nonmarket studies and how these studies should be designed. Thus, we might ask: Can we tolerate the additional accuracy concerns that are necessarily involved in the benefits transfer process?

One answer is to assert that the stability of the foundation for the benefits transfer process depends on the intended use of a particular application of the benefits transfer process. As an illustration, consider a juxtaposition of perceived needs and purpose of a benefits transfer

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[8] I understand that the provision rule for *JEEM* is that at least the data directly utilized in the reported results must be made available.

exercise. Figure 1 illustrates a stylized continuum of uses representing alternative applications of benefits transfer.

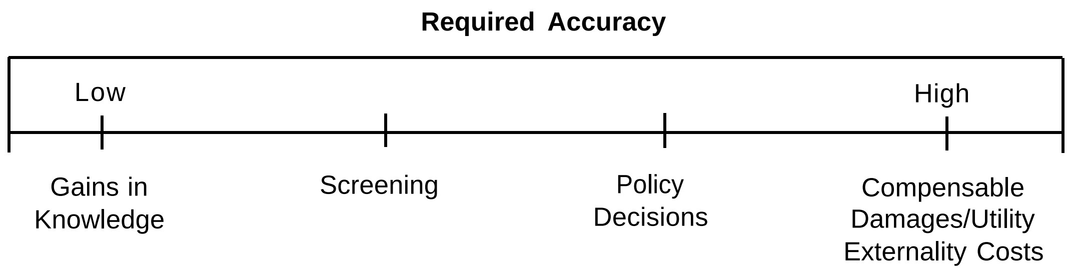

Figure 1. A Continuum of Decision Settings from Least Required Accuracy to Most Required Accuracy

Viewing the required level of accuracy for a benefits transfer within a conditional framework provides two insights. The use of the information inherently determines the underlying accuracy requirements. This insight applies in both the primary data collection case and the benefits transfer cases. For instance, gains in knowledge might be represented by benefits transfer uses such as the scope of the U.S. Geological mapping program. Screening efforts might be represented by the CERCLA Type A analysis. Policy decisions might involve regulatory rule making, and compensable damages might involve cases associated with large-scale natural resource damage assessments and externality costing for electric utilities. A difference between the policy decisions and the compensable damage cases is that, while in both cases real dollars are exchanged, we do not know precisely whom in the policy case. That is, the policy case includes a hidden distributional issue. In the compensable case, real dollars are exchanged and the parties are relatively more easily identifiable.[9]

A continuum such as this suggests accuracy tempered by the use of the valuation information. For instance, in the case of gains from knowledge we might argue that some decisions, if incorrect, will not result in too high a cost to society. In the cases where large dollar amounts are involved the response is sometimes different. Often one hears that, as real dollars become involved, the information (either from a primary or benefits transfer study) is not precise enough. That is, as the real economic commitment becomes more real, we should not use that information for decision making. The argument that we cannot undertake a policy response without knowing the exact nature of the functional relationships echoes the earlier implication of

[9] The issue of compensable damages and real economic commitment has come to the fore recently. I suggest that we have been making real economic commitments for years through regulatory policy that relies on nonmarket valuation.

the theory of second best. Reaction to nihilism of the theory of second best was swift. Several researchers argued that piecemeal welfare policies could be pursued for those sectors satisfying separability from the original distorted sector. Relevant to the benefits transfer issue is the work of Yew-Kwang Ng (1977 and 1979) regarding a third best allocation. Ng demonstrates that. in the absence of perfect information, correcting a distortion will always improve social welfare in an expected value sense. Decisions based on even imperfect information, as from a benefits transfer, are superior to no decisions.

SOME SAMPLE GENERIC GUIDELINES FOR BENEFITS TRANSFER PROTOCOLS

The original site study must be scientifically sound in the use of conceptually correct economic methods, experimental design, and implementation procedures. The original site study should report, maybe in an appendix, the empirical procedures, including details regarding all of the information collected, and whether the information was useful in the empirical process.

The commodity of value should be similar between the study and policy site. Assessing this similarity might include quality and quantity considerations as well as the property right structure. In addition the study and policy site markets should be similar, an assessment that could include innumerable considerations. The overall issue becomes, what is similar enough?

To address the degree of similarity, consider a simplified benefits transfer framework. For the study site (A) the results of a study enable one to estimate the following:

$$V^A = \beta_0^A + \beta_1^A X_s^A + \beta_2^A X_g^A + \beta_3^A X_m^A$$

where

V^A = individual valuation regarding site A;

X_s^A = vector of socioeconomic characteristics (e.g., income, age, cultural);

X_g^A = characteristics of the commodity (physical-quality and quantity and economic relevant notions [such as complement's, substitute's uniqueness]);

X_m^A = market conditions (size and composition).

The β's are the regression coefficients and are instrumental in the benefits transfer process.

For the policy site we estimate the following:

$$V^B = \beta_0^A + \beta_1^A X_s^B + \beta_2^A X_g^B + \beta_3^A X_m^B$$

where

V^B = individual valuation at site B, based on the β's of site A;

X_s^B = vector of socio-economic characteristics at B;

X_g^B = vector of characteristics of the commodity at B; and

X_m^B = vector of market conditions at site B.

We are interested in the β coefficients. That is, is it acceptable to use the coefficients and implicitly the underlying distributions from the study site to estimate the value for the policy site? The research question is characterized in Figure 2. Given the array of information used in valuation studies, what conditions are necessary for us to rely on the V^B estimated from the V^A equation? That is, for site A each of the subelements (e.g., for X_s, a subelement is income), and site B will have a corresponding distribution. The diagonal squares represent identical variables. If this were to occur then the benefits transfer process would not be of concern because the study and policy sites would be essentially identical. However, this condition is highly unlikely. The question then becomes: How similar are these distributions? How similar must they be for different uses of the benefits transfer process for alternative uses?

Can the issues raised in this paper be answered by the existing base of nonmarket studies? The base of studies from which a benefits transfer study can build is quite thin, at least for contingent valuation applications. This paucity stems, in part, from the existing incentive structure to publish and obtain research funds. The funding environment and the publishing environment have encouraged, if not required, studies that are unique. Often this uniqueness can be found in the nature of the good valued. As such not enough studies address the same issue.

The overall number of studies that are not replications is large; thus, the number of off-diagonal studies is large. That is, we will be typically off the diagonal. Unlike the more traditional science-oriented disciplines, replication in economics and the publication of data are not viewed as, worthwhile. This attitude is not bad. However, we might need to consider other forms of research acceptable and publishable as contributions to the literature, especially in a discipline that contributes so heavily to the policy arena. Editors *and* reviewers must confront this issue. Essentially, for the case of benefits transfer, we might want to consider what constitutes a substantive contribution to the literature

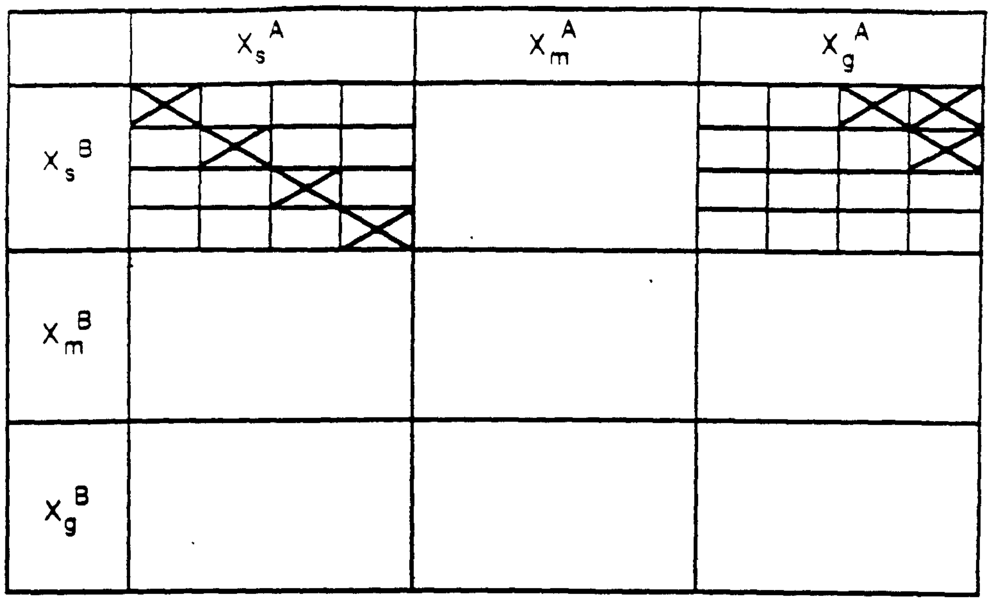

Figure 2. Distribution Issues

DESIGNING A META-ANALYSIS

Further research is necessary if we are to more fully understand the reliability requirements of the benefits transfer process. Using meta-analysis can further our understanding of the importance of various components of existing studies and help focus our research efforts. The laboratory and field settings also offer the opportunity to explore various protocol guidelines under varying degrees of control and realism. As such, I suggest a combined effort involving all three settings. We have at least two ways of conducting a benefits transfer. Researchers could simply take the value elicited at the study site and apply it directly to the policy site. For example, a value for a change in clean air in Los Angeles may be applied directly to a similar change in air quality in Denver. This application is clearly simplistic, and most researchers would not wish to follow such an approach. A more technically valid strategy is to employ the coefficients estimated with the study site data to the variables describing the policy site. We need a protocol to judge sufficiently similar pairs of policy and study sites to employ benefits transfer. To this end I offer a first hypothesis.

> H1: Benefits transfer are robust to differences in site characteristics-whether $\mathbf{X_s}$, $\mathbf{X_g}$, or $\mathbf{X_m}$ or a combination of differences.

If H1 is not refuted then we are able to conduct defensible benefits transfer although the policy and field sites may have substantially different characteristics. Researchers may conduct the following tests to evaluate this hypothesis:

- examine previous value elicitation (CVM, TCM, or HPM) studies to determine the elasticity of estimated values with respect to the independent variables. Lower elasticities imply that we may employ the obtained values across sites that are different in terms of those variables for which the elasticities are low:

- conduct laboratory investigations in which values are elicited in different institutions where X_s, X_g, and X_m are varied individually to determine the impact of these differences. Again. this will indicate the characteristics critical to successful application of benefits transfer; and

- investigate the linearity of the valuation relationship obtained at the study site. The more linear this relationship the more critical are similarities in site characteristics between the study and policy site to successful benefits transfer.

Hypothesis 2 relates to the need to conduct and publish studies replicating previous work.

> H2: The values generated with the coefficients from the study site applied to the policy site characteristics are identical to the values that would be obtained from a primary study at the policy site.

A test of this hypothesis requires conducting at least a pilot study at the policy site. Essentially, we would then have original site estimates at both the study and policy sites. The values obtained via benefits transfer, V^B given β^A and X^B, would be compared with the primary estimates, V^B given β^B and X^B. If this hypothesis is not refuted through repeated investigations, the validity of benefits transfer would be supported for settings similar to those studied.

If values for a particular good obtained at a single site are not consistent across time, preferences are not stable and imply that benefits transfer is a questionable practice because it depends on the stability of preferences over both time and location. This characteristic gives rise to a third hypothesis:

> H3: The values from the study site are robust over time if underlying site characteristics have not changed

Robustness might be viewed as representing stable preferences. Whittington et al (1992) has addressed the effects of “time to think" and Kealy, Montgomery, and Dovido (1990) the stability of willingness-to-pay values over time. Here we are interested in the shelf life of any given set of studies. What are the limits? Are recreation values sufficiently stable over a 10-year period? We might consider replicating some of the earlier applications to address this question. Repeated work with a fixed pool of subjects could also possibly give us some insights. The time-to-think issue is relevant here because it implies the primary estimates are themselves subject to accuracy problems; most contingent valuation method studies do not provide much of a thinking period between the presentation of information and the elicitation of values.

If we argue that the institutional setting is not important in individual valuations, then we should not observe interactive effects between the vector components, X_s, X_g, and X_m, of our valuation studies. This characteristic suggests a fourth hypothesis:

> H4: No interaction effects occur between X_s, X_g, and X_m. Thus differences in *some* of these variables between the study and policy site do not imply that we are unable to use the coefficients estimated for the remaining variables in a benefits transfer.

One possible test of this hypothesis would involve econometrically checking for interaction effects with the primary data from the study site. Another test would involve using the meta-analysis technique as suggested by Smith and Kaoru (1990) and Walsh, Johnson, and McKean (1989). A series of laboratory experiments could also be designed to investigate the interactions of the components of the institutional setting with the values elicited from individuals.

The more significant the interaction effects the more similar we will require settings to be if we are to employ benefits transfer. An investigation of these (and possibly other) hypotheses generated by a systematic investigation of benefits transfer applications will move us toward protocols for benefits transfer.

CONCLUSION

In sum, no matter how well developed the benefits transfer process becomes, it will still have the accuracy problems of the original studies. The accuracy needs of various types of benefits transfer studies will vary. Overall accuracy can only be expected to deteriorate. The current collection of original studies is not sufficient for fine tuning the benefits transfer process We may need to conduct additional primary studies in various settings such as the laboratory and the field and to continue using meta analyses to improve our understanding and the accuracy of benefits transfer.

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BENEFITS TRANSFER: HOW GOOD IS GOOD ENOUGH?

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ABSTRACT

Transferring benefits estimates developed in one context to other contexts to analyze related valuation questions is appealing because it can save time and resources. However, fundamental questions regarding the accuracy of the transfer must be addressed to determine first whether the transfer should be done at all, second how it should be done, and third how much confidence to place in the transferred results. The answers to these questions will depend on the purpose of the analysis. Assessing the basic purpose of the analysis is a value of information question. Reducing uncertainty in benefits estimates requires time and money. The benefits of reduced uncertainty are finite and probably diminishing at the margin. The political/institutional context for the benefit analysis is an important factor in determining how much accuracy is needed. In some cases a clear demonstration of positive net benefits may be required, but in other cases evidence supporting the likelihood that benefits fall within a given range may be sufficient. Judging whether the uncertainty involved in a transfer is acceptable requires considering the decision-making context, as well as the economic valuation questions involved. This paper raises and discusses the following questions in this context:

- Is the likely direction of potential error in the transferred results clear?
- Is a benefits transfer analysis better than no benefit analysis at all?
- Does the regulatory or other decision-making context require that benefits be demonstrated to exceed costs or are other factors more central to the decision?
- What is the actual feasibility of conducting a new study?
- How much might a new study be realistically expected to reduce uncertainty?
- What are the chances of being so far wrong that a different decision would result?

The markets for benefit practitioners' analytical products are people making decisions. Decision makers obviously prefer to obtain defensible benefits information for as little expenditure as possible. Benefits transfers offer quicker and less expensive results than undertaking original benefit analyses, but they extract a price in terms of reduced accuracy, validity, and acceptability of the results. The question then becomes, under what circumstances does a benefits transfer provide adequate information for decision making?

Sufficient accuracy cannot be objectively defined independent of the context. Adequacy is not a matter of simply defining acceptable confidence intervals on the estimates and assuring the estimates meet that standard. The institutional context motivates the need for benefit analysis

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and must be considered when determining a sufficient level of accuracy. "Good enough" can be determined only by considering the the role of benefit analysis in the decision-making process, and the tolerance for uncertainty in the benefits estimates in that setting.

In some situations, more sophisticated analysis, even if the results are statistically different from previously available estimates, simply may not make a difference to the decision at hand. In other cases more detailed study and analysis, even if it merely confirms previous results with a greater degree of certainty, may alter the decision. A judgment that more analysts won't make any difference to the decision at hand provides a clear stopping point. Given the time and money required for additional benefit analysis, the question is best stated as a value-added question: Will it make enough of a difference to justify the cost?

In this paper we explore several analytical and institutional issues in deciding how good is good enough. The following section describes a spectrum of benefit analysis choices into which benefits transfer fits and discusses factors to consider when determining the appropriate level of benefit analysis to meet the need of the decision maker. Next, we describe some of the institutional settings where benefit analysis is used and how these uses differ. Finally, we make a few comments about strategic considerations that can play a role in the benefit analysis process.

THE BENEFIT ANALYSIS SPECTRUM

Discussions about benefits transfer have tended to focus on conducting a benefits transfer versus conducting an original study, as if these are the only two options. In reality, a wide range of options for benefit analysis can be matched to each setting, depending on how much new information needs to be generated, how much can be borrowed, and how much detail is needed in the results. A benefit analysis spectrum may be defined as follows, with detail and effort increasing from first to last:

- qualitative benefit analysis
- transfer scoping analysis
- full benefits transfer
- original pilot study
- full original study

A *qualitative benefit analysis* is the lowest level of the benefit analysis spectrum. Qualitative analysis presents as much information as possible on the physical, social, and economic impacts of the policy option, as well as information on the demand for the policy's effects, but it does not attempt to estimate the monetary benefits. The next level of the spectrum *is transfer scoping analysis,* which locates and examines existing relevant benefit studies for method, results, and relationship to the decision option in question. Transfer scoping includes analyzing the possibility of preparing a benefits transfer but stops short of adopting the existing results to the current situation. The next level is a *full benefits transfer,* including designing an approach for applying the information from existing studies to the current decision, obtaining additional necessary information on the current question, preparing a quantitative benefits estimate, and assessing the quality of information in that estimate. The level of effort for a benefits transfer can vary considerably: it can range from a simple threshold or bounding analysis to detailed procedures to adjust and interpret results from previous studies and analysis of the sensitivity of results to specific transfer assumptions. The fourth level is an *original pilot study*. Pilot studies involve method and instrument development with a small-scale application. An original pilot study can address some of the questions raised by a benefits transfer, such as the degree to which changes in the specific scenarios affect the willingness-to-pay (WTP) estimates, and provide preliminary new benefits estimates. A pilot study also can address the feasibility of conducting a full benefit analysis. The final level is *full original benefit analysis,* involving extensive data collection among a representative sample of the affected population.

This spectrum is laid out in the same order as the steps an researcher typically takes in preparing a benefit analysis. In most cases, a full-blown original benefit analysis is not prepared, but even when it is, some amount of transfer scoping is usually done first. Researchers usually decide that somewhere along the spectrum a study short of a full original study is adequate for the current purposes and that additional steps are either impossible (usually because of time or money constraints), infeasible (e.g., focus groups indicate tremendous difficulty with evaluating the decision in a monetary context), or that the value of potential improvements in the quality of information from the next level of analysis is limited for the decision at hand.

Despite the level of effort judged adequate for a given benefit analysis, researchers will help ensure the professional credibility of the analysis and results by including the following steps:

- carefully reviewing and reporting the underlying studies;
- providing the underlying studies and data as part of the administrative record;
- discussing and documenting all transfer assumptions, omissions, and known biases;
- supporting assumptions with data and literature;
- characterizing uncertainty in the results;
- providing other supporting data/literature;

- ensuring consistency with scientific and economic theory; and
- providing specific transfer algorithms or programs.

This kind of quality control and full reporting is required for any benefits transfer to be good enough; bad analysis is never good enough no matter how tangential to the decision at hand. When two parties come up with different benefit estimates, this kind of reporting of the analysis allows third parties to sort out the sources of the differences.

MEETING THE NEED: WILL MORE ACCURATE BENEFITS INFORMATION MAKE A DIFFERENCE?

Everyone faced with an option to expend greater effort to obtain more precise benefits information must confront the fundamental question: Will more accurate benefits information make a difference to the decision at hand? Although moving up the benefits analysis spectrum can provide additional information and diminishing uncertainty, it is not necessarily the better option. Whether it is better to move up the benefits analysis spectrum is a judgment that can be made only in the specific context of the situation. If a more complex study would be costly and delay the decision but could not influence the outcome because of institutional factors, it is not a *better* study for that situation. The decision maker faces a constrained optimization problem where the optimal solution is rarely the unconstrained global maximum.

In many situations a benefits transfer may provide adequate information for the decision at hand and, therefore, be the preferred level of analysis even though an original study might provide more precise benefit estimates. For example, a benefits transfer will likely provide a range of plausible benefit estimates (maybe even a probability distribution). If the entire range of plausible estimates falls above or below the costs of the action under consideration, *and* if the decision criterion is based on positive net benefits of any magnitude, then increased precision in the benefit estimates cannot change the decision

Value of Information Considerations

Deciding how far to go along the benefits analysis spectrum can be analyzed from a value of information perspective. Each step along the spectrum represents a greater level of effort that hopefully, will provide more information about the benefits of the program under consideration but at a cost of a greater investment of resources, including time. The value of information analysis says that additional information gathering (in this case benefits analysis) should be undertaken as long as the benefits of the additional information exceed the costs of obtaining it (Freeman, 1984). Estimating the expected costs of additional levels of effort required for another step along the continuum is probably fairly straightforward, but estimating the expected benefits of additional effort is probably not so straightforward.

What are the expected benefits of the additional information obtained when additional effort is put into benefits analysis? Let's focus on the additional effort required for an original benefits analysis relative to a benefits transfer. A value of information analysis suggests that an original study would eliminate (or reduce) the uncertainty in the benefits estimates. We expect that a benefits transfer might, at best, provide a probability distribution of benefits estimates due to various sources of uncertainty. If some part of the benefits distribution falls below the costs of the program, while the expected value of the benefits exceeds costs, then there is some risk that a wrong decision is being made if the program is undertaken. The reverse situation of expected benefits falling below costs, while part of the distribution exceeds costs, might also occur. (As noted above, if the full benefits distribution falls entirely above or below the estimated costs of the program then there is little risk of making a wrong decision, and additional benefits analysis is not needed.) The benefit of additional information is a function of the probability of a wrong decision and the magnitude of the negative net benefits that will be incurred if a wrong decision is made.

If the researcher has the following information, the value of information framework can provide a clear direction about whether an original benefits study should he undertaken:

- *a probability distribution for expected benefits* so that the probability of making a wrong decision can be reasonably estimated,
- *an estimate of negative net benefits* if a wrong decision is made,
- *an estimate of the reduction in uncertainty* in the benefits estimates that could be obtained with an original benefits study, and
- *an estimate of the cost* of an original benefits study.

Clearly, in many situations much of this information will be unknown or highly uncertain. Designing this decision framework and filling in plausible ranges for unknown elements may be useful in judging the sensitivity to the different elements of the decision to do an original study.

Reductions in Uncertainty Expected From an Original Study

An interesting link in the value of information framework is the question of how much an original benefits study can be expected to reduce the uncertainty in the benefits estimates relative to a benefits transfer. Much of the discussion of the pros and cons of benefits transfer has presumed that an original study could be conducted and would provide reliable benefits estimates. Given that available economic techniques for estimating benefits related to nonmarket goods are subject to considerable uncertainty, and in some cases considerable controversy, this presumption may not be appropriate in many instances. The state of the art in benefits estimation is such that uncertainty in the benefits estimates remains high even if an original benefits study is undertaken.

Estimating how much an original study may reduce uncertainty in the benefits estimates before the study is completed and the results thoroughly evaluated is very difficult. If we knew enough to accurately predict the effects of the specific circumstances of the original study on the uncertainty in the benefits estimates, we would probably also know enough to predict how the benefits estimates would change as well, so a new study would not be needed. More likely, the researcher begins with a set of benefits estimates for similar, but not exactly the same, circumstances. Some evidence may exist about how certain characteristics of the site or good in question affect the benefits estimates, at least in terms of the direction of the effect (positive or negative), but this evidence is often not very precise. For example, consider the benefits of protecting a recreational fishing spot. Predicting that benefits are higher at a site where the average size of the catch is higher may be possible, but uncertainty about how much higher the benefits are may also exist. The researcher may assume that a site with a prettier view would have greater benefits, but perhaps no evidence on this is available. A new study may find that the view has no significant effect on what fishermen are willing to pay to protect a given fishing spot. More studies over time might actually result in greater acknowledged uncertainty in the benefits estimates if the estimated effects of certain characteristics on the benefits estimates are not consistent and if the amount of unexplained variation in estimates across studies increases. The designers of an original study can count on having more information when the study is completed, but having reduced uncertainty in the benefits estimates for the specific question at hand is only one of several possible outcomes.

In most cases an original study should not be treated as supplanting all previous work but as adding to the body of available information. The evaluation of the results of an original benefits study should consider the results of previous similar studies. Atkinson, Crocker, and Shogren (1992) conclude that given uncertainty in all the benefits estimates, the best estimate of benefits consider, in some appropriately weighted fashion, estimates from past studies as well as from an original study designed specifically for circumstances at hand. This conclusion, based on an empirical Bayesian approach, appeals to common sense. Most available benefits estimation techniques involve considerable latitude on the part of the researcher in terms of study design features, some of which may have unexpected and inadvertent influences on the results. Researchers and decision makers would be well advised to evaluate results of any original benefits study in light of previous related studies to help determine how much weight to place on the original study results for the decision at hand.

Different Sources of Uncertainty

Discussions about uncertainty in benefits transfers often focus primarily on the uncertainty in the average benefit to the affected individual or party and on the characteristics that determine this average benefit. This focus implies that the ideal benefits transfer can be undertaken if we have a value function that includes all relevant individual and site or good characteristics. For example, the focus for visibility benefits transfer has been the WTP function for the household, which might incorporate income, education, and other characteristics of the household, and location, use patterns, and other characteristics of the site where visibility is expected to change. As Smith (1992) notes, uncertainty about the size of the market (i.e., number of households affected) may have a greater impact on results than uncertainty in the average WTP per household.

Noneconomic Sources of Uncertainty

Benefits analysis related to a change in environmental quality typically involves a physical science component as well as an economic component because characterizing the environmental impact in physical terms is usually necessary before the economic value of the change can be estimated. For example, for the Best Available Retrofit Technology (BART) analysis of the Navajo Generating Station, the environmental impact of concern for the benefits analysis was the change in visibility that might be expected at the Grand Canyon as a result of reduced emissions from the power plant. Therefore, estimating the predicted change in visibility conditions at the park was necessary before the value of this change could be estimated.

Considering the level of uncertainty that exists in the physical science component of the benefits assessment may be important for the economist when determining the appropriate level of benefits analysis to undertake (Smith, 1992). The decision maker may have little advantage in having fine-tuned economic estimates if the physical science component is associated with a wide range of uncertainty.

THE MARKET FOR BENEFITS ANALYSIS: WHAT IS THE NEED?

Benefit analysis has both formal and informal roles in many decision-making processes in the private and public sectors, including the judicial, executive, and legislative branches of the government. The roles of benefit analysis vary substantially among and within the different government branches. Our basic contention in this paper is that the appropriate level of benefit analysis must be determined within the context of the specific institutional setting. The potential influence on the outcome, legal limitations on using benefit analysis, time and money constraints, amount and quality of available benefits information from previous studies, propensity of individuals and institutions to consider benefits information, and even strategic considerations are all factors in determining what is "good enough" for each situation.

Various institutional settings ask very different questions of benefit analysis. Clearly, the question being asked influences the appropriate level of effort. At one extreme are situations ultimately requiring a single dollar amount, such as efforts to incorporate environmental externalities in utility planning. Here a direct link can be made between the magnitude of the benefits estimates and utility rates. Marginal changes in the estimates can result in a marginal change in the outcome, so reducing uncertainty is highly desirable. In this case, only very good transfers or new studies may be good enough.

In other settings, the benefit analysis question requires selecting among options. This situation is most analogous to the neoclassical model, where the goal is to maximize net benefits (benefits minus costs). Executive Order (E.O.) 12291 emphasizes this point of view, directing federal agencies to examine the most important alternative options in some detail. Within the full legal range of options, agencies should let the primary criterion be to maximize expected net benefits. Uncertainty tolerance is set by the ability to distinguish between the net benefits of the options.

A third type of question arises from a dichotomous choice situation: should we do this or not? A classic example is the analysis of whether to build a dam in the Snake River's Hell's Canyon (Fisher, Krutilla, and Cicchetti, 1972). The key question involves the *sign* of the net benefits, but not necessarily the magnitude, and the direction of the likely error. Uncertainty tolerance is determined by the perceived likelihood that the true net benefits have the opposite sign of the estimate.

A fourth type of question is, what is the least costly way to meet legal requirements for analysis that may be tangential to the final decision? Certain situations require some form of benefit analysis, but simultaneously legally preclude considering benefits or render any analysis of alternatives moot by legally mandating and specifying all the relevant features of the action For example, the National Ambient Air Quality Standards for criteria air pollutants are set to protect public health with a margin of safety regardless of costs as mandated by the Clean Air Act. EPA conducts benefit analyses for proposed regulations under this statute to meet administrative requirements such as E.O. 12291, but demonstrating that benefits exceed costs is not required under this legislation, which creates a low threshold for sufficient accuracy.

A fifth situation is where benefit analysis is not directly tied to an immediate decision but is part of an information gathering or disseminating function. Fact finding can be sponsored by any interested party very early in the policy process with a goal of attracting sufficient interest to get an issue on the agenda or moved up in the schedule. Benefit analysis can be one part of a scoping process that questions what we know, what we don't know, and what we need to know to proceed. Sponsors motivated for their own reasons to attract broader attention to an issue may want to use benefit analysis to influence relevant people about the importance of the issue. Benefit analysis can also play a role in setting research agendas by indicating where better information would be most likely to make a difference.

At the other end of the policy process, public agencies charged with implementing an already decided policy need to build and maintain public consensus among affected parties about the desirability of the policy. Benefit analysis can help focus public and private attention on the reasons for undertaking costly or burdensome activities. "Selling a program" does not end when a decision is made but must be continually pursued as long as the decision is reversible. Benefit analyses may be useful, and very simple benefits transfers may be good enough

Judicial Branch

Judicial proceedings are one setting where the outcome is potentially directly tied to the magnitude of the estimated benefits. A familiar example is monetary damages in a natural resource damage assessment under the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA or "the Superfund law"). Of all the settings for benefit analysis, uncertainty tolerance may be lowest in litigated damage assessment cases. When a CERCLA case is decided in court, the judge, the trustees, and the potentially responsible parties have a keen interest in the size of the final judgment. Marginal changes in the benefit estimate can affect the marginal size of the damage judgment, increasing the need for reducing benefit uncertainty. The U.S Department of the Interior published guidelines *(Federal Register,* 1980) on the CERCLA benefit analysis, describing acceptable approaches for benefit analysis. Benefits transfers are permissible in the "Type A" model but only between fairly well-matched situations because the cost of new studies is presumed to be large relative to the potential damages associated with a relatively small pollution incident. The incentive for original work is fairly high.

Another role of benefit assessment in damage assessment cases can tolerate more uncertainty and hence often relies on benefits transfer. Either party in a potential litigation must establish a broad strategy they will follow. Each party may want to have the issues decided in court based on a detailed presentation of the evidence. Conversely, the case could be settled out of court. When considering whether to settle, each party considers an acceptable settlement, the likelihood of winning in court, and the likely size of the court's decision. In doing so, each party may consider the magnitude of available benefit estimates from either transfers or original studies.

Executive Branch

The executive branch's responsibilities to prepare, implement and enforce regulations have a number of very different institutional settings that include benefit analysis as one consideration. Each potential application of benefit analysis has its own set of legal, procedural, practical, and political issues that affect the possible role benefit analysis can play. The specific framework sets either upper or lower limits (or both) on the influence of benefits estimates even before considering the quality of the potentially available benefit information.

Relatively few regulatory situations legally or procedurally allow using benefit analysis as a central tool in the decision process. One notable exception is the Toxic Substance Control Act (TSCA), which explicitly allows the use of benefit analysis in setting chemical compound exposure regulations. The basic TSCA objective is to prevent "unreasonable risk," and benefit analysis is one way of assessing reasonableness. Although no legal or procedural impediments exist to using benefit analysis, many actual TSCA regulations have relied on health risk or cost-effectiveness criteria, rather than monetized benefits. However, in 1991 the federal court overturned EPA's ban on asbestos under TSCA and found that EPA insufficiently examined alternatives to an outright ban. The court ruled that although a strict quantified benefit-cost criterion is not required, unsubstantiated statements that benefits clearly exceed costs are not a sufficient rationale to justify a very costly program. How EPA will respond to the court ruling in the future use of benefit analysis under TSCA remains to be seen.

The best known use of benefit analysis in the federal executive branch is Regulatory Impact Analysis (RIA) documents. E.O. 12291 requires benefit-cost analysis of all "major rules" (regulations or requirements with annual costs over $100 million that cause a major increase in prices or have significant impact on competition, employment investment, or international competition)[1]. E.O. 12291 charges government agencies with the role of the neoclassical benevolent social planner in traditional economic models by directing the agencies to select, as permitted by the law, the policy option with least net cost to society. The guidance issued by the Office of Management and Budget (OMB) on the benefit analysis required in an RIA encourages selecting the highest level of benefit analysis by stating "[A]n attempt should be made to quantify all potential real incremental benefits to society in monetary terms to the maximum extent possible" ("Regulatory Impact Analysis Guidance," 1989. p. 568). But the 12291 guidance also recognizes the choice depends on the situation, by saying, "The amount of analysis (whether scientific, statistical, or economic) that a particular issue requires depends on how crucial that issue is to determining the best alternative and on the complexity of the issue. Regulatory analysis inevitably involves uncertainties and requires informed professional judgments" ("Regulatory Impact Analysis Guidance," 1989, p. 561).

The E.O. 12291 guidance recognizes that in some regulatory situations the law prohibits considering the monetary benefits, or any other economic factors, in determining the best regulatory decision. This principle is commonly embedded in many of the United States' health-based statutes and has been upheld in federal court. Thus, the potential for a dichotomy exists: an Executive Order requires preparing a benefit cost analysis, but the implementing legislation prohibits considering such information in the regulatory process. Even when more accurate benefits information could be obtained, the legal barriers to using benefit analysis often discourage the government from committing significant resources to preparing benefits analysis for E.O. 12291. The legal status, combined with chronically short budgets and pressing time constraints, often limits the federal government to relatively quick and low-cost forms of benefit analysis. The legal limitations and budget constraints result in relatively greater uncertainty in many RIAs.

On the other hand, any benefit information included in an RIA is not ignored. The OMB examines the benefits information presented when fulfilling their duties under E.O. 12291 to examine the economic efficiency of all proposed regulations. Federal agencies, aware of the role

[1] The role of benefit analysis has been reaffirmed and expanded in additional Executive Orders and several policy statements from the President's Council on Competitiveness. On March 15, 1991, then Vice President Quayle wrote to EPA reaffirming the Administration's position that E.O. 12291 applies to "all agency policy guidance that affects the public. Such policy guidance includes not only regulations that are published for notice and comment, but also strategy statements, guidelines. policy manuals, grant and loan procedures, Advance Notices of Proposed Rule Making, press releases and other documents announcing or implementing regulatory policy that affects the public." E.O. 12498 directs the agencies to consider benefit analysis in setting regulatory priorities. Further, the 1991/92 regulatory moratorium directs federal agencies "to estimate the likely costs and benefits of legislative proposals under active consideration by Congress or to be proposed by the agency."

of benefit analysis in the OMB review process, try to allocate their scarce benefit estimate resources to issues where the benefit information is most likely to make a difference.

The need to prioritize the level of effort has led to an informal set of "acceptable" cost-effectiveness (e.g., cost per unit risk reduction or cost per unit effluent reduction) cutoffs in some broad categories.[2] Policy options with costs clearly below the "going rate" are good candidates for minimal benefits analysis. Options with costs in excess of the cutoff warrant additional benefits analysis or other justification. Cost-effectiveness cutoffs are really one type of transfer, applying the same criteria of implicit benefits from one setting to another. Cost-effectiveness cutoffs are only a benefits transfer to the extent that benefits information is considered when establishing the cutoff levels. However, cutoffs are typically applied as a coefficient transfer not a benefits function transfer, which limits the ability to custom fit the cutoffs to the specifies of each situation. thereby increasing the uncertainty.

One recent regulatory action did not have significant harriers to considering benefit analysis as a central part of the regulatory process. The Clean Air Act §169A protects visibility at national parks and wilderness areas, for example. If EPA determines that a visibility impairment exists, then EPA must determine the appropriate response. In selecting the BART level of abatement effort, the Clean Air Act §169A states that the decision "shall take into consideration the costs of compliance, the energy and nonair quality environmental impacts of compliance, any existing pollution control technology in use at the source, the remaining useful life of the source, and the degree of improvement in visibility." Although this legislative language does not require using economic benefit analysis, it clearly opens the door.

Although §169A was added to the CAA in 1977, EPA has required emission abatement to protect visibility only once. In 1990 EPA proposed a determination that the Navajo Generating Station (NGS), a large coal-fired electric generating facility in Page, Arizona, caused significant visibility impairment at the Grand Canyon National Park. When EPA proposed the emission reduction in February 1991 EPA said that it "was not required as a part of the BART analysis to estimate monetary benefits associated with improving visibility in the Grand Canyon. However, as a check of reasonableness for its approach, EPA evaluated and considered the benefit analysis developed as a part of the RIA" (Federal Register, 1991, p. 5,182). EPA used a benefits transfer based on an existing contingent valuation study to estimate monetary benefits. The draft RIA concluded that benefits may exceed costs with a fairly wide uncertainty range.

[2] For instance, in 1985 EPA established "policy-derived" cost-effectiveness guidelines for air pollution New Source Performance Standards of $3,000/megagram for particulate matter and $1,250/megagram for both sulfur dioxide and volatile organic compounds (Elkins and Russell, 1985).

Prior to proposal the NGS commissioned a pilot contingent valuation study directly concerned with the benefits of reducing sulfur dioxide emissions from NGS. The NGS study concluded that costs exceed benefits. EPA invited comments during proposal on both benefit studies. However, in the final rule, EPA stated, “[b]ecause the benefits analysis forms no part of [the] legal basis for today's action, EPA is not responding to those comments” (*Federal Register,* 1992, p. 50,184). The final rule requires NGS to reduce its sulfur emissions by 90 percent. It seems that each side used sufficient benefit analysis to counter the benefit-cost conclusions presented by the other, perhaps causing the benefits analyses to be side-stepped in the official decision-making process.

State and local agencies are also becoming more interested in benefits analysis. For example, the South Coast Air Quality Management District (SCAQMD) is the local air pollution control authority in the Los Angeles area. Under the California Clean Air Act, in 1989 the SCAQMD approved a massive plan to reduce air pollution in the South Coast. As part of preparing the plan, the SCAQMD asked the California State University Fullerton Foundation to prepare an economic evaluation of the potential health benefits of improving air quality in the South Coast. The report examined the benefits from a number of health and welfare endpoints associated with various pollutants (Hall et al., 1989). Part of the motivation for this study was to help build public support for the pollution control measures set forth under the plan by demonstrating that substantial benefits would accrue as a result of the control costs incurred.

Another example of state interest in benefits is the New York State Energy Research and Development Authority (NYSERDA). New York has a policy of considering the full social costs in electric utility planning. NYSERDA asked the Pace University Center for Environmental Legal Studies Energy Project to prepare a study of the environmental externality costs of electric utility operations (Ottinger et al., 1990). The study examines the social costs of available methods of generating electricity as well as the social costs of demand-side management programs.

Legislative Branch

Legislative development is the third broad government arena for benefit analysis. The U.S. Congress or state legislatures make many fundamental choices long before the specific regulations are promulgated or damage suits litigated. Congress is increasingly interested in benefit analysis and has recently either prepared or required several major benefit studies. Three examples of Congress’s recent interest in benefits are the inclusion of benefits assessment in the change to the National Acid Precipitation Assessment Program (NAPAP), the Office of

Technology Assessment (a congressional entity) report *Catching Our Breath: Next Steps for Reducing Urban Ozone,* and a retrospective and prospective report on benefits and costs required by §812 of the Clean Air Act.

The NAPAP State of Science and Technology (SOS/T) reports include a review of the state of knowledge about physical and economic benefits for environmental effects categories associated with acid rain (Brown et al., 1990). The NAPAP *1990 Integrated Assessment Report* develops a "quality of information" ranking system for all information in the SOS/T, including monetized benefits information. In general, NAPAP used fairly rigorous criteria for assessing the quality benefits information. The *Integrated Assessment* includes monetized benefit information on only four environmental endpoints: national agriculture, forests in the southeast, recreational fishing in the Adirondack Mountain region, and urban visibility in the east. Eight other endpoints[3] of concern are qualitatively discussed, but monetized benefit estimates are not developed because of NAPAP's assessment of inadequate information on physical damages. valuation, or both. The benefits estimation techniques used in the *Integrated Assessment* include supply/demand analysis for commercial crops and forest products, travel-cost for recreational fishing, and a blend of meta-analysis, expert judgment and benefits transfer for visibility.

The congressional committees working on reauthorizing the Clean Air Act requested that the Office of Technology Assessment prepare the analysis in *Catching our Breath.* Ozone is the United States' most widespread and persistent air pollution problem. In spite of considerable effort and much progress, 45 percent of the U.S. population lived in metropolitan areas that did not meet the ozone air quality standards in 1988 (EPA. 1990). Because of the abatement activities already in place, further progress on ozone will be increasingly expensive. OTA's analysis focused on two environmental endpoints of ozone. The benefits analysis used expert judgment based on existing literature for the value of reducing health effects and supply/demand analysis for commercial crop effects.

Section 812 of the Clean Air Act Amendments of 1990 expands the scope of the existing § 312 report on the cost of federal air pollution programs. The goal of the expanded *Cost of Clean Air* report is to include monetary benefit analysis in a comprehensive examination of the full social and private costs and benefits of the Clean Air Act. The first report must estimate the costs and benefits of all air programs prior to the 1990 Amendments. After the "retrospective" report is issued, EPA must periodically update the retrospective report and prepare a "prospective" report, with projections of the costs and benefits of further progress in reducing air

[3] other terrestrial ecosystems, water-based recreation, commercial fishing, other aquatic ecosystems, building material, cultural materials, and human health.

pollution. The Amendments create an Advisory Council on Clean Air compliance Analysis to peer review the data methodology, and findings in the report and to make recommendations to EPA.[4]

Nongovernment-Sponsored Benefit Analysis

Recognizing that benefit analysis plays a role in the public decision process, various groups outside the government also produce benefit analyses.. These efforts range from publicizing existing work to undertaking substantive new efforts. Affected parties in legal or regulatory proceedings have various legal and procedural opportunities to provide benefits information. But outside groups also provide benefits information in other settings as well. The motives for providing such information likely range across the spectrum, from pro bono provision of information to narrow strategic advocacy. Sometimes the analysis is obviously tied to a particular action pending in Congress or an issue emerging in the national environmental or political landscape. Two recent examples are the series of articles written by Portney and Krupnick (Portney, 1990; Krupnick and Portney, 1991). and the American Lung Association's latest survey of studies on the health costs of air pollution (Cannon, 1990).

STRATEGIC CONSIDERATIONS: BENEFIT ANALYSIS IN THE REAL WORLD

The acceptable level of "good enough" benefit analysis is not determined solely by the particular legal situation. A number of strategic or tactical issues face all the interested parties who have the option of producing benefit analysis. Economic researchers are seldom the ultimate public policy decision makers, and economic efficiency is not necessarily the primary concern of all parties. Benefit analysis is typically prepared at the request of, and for the purposes of, someone else. The "client" must decide to accept a given level of benefits effort (perhaps a level already provided by someone else), or to undertake more extensive analysis. That decision is basically driven by the question. "Are further efforts likely to make a difference that I will like?" The researcher can provide useful opinions about what additional efforts will likely produce and an evaluation of the influence on uncertainty from more information, but the decision to go forward or not rests with the client's evaluation of whether the analysis will further their interests. Ideally, of course, the client's interests include making rational and socially beneficial decisions based on objective information. However, this is not always the case, and the researcher may be more vulnerable to manipulation and/or misinterpretation if unaware of all the client's motives for requesting benefit analysis.

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[4] The initial members of the Council are R. Cummings, D. Dudek AM. Freeman, R. Mendelsohn, W. Nordhaus. W. Oates, P. Portney, R. Schmalensee, T. Tietenberg, and K. Viscusi.

Benefits researchers are doing a great disservice to themselves, their client, and the profession in general if they allow strategic or tactical considerations to influence the content of a benefit analysis. Current standard practices of careful reporting of data or results taken from other sources, open disclosure of new data, survey instruments and methods, detailed descriptions of assumptions, biases and omissions, careful attention to economic theory and statistical procedure, and adequate quality control procedures are important to maintain, no matter how the client intends to use the results. Bad analysis is never good enough, despite the client's interests.

However, even if benefit analysis can be totally inoculated from deliberate strategic mis-preparation, the client may still face various strategic considerations. For instance, an argument that a new analysis must be prepared because the level of uncertainty in the existing benefits transfer is unacceptable may be a pretext, where the real motivation is a stalling tactic. A new benefit study that costs less than the present value of a delayed decision can be an economically rational move by a client with adequate resources to invest.

Another strategic consideration that a client must carefully evaluate is the amount of scrutiny that the benefit analysis will undergo. If the client could be assured of an impartial review by knowledgeable people, the decision could focus on issues of reducing uncertainty and providing better information, for example. However, in the real world benefit analysis is often reviewed in an adversarial setting where the audience (e.g., decision makers, juries) may not have a great deal of technical expertise. A greater level of effort may be required, not because more information is really needed, but to protect the analysis from being discredited in the eyes of the nonexpert audience by voluminous criticisms.

Setting a precedent can also be an important issue that influences the level of analysis one side or the other is willing to support. The total return to an investment in additional research may be much greater than the expected return from the current situation. If one side establishes a precedent in a small case on whether benefits can be measured, determines the appropriate way to estimate benefits, or a benefits function, the larger payoff may come later in a different and larger case.

Our final point on strategic issues is the different ability of parties to afford additional efforts. Consider a David and Goliath situation, where a government or a court is considering whether to require a solution to a particular pollution problem. The affected parties may not have equal ability to provide additional analysis. If the side with the largest resources perceives the outcome may be more favorable if they provide additional information that reduces the benefits uncertainty, they can provide the further analysis. The other side's income or wealth limits can prevent them from exercising a similar option. This issue does not only exist in "big corporation versus the little guy" settings: the resources of a well-funded national advocacy group can far surpass the resources of a property owner or small business. The "decision maker" must keep these tactical issues in mind when reviewing additional information that has been submitted. Silence from one side may be more reflective of current wealth than of the magnitude of the actual benefits. Newly provided analysis may reflect as much information on the submitter's analysis of the likely outcome as it does of the real issues in the case.

FUTURE DIRECTIONS

Benefit estimation is both an art and a science, combining theory from the social sciences, techniques from statistics, and sound judgment on the part of the practitioner. Progress will be made as we improve our art, our techniques, and our science. One often noted weakness in the current state of economic science in general is the relative infrequency with which results are tested. One cornerstone of the scientific method is the replicability of results, but the economics profession does not usually emphasize repeating analysis. The aversion to repeating analyses is not due to malicious intent but to scarce resources, ever expanding research agendas, and a pressing need to try to provide answers to the crucial problems confronting society. However, it does result in greater uncertainty in our results, frequently conflicting conclusions, and diminished acceptability of our results. This problem is endemic to most of economics but is particularly relevant to the issue of benefits transfer. Much of the uncertainty associated with benefits transfer comes from the limited knowledge we have about how different specifics about the assessment situation in question will influence the estimates. As we gain a better understanding of the effects that variations in our techniques have on benefit estimates for a single situation and on the differences identical techniques produce when used in different situations, we will improve our ability to use benefits transfer techniques and understand the associated uncertainties. Consequently, our ability to meet the need of the decision maker at the lowest possible cost will also improve.

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WHAT IS CONSUMER'S SURPLUS *FOR A DAY OF USE?* AND WHAT DOES IT TELL US ABOUT CONSUMER'S SURPLUS?

Edward R. Morey*

ABSTRACT

Compensating variation *for a day of use* is a well-defined concept for a change in the price of a recreational site but is not, in general, a well-defined concept for a change in the characteristics of a site. Sufficient conditions for when it is well-defined for characteristics changes are identified. These sufficient conditions are assumed in most discrete-choice models of recreational participation and site choice. When well-defined, compensating variation for a day of use multiplied by the number of days in the original state (proposed state) is a Laspeyres index (Paasche index) that bounds the compensating variation (CV) from below (above). The first approximation is a linear approximation to the CV, and the second approximation is a linear approximation to the equivalent variation. The average of these two approximations is an *almost* second-order approximation to the CV and is akin to the Harberger triangle. Simulation results indicate the bias in the linear approximations can be small or large, and the bias in the average of these two linear approximations while often quite small can be large if the proposed changed will result in a large percentage change in the predicted number of days.

Consumer's surplus *for a day of use* is a common way to express the benefits a representative individual derives from a recreational site. The U.S. Forest Service uses consumer's surplus for a day of use as the basic measure of a site's recreational value. Walsh, Johnson, and McKean (1991) surveyed twenty years of empirical research on the recreational value of our national forests. They note, "The standard unit of measurement is an activity day, defined as one person on-site for any part of a calendar day" (p. 176). Derivation of *day of use* measures is common in both the travel-cost and contingent valuation literature and is particularly common in the discrete-choice variants of these methodologies. A few examples are Bockstael, Hanemann, and Strand (1984); Carson, Hanemann, and Wegge (1987); Cameron (1988); and Cameron and James (1987).

Why the attraction to consumer's surplus for a day of use when the desired welfare measure for policy analysis is not consumer's surplus for a unit consumed but instead consumer's surplus? For a given time period such as a year, the policy maker wants to how how each individual values a change in prices or site characteristics rather than his or her value

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per day of use for that change.[1] However, policy makers and economists alike are attracted to for a day of use measures for a number of reasons, one being consumer's surplus day of use lends itself to use in *benefit transfers.* The notion is that once a representative individual's consumer's surplus for a day of use has been estimated for *X-ing* at one site where "X" is a recreational activity such as fishing or hiking, the analyst can obtain that individual's consumer's surplus for the site or any similar site by multiplying consumer's surplus for a day of use at the first site by the number of days spent *X-ing* at the site to be valued.

This paper examines the concept of consumer's surplus for a unit of use and identifies its relationship to consumer's surplus per unit of time. Does consumer's surplus for a unit of use stand alone as a well-defined concept, and if so, should it be the standard-bearer for transferring benefit measures from one site to another?

We begin our examination of these issues with a thought experiment. Consider the maximum you would pay to have the price you pay for the next Coke you drink reduced by $0.50. Your answer is $0.50. Further note that this is how much you would pay each and every time you purchase a Coke to have the price of that Coke reduced by $0.50. Fifty cents is your consumer's surplus for a unit of use for having the price of Coke reduced by $0.50 (i.e., it's your *per-Coke* consumer's surplus for the price reduction).

Consider now a similar thought experiment for a reduction in the cost of a day at a recreational site.[2] For simplicity, assume a world of three commodities: two types of activities, days at a recreational site and days at home, and a numeraire good that can be consumed anywhere. What is the maximum amount an individual would pay each time he or she spent a day at the site to have the cost of that day reduced from P_t^0 to P_t^1 where P_t is the cost for the day? The answer is $(P_t^0 - P_t^1)$, which is the individual's day of use compensating variation (CV) for the price change, denoted CVDU.[3]

CVDU is represented graphically in Figure 1 as the vertical distance ab, whereas the individual's CV associated with the change is the area $P_t^0 acP_t^1$. Obviously, CVDU $\neq$ CV. The issue is, therefore, how CV can be derived, *or approximated*, from the CVDU.

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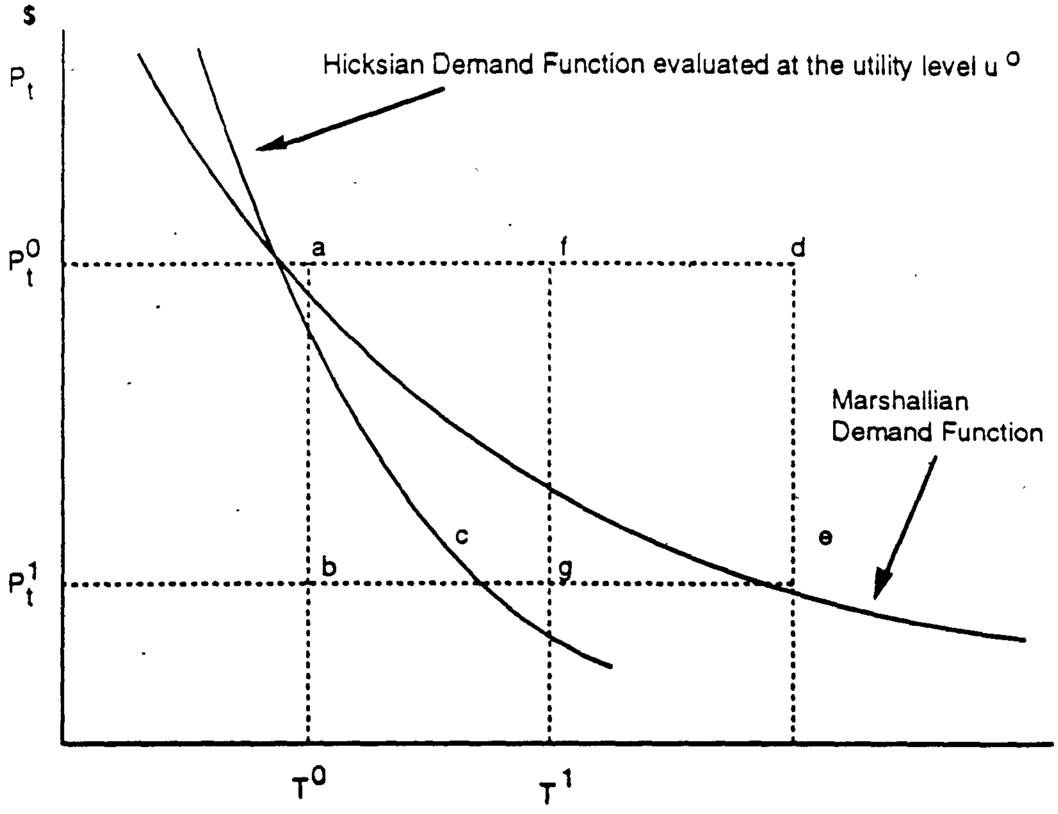
[1] Consumer's surplus is defined here as either the compensating variation or the equivalent variation associated with the change. It is defined for a specific time period such as a year or season.

[2] Later, I consider the more complicated issue of the consumer's surplus and the consumer's surplus for a unit of use for a change in the characteristics of a recreational site.

[3] Note that CV for a day of use, CVDU, is not the same as the CV for a day.



T = Number of days at the site

Figure 1. Per Day of Use Compensating Variation

Consider multiplying CVDU by the number of days at the site.[4] The figure obtained depends on whether CVDU is multiplied by the number of days at the site in the original state, the number of days in the proposed state, or some average of the two. Define $CV_t^0 \equiv (T^0 \times CVDU)$, where T^0 is the number of days when $P_t = P_t^0$. Graphically, CV^0 is the area $P_t^0abP_t^1$. Define $CV_t^1 \equiv (T_1 \times CVDU)$, where T^1 is the number of days when $P_t = P_t^1$. Graphically, CV_t^1 is the area $P_t^0deP_t^1$. As

[4]Considering day of use consumer's surplus measures, Bocksteal, Hanemann, and Strand (1984) state, "The calculation of CV according to equation (20) yields an estimate of the compensating variation *per choice occasion* for the household. To obtain annual or seasonal benefit estimates this number must be multiplied by the number of trips the individual takes" (p. 10-28). In the same vein, Carson, Hanemann, and Wegge (1987) state, "The benefit is measured in terms of the maximum amount of money the individual would be willing to pay to ensure that the alternative is available whenever he makes a fishing choice. We therefore obtain an estimate of benefit per choice occasion, i.e., per fishing trip to any site, not just per-trip to the particular site of interest. Because our resident angler model is estimated on a weekly basis, the benefit to an individual is the benefit per choice occasion during that week, multiplied by the predicted number of trips (choice occasions) that week" (p. 8-23).

Figure 1 suggests, CV_t^0 is a Laspeyres index that bounds the CV from below, and CV_t^1 is a Paasche index that bounds the CV from above.

Theorem 1:

$$CV_t^0 \equiv \left[T^0\left(P_t^0 - P_t^1\right)\right] \leq CV \tag{1}$$

and

$$CV_t^1 \equiv \left[T^1\left(P_t^0 - P_t^1\right)\right] \geq CV. \tag{2}$$

Proof that $\left[T^0\left(P_t^0 - P_t^1\right)\right] \leq CV$

Define the indirect utility function for the season as V = $V(Y, P_h, P_t)$ where Y is income. P_h is the cost of each day at home, $V^0 \equiv V(Y, P_h^0 P_t^0)$, and $V^1 \equiv V(Y, P_h^0 P_t^1)$. Dual to this indirect utility function is the expenditure function E = $E(V, P_h, P_t)$. Define T as the number of days at the site, H as the number of days at home, and let N denote the quantity of the numeraire consumed (i.e., N $\equiv$ Y $- P_t T - P_h H$).

By definition, the CV for a change from $\left\{P_h^0, P_t^0\right\}$ to $\left\{P_h^0, P_t^1\right\}$ is

$$CV = E\left(V^0, P_h^0, P_t^0\right) - E\left(V^0, P_h^0, P_t^1\right) \tag{3}$$

By definition of the expenditure function

$$E\left(V^0, P_h^0, P_t^0\right) = P_t^0 T^0 + P_h^0 H^0 + N^0 \tag{4}$$

and

$$E\left(V^1, P_h^0, P_t^1\right) = P_t^1 T^1 + P_h^0 H^1 + N^1 \tag{5}$$

Substitute Eq. (4) into Eq. (3) to obtain

$$CV = \left(P_t^0 T^0 + P_h^0 H^0 + N^0\right) - E\left(V^0, P_h^0, P_t^1\right) \tag{6}$$

Now note that

$$E\left(V^o, P_h^o, P_t^1\right) \leq P_t^1 T^o + P_h^o H^o + N^o \tag{7}$$

because T^o, H^o, and N^o are by definition capable of producing V^o. Therefore, $P_t^1 T^o + P_h^o H^o + N^o$ are sufficient expenditures to produce V^o given P_t^1 and P_h^o. However, $E(V^o, P_h^o, P_t^1)$ is by definition the minimum expenditures required to produce V^o given P_t^1 and P_h^o.

Given Eq. (6) and Eq. (7),

$$CV \geq \left(P_t^o T^o + P_h^o H^o + N^o\right) - \left(P_t^1 T^o + P_h^o H^o + N^o\right) = T^o \times \left(P_t^o \text{ and } P_t^1\right) \quad \textbf{q.e.d.} \tag{8}$$

The proof that $[T^1 \times (P_t^o - P_t^1)] \geq CV$ is analogous to the proof that $[T^o \times (P_t^o - P_t^1)] \leq CV$.

Further note that from Eq. (6), Eq. (7), and the definition of CV_t^o, it follows that

$$CV - CV_t^o = P_t^1 T^o + P_h^o H^o + N^o - E\left(V^o, P_h^o, P_t^o\right) \geq 0 \tag{9}$$

As Eq. (9) indicates, the bias in CV_t^o is how much the expenditures to produce V^o would decline at the proposed prices if the individual is allowed to adjust his allocation from $\{T^o, H^o, N^o\}$ to $\{T^1, H^1, N^1\}$.

CV_t^o also a linear approximation to the CV for a change in P_t, that is

$$CV = E\left(V^1, P_h^o, P_t^1\right) - E\left(V^o, P_h^o, P_t^1\right) \tag{10}$$

$$\approx E\left(V^1, P_h^o, P_t^1\right) - [E\left(V^o, P_h^o, P_t^o\right) + \frac{\partial E\,(V^o, P_h^o P_t^o)}{\partial P_t}(P_h^1 - P_t^o)]$$

by Taylor's Theorem

$$= -\frac{\partial E\left(V^o, P_h^o P_t^o\right)}{\partial P_t}\left(P_h^1 - P_t^o\right) \quad \text{since } E\left(V^1, P_h^o, P_t^1\right) = E\left(V^o, P_h^o, P_t^o\right) = Y$$

$$\equiv T^o\left(P_t^o - P_t^1\right) \equiv CV_t^o$$

by Shepard's lemma

By an analogous argument, CV_t^1 a linear approximation to the equivalent variation.

Note that CV_t^o is akin to a linear approximation to the CV that is essentially due to Hicks (1942 and 1946). The Hicksian approximation to the CV, which is in terms of quantity changes rather than price changes, is

$$CV \approx P^1(X^1 - X^0) \text{ (Diewert, 1987)} \tag{11}$$

where $X \equiv (H, T, N)$ and $P \equiv (P_h, P_t, 1)$.[5] Therefore CV_t^o might be labeled Hicksian price-change approximation to the CV.

Summarizing to here, $[T^o(P_h^o - P_t^1)]$ and $[T^1(P_h^o - P_t^1)]$ are respectively lower and upper bounds on the CV, and $[T^o(P_h^o - P_t^1)]$ is, in addition, a linear approximation to the CV. These results make consumer's surplus for a day of use, $(P^o - P^1)$, useful.

Unfortunately, neither CV_t^o or CV_t^1 will always closely approximate the CV. Put simply, the actual degree of bias in these linear approximations depends on the individual's preferences and the magnitude of the price change. The bias can be small or large. For example, in Figure 1 the bias is significant visually. Intuitively, the bias in CV_t^o and CV_t^1 results because neither measure considers the substitutability between days at home and days at the site. The degree of bias in each of these measures is an increasing function of the *marginal rate of substitution* between days at home and days at the site and of the magnitude of the price change; the greater the change in T that will result from the proposed price change, the greater the bias.

In contrast to these linear approximations, the average of CV_t^o and CV_t^1 is *almost* a second-order approximation to the CV for a change in P_t. Denote this average CV_t^{ave}

$$\begin{aligned} CV_t^{ave} &= \frac{1}{2}\left(CV_t^o + CV_t^1\right) = \left(P_t^o - P_t^1\right) \frac{1}{2} \left(T^1 + T^o\right) \\ &= T^o\left(P_t^o - P_t^1\right) + \frac{1}{2}\left(P_t^o - P_t^1\right)\left(T^1 + T^o\right) \end{aligned} \tag{12}$$

CV_t^{ave} will almost always better approximate the CV than either CV_t^o or CV_t^1.

In contrast to CV_t^{ave}, an exact second-order approximation to the CV for a change in P_t is

$$CV = E\left(V^1, P_h^o, P_t^1\right) - E\left(V^o, P_h^o, P_t^1\right) \tag{13}$$

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[5] **If we restrict the change in P to a change in P_t, Eq. (10) simplifies to**

$$P^1(X^1 - X^o) = P_t^1(T^1 - T^o) + P_h^o(H^1 - H^o) + (N^1 - N^o)$$

$$= E\left(V^1, P_h^o, P_t^1\right) - \left[E\left(V^o, P_h^o, P_t^o\right) + \frac{\partial E\left(V^o, P_h^o P_t^o\right)}{\partial P_t}\left(P_h^1 - P_t^o\right) + \frac{1}{2}\frac{\partial^2 E\left(V^o, P_h^o P_t^o\right)}{\partial P_t^2}\left(P_t^1 - P_t^o\right)^2\right]$$ by Taylor's Theorem

$$= -\frac{\partial E\left(V^o, P_h^o P_t^o\right)}{\partial P_t}\left(P_t^1 - P_t^o\right) - \frac{1}{2}\frac{\partial^2 E\left(V^o, P_h^o P_t^o\right)}{\partial P_t^2}\left(P_t^1 - P_t^o\right)^2$$

because

$$E\left(V^1, P_h^o, P_t^1\right) = E\left(V^o, P_h^o, P_t^o\right) = Y$$

$$= T^o\left(P_t^o - P_t^1\right) + \frac{1}{2}\frac{\partial T\left(V^o, P_h^o P_t^o\right)}{\partial P_t}\left(P_t^1 - P_t^o\right)\left(P_t^o - P_t^1\right)$$

by Shepard's lemma

Comparing Eq. (12) and (13), the difference between CV_t^{ave} and an exact second-order approximation to the CV is the difference between $(T^1 - T^o)$ and the change in P_t, $(P_t^1 - P_t^o)$, multiplied by the slope of the Hicksian demand function for T evaluated at the initial utility level and prices,

$$\frac{\partial T\left(V^o, P_h^o P_t^o\right)}{\partial P_t}$$

Note that a different almost second-order approximation to the CV is the well-known Harberger triangle,[6] $(P^o(X^1 - X^o) + \frac{1}{2}(P^1 - P^o)(X^1 - X^o))$. The difference between CV_t^{ave} and the Harberger triangle is CV_t^{ave} is an almost second-order approximation to the CV in terms of the price change, and the Harberger triangle is an almost second-order approximation to the CV in terms of the quantity changes. In this sense CV_t^{ave} might be labeled the price-change equivalent to the Harberger triangle

Summarizing the last few paragraphs, CV for a day of use can be used to obtain an almost second-order approximation to the CV by multiplying CV for a day of use by average

[6]For more details on the properties of the Harberger triangle see Harberger (1971), Diewert (1976 and 1987), and Weitzman (1988).

number of days at the site in the initial and proposed states. In general, this approximation is better than the approximation obtained by multiplying CV for a day of use by the number of days at the site in one of the states.

To get a feel for how large biases in CV_t^o, CV_t^1, and CV_t^{ave} can be, I ran 100 simulations. Simulations tell us nothing about how small or large the bias will be in any particular real world example. They are by definition assumption-specific; a particular preference ordering is assumed, and then the bias is determined for different price changes for that preference ordering. The simulations reported here are based on a simple repeated discrete-choice random-utility model that explains the probability of visiting the site on any given day. No claim is made that this discrete-choice model reflects truth. The largest bias I generated is a case where the price reduction causes the probability of visiting the site each day to increase from effectively zero to 2 percent. For this case, CV = \$18.25, CV_t^o = \$0.0025, and CV_t^1 = \$203.40.

For comparison, a case where the price reduction causes the probability to increase from 4 to 9 percent resulted in a CV of \$58.95, a CV_t^o of \$35.34, and a CV_t^1 of \$90.56, and a case where a price increase causes the probability to decrease from 4 to 1 percent results in a CV of -\$22.59, a CV_t^o of -\$35.34, and a CV_t^1 of -\$13.30. For the 100 simulations, neither CV_t^o nor CV_t^1 closely approximate the CV unless the price change caused the probability to change by less than 10 percent, and then CV, CV_t^o, and CV_t^1 are all effectively zero. For example, a price decrease that caused the probability to increase from 2 to 2.04 percent (a 2 percent change) resulted in a CV of \$0.3233, a CV_t^o of \$0.3205, and a CV_t^1 of \$0.3262, but a price decrease that caused the probability to decrease from 34 to 26 percent (a 30 percent change) resulted in a CV of -\$101.30, a CV_t^o of -\$113.60, and a CV_t^1 of -\$89.50. These simulation results are just an example, but they do indicate the potential for a bias and one that increases as the significance of the price change increases.

CV_t^{ave} much more closely approximates the CV. For the eight simulation results noted above, the CV's and their corresponding CV_t^{ave}'s are {\$18.25 and \$101.70}, {\$58.95 and \$62.95}, {-\$22.59 and -\$24.32}, {\$0.3233 and \$0.3234}, and {-\$101.30 and -\$101.50}. Except for the first set, CV and CV_t^{ave} are all similar. In the first case, a five-fold difference exists between the CV and the CV_t^{ave}. Again, these simulation results should not be taken too seriously, but they do suggest that the CV_t^{ave} closely approximates the CV except in cases in which the price change will cause a great change in the number of days at the site. However. bias is significant because any policy that increases demand from effectively zero to a small number of days will involve a large multiplicative change in total demand.

Up to this point we have only considered the CV associated with a change in the price of a day at the site. However, often we need to estimate or approximate the CV associated with a change in the characteristics of a site. How much of the argument above generalizes to cases involving changes in characteristics?

To begin our investigation of this question, again consider our Coke-drinking thought experiment, but now determine how much you would pay to have the number of calories in the ith Coke that you drink reduced by 50 percent (with all other product characteristics unchanged). Without loss of generality, I'll denote your answer α_i. This amount, α_i, is your CV for this calorie reduction *for the ith Coke drank.* Contrast this amount with a *per-Coke* CV for this calorie reduction that is independent of the number of Cokes you choose to drink. A *per-Coke* CV independent of the number of Cokes you choose to drink only exists if $\alpha_i = \alpha \ \forall$ i, in which case is the per-Coke CV. In cases such as our first thought experiment where the change is solely a price change, $\alpha_i = \alpha =$ the price reduction $\forall$ **i,** but typically $\alpha_i \neq \alpha \ \forall$ i if the change involves a change in the characteristics of the commodity. For example, how much I would pay to have the calories reduced in the last Coke I drink will increase as I drink more Cokes.

By definition, $\alpha_i = \alpha \ \forall$ i only if how you value the change in monetary terms is independent of the number of Cokes you choose to drink. This must be true for a change in the price of a Coke, but what would be sufficient to make it true for a change in the characteristics of the Coke? A *sufficient* but not *necessary* condition is a world with the following properties:[7]

- Assume a world of only three commodities: two activities, drinking a Coke and not drinking a Coke, and a numeraire good.
- Both activities take all day.
- If you choose not to drink a Coke you spend all of your income for the day on the numeraire. Otherwise you allocate to the numeraire your income for the day minus the price of the Coke.
- How much utility you receive on a day is only a function of whether you drink a Coke that day, the amount of the numeraire consumed that day, and the characteristics of Coke. If these four conditions hold, you will always have a CV *per Coke drank* for a change in the price and/or characteristics of Coke, which is independent of the number of Cokes you choose to drink.

Now consider a similar thought experiment for a change in the characteristics of a recreational site. As before, assume a world of three commodities: two types of activities, days at the recreational site and days at home, and a numeraire good that can be consumed anywhere.

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[7] **The reason I choose these properties rather than some other set of sufficient conditions will become clear.**

What is the maximum amount an individual would pay each and every time he or she spends a day at the site to have characteristics of the site be C^1 rather than C^0? As our last thought experiment indicates, the individual will not in general be able to answer this question because there is no such amount. For changes in the characteristics of a site, a constant CV *for a day of use,* α, does not usually exist.

In a world with a recreational site but no Coke, $\alpha_i = \alpha \; \forall$ i only if the manner in which the individual values the change in the site in money terms is independent of the number of days he or she spends at the site. $\alpha_i = \alpha \; \forall$ i must be true for a change in the price of a day at the site but does not have to be true for changes in the characteristics of the site.

A constant CV for a day of use will exist for an individual in our world of three commodities only if we make the additional assumption that the utility the individual receives on a day is only a function of whether he or she spends that day at the site, the amount of the numeraire consumed that day, and the characteristics of the site. In this case, $\alpha_i = \alpha \; \forall$ i for any change in the price of a day and/or change in the characteristics of the site. Note that when this assumption is made a price change always exists that would make the individual indifferent between that price change and the proposed change in the characteristics, and this price change is independent of the number of days spent at the site. We might denote this price change as the *quality-equivalent price change.* Therefore, when we adopt the additional assumption outlined above, any change in the characteristics of a site can be *converted* into its *quality-equivalent price change,* and Theorem 1 and all the approximation results apply in terms of this price change. The fact that a characteristics change can be converted into an equivalent price change when these restrictive assumptions hold makes Theorem 1 and the approximation results particularly relevant to discrete-choice models of recreational demand.

The assumption that the utility the individual receives on a day is only a function of whether he or she spends that day at a site, the amount of the numeraire consumed that day, and the characteristics of the site is the basic assumption of many discrete-choice models of recreational demand. Therefore a constant CV for a day of use can be derived for changes in both prices and characteristics from most discrete-choice models of recreational demand.[8] Consider a simple dichotomous Logit or Probit model designed to predict the probability that an individual will visit a particular site on a given day. Such models are based on two conditional indirect utility functions. One function specifies the utility received for the day if the site is visited, and the other function specifies the utility received for the day if the site is not visited.

[8] For example see, the earlier references to Bockstael, Hanemann, and Strand (1984) and Carson, Hanemann, and Wegge (1987).

From such a random-utility model we can derive an expected CV *per day* for any change in the price or characteristics of the site. This constant CV per day can, for example, be multiplied by the number of days in the year to get the CV for the year. From this discrete-choice model we can also derive a CV for a day of use. Note CV for a day of use is not the same thing as CV per day. CV for a day of use is what CV per day would be if the individual were constrained to spend the day at the site. The individual is not constrained in this way.

Theorem 1 and the approximation results imply the following for this simple discrete-choice model of recreational demand: CV for a day of use multiplied by the number of days each year to the site in the original state is both a lower bound and a linear approximation to the yearly CV associated with the change; CV for a day of use multiplied by the number of days each year to the site in the proposed state is both an upper bound on the yearly CV and a linear approximation to the yearly equivalent variation, EV, associated with the change; and CV for a day of use multiplied by the average of the number of days at the site in the two states is almost a second-order approximation to the CV associated with the change. The simulation results discussed earlier were all derived from a discrete-choice random utility model. Therefore, even though the original discussion of simulation results described the CVs as those for price changes, they could for this model also be described as CVs resulting from changes in the characteristics of the site. This assertion is true because any change in the characteristics of the site has a *quality-equivalent price change* if we assume that the utility the individual receives on a day is only a function of whether he or she spends that day at a site, the amount of the numeraire consumed that day, and the characteristics of the site.

CONCLUSIONS

Care is required when using consumer’s surplus for a day of use. Consumer’s surplus for a day of use exists for any change in the price of a day at a recreational site and is equal to the price change. However, if the change involves a change in the characteristics of the site, a constant CV per day of use does not, in general, exist. In addition, even when a constant consumer’s surplus for a day of use does exist, multiplying it by the number of days at the site in the original state provides only a lower bound on the consumer’s surplus, and multiplying it by the number of days at the site in the proposed state provides only an upper bound on the consumer’s surplus. Simulations show the bias in these approximations can be small or large. The average of the two bounds often closely approximates the consumer’s surplus, but even this average can be significantly biased for numerous proposed policies.

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GROUNDWATER VALUATION: DOUGHERTY COUNTY, GEORGIA

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ABSTRACT

The benefit transfer problem addressed here involves using existing valuation data to transfer estimates of groundwater quality benefits to Dougherty County, Georgia. Groundwater provides the sole source of almost all drinking water supplies in the county. In addition, the availability of abundant groundwater supplies, combined with good sandy soil and a mild climate, make this county a major agricultural production region. In the Dougherty County region, a high potential exists for chemical fertilizers and pesticides used in agricultural production to leach through the soil and contaminate groundwater supplies,

We evaluated groundwater valuation estimates from several previous studies as potential candidates for transfer to Dougherty County. Because of a number of limitations, the valuation estimates reported in previous studies provide, at best, "ball park" estimates of groundwater protection benefits in Dougherty County and therefore are suitable for only a "scoping" type analysis. The "transferability" of existing valuation estimates to Dougherty County might be improved by reestimating valuation models from existing data, obtaining additional secondary data from each existing study site, and conducting a small and inexpensive survey at the policy site (Dougherty County) to collect primary data on a limited number of key valuation variables (e.g., subjective supply and demand uncertainty). Benefit transfer holds promise as a potential alternative for valuing groundwater protection. However, much more research is needed to establish acceptable protocols for transferring benefit estimates from one site to another.

In many regions of the U.S. groundwater provides the major source of water for municipal, industrial, and agricultural activities. The continued use of groundwater to support these economic activities can be threatened by the activities themselves. For example, toxic chemicals from municipal and industrial waste dumps may leach through the soil and contaminate groundwater supplies. Chemical fertilizers and pesticides applied on agricultural land may also result in toxic chemicals leaching through the soil and contaminating groundwater supplies. One question of general interest is, "What are the benefits to the general public in a specific area of 'safe' groundwater quality (where safe implies that chemical concentrations in

*University of Georgia and University or Maine, respectively. We would like to thank Steven Edwards and Bruce Lindsay for providing information from their studies of groundwater protection benefits. Members of the case study group included David Brookshire (University of New Mexico), Lon Carlson (Argonne National Laboratory), Steve Crutchfield (USDA, Economic Research Service), Martin David (University of Wisconsin), Richard Dubourg (University College London), Stephen Farber (University of Pittsburgh), John Hoehn (Michigan State University), Linda Langner (USDA, Forest Service), Michael LeBlanc (USDA, Economic Research Service), Marc Ribaudo (USDA, Economic Research Service), and Rodney Weicher (NOAA). All errors, omissions, and opinions are solely attributable to the authors.

the water are within EPA health advisory levels)? Benefit transfer provides a potential means of addressing this question.

This paper proposes a protocol for transferring existing groundwater quality benefits using a case study approach. We present background information on the valuation problem for the case study “policy site” and discuss individual and aggregate values. We present a proposed benefit transfer protocol for the case study and assess the applicability of existing groundwater valuation data at “study sites.” Finally we conduct a validity check of the proposed protocol and discuss implications for future benefit transfer research.

VALUATION PROBLEM BACKGROUND

Dougherty County, located in southwest Georgia on the southern Atlantic Coastal Plain, is underlain by a deep succession of sand, clay, and carbonate rocks that form a large aquifer system (Rouhani and Hall, 1988). Groundwater provides the source of almost all drinking water supplies in Dougherty County, which includes the City of Albany (Pierce, Barbar, and Stiles, 1982). The geographic and physical features of Dougherty County are illustrated in the maps provided in Appendix A.

The availability of abundant groundwater supplies, combined with good sandy soil and a mild climate, makes agriculture the largest industry in the county. Major agricultural products in the county include peanuts, soybeans, wheat, and corn. This crop production in the county involves heavy use of chemical fertilizers and pesticides. Some of these chemicals may be persistent and eventually leach through the soil and contaminate groundwater supplies. Because of the way groundwater moves underground, surface contamination in one area can spread to groundwater supplies many miles away (Cohen, Creeger, and Enfield, 1984; Kundell, 1980; Sun, 1990).

Contamination of groundwater by agricultural chemicals was first discovered in the late 1970s. By 1986, EPA groundwater testing studies had detected 19 pesticides in groundwater supplies in 24 states where the source of contamination was most likely agricultural application (U.S. EPA, 1987). Farms in Georgia and across the U.S. commonly apply large amounts of nitrogen fertilizer to crops. Nitrogen in fertilizer, after it leaches through the soil, may show up as nitrate in groundwater supplies. In 1986, an EPA study found that 2.7 percent of rural wells in the U.S. had nitrate concentrations exceeding the EPA health advisory level of 10 ppm (parts per million). Nitrate has been found in groundwater samples tested in Georgia, Florida, North Carolina, South Carolina, and Virginia (Hayes, Maslia, and Meeks, 1983; McConnel et al., 1984; Williams et al., 1988).

The empirical evidence from groundwater testing studies which is fairly sparse suggests that concentrations of agricultural chemical contaminants (pesticides and nitrates) in the Dougherty Country area are within EPA standards for safe drinking water (Georgia DNR, 1989; Nielson and Lee, 1987; Sun, 1990; Williams et al., 1988). Nielson and Lee (1987). however, identify the Dougherty County area as a region with potential for groundwater contamination by agricultural chemicals. Because groundwater is the major source of drinking water in Dougherty County (including both municipal and private wells), groundwater contamination by agricultural chemicals is a potential public health threat. Potential negative health effects associated with ingesting chemical contaminants are summarized by the U.S. EPA (1989).

Using the potential Pareto-improvement criteria as a decision rule, a groundwater protection program would be justified if the benefits of the program exceed the costs. The overall objective of this case study is to estimate the benefits of groundwater protection in Dougherty County via benefits transfer. The major challenge is to develop a protocol for using existing groundwater valuation data at identified study sites to address the specific valuation problem in Dougherty County (the policy site).

VALUE MEASURE CONCEPTS

A theoretically appropriate individual value measure requires a clear definition of the commodity or service to be valued. Figure 1 illustrates how we can define the commodity or service of interest in our case study. The initial concern in the case study is with the uses of chemicals by the agricultural industry in Dougherty County. These uses involve human activities such as mixing chemicals at wholesale and retail farm stores, mixing and applying chemicals on farms, and disposing of used chemical containers.

Chemical uses combine with physical pathways to create potential groundwater contamination situations. For example, improperly mixing highly concentrated chemical solutions near unprotected wellheads create a situation in which groundwater contamination may easily occur. Groundwater contamination may also occur when negligence on the part of chemical users is not apparent. For example, farmers may be properly and safely mixing and applying agricultural chemicals. The soil on the their farms, however, may be relatively porous and located directly above a groundwater aquifer. In this situation a high potential exists for agricultural chemicals to leach through the soil into the aquifer.

Assessment of chemical uses and physical pathways can help scientists to identify areas-like Dougherty County-where groundwater contamination may be a problem. As illustrated in Figure 1, groundwater monitoring (e.g., test wells) provides information on current

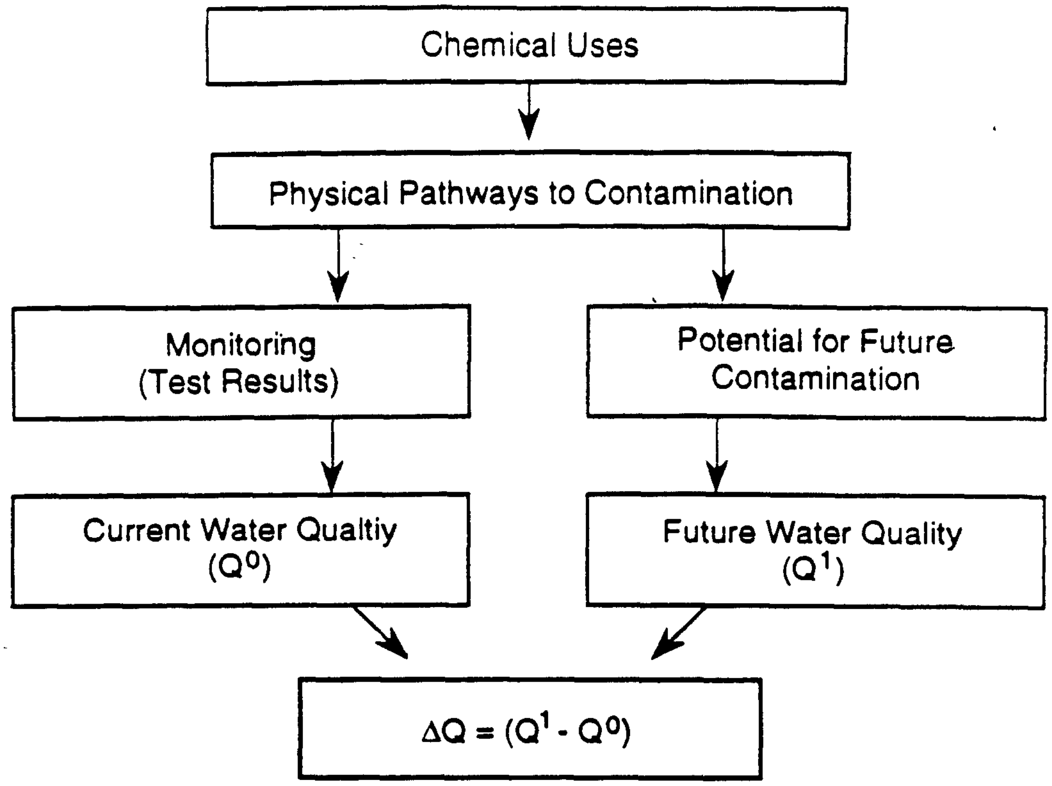

Figure 1. Definition of Commody of Service to be Valued

groundwater quality **(Q^o).** The results of current groundwater monitoring, combined with an assessment of future chemical uses and potential pathways to contamination, provide information on probable future water quality **(Q^1).** The probable-change in water quality **(ΔQ)** is then defined as **($Q^1 - Q^o$).**

As discussed earlier, monitoring data suggests that groundwater quality in Dougherty County is currently "safe." However, because of existing chemical uses and physical features, a relatively high potential exists for groundwater quality to become "unsafe" in the future from increased agricultural chemical contamination. Hence, **$Q^1 < Q^o$,** which implies that **ΔQ** represents an uncertain decrease in water quality. Uncertainty enters the policy analysis in terms of whether **Q^o** will be maintained or **Q^1** will occur. In addition, if **Q^1** occurs, the timing of this water quality degradation may be a random event

Suppose next that a groundwater protection policy, denoted as Z, is proposed for Dougherty County to prevent a degradation in water quality from **Q^o** to **Q^1.** Thus, in this case study the objective is to value the groundwater protection services provided by Policy Z. We assume that without Policy Z groundwater will not be treated for chemicals by any other public policy or program. We also assume that Policy Z will be 100 percent effective at protecting current water quality. Thus, the service provided by Policy Z is certain protection of current groundwater quality (Q^o) from uncertain degraded water quality (Q^1) in the future.

Individual Valuation Model

To define the theoretically appropriate measure of welfare change associated with Policy Z, we must make assumptions about the structure of groundwater quality property rights. If households have rights to water quality level Q^1, the theoretically valid measure of welfare change would be a citizen's willingness-to-pay (WTP) for Policy Z. If households have rights to water quality Q^o, the theoretically valid measure of welfare change would be a citizen's willingness-to-accept (WTA) compensation to face the threat of Q^1 by forgoing Policy Z.

In the case of Dougherty County, property rights to groundwater quality are ambiguous. Because of this ambiguity, we select WTP as the welfare change measure for this case study. This selection is based on two considerations. First, when property rights are ambiguous, the public is likely to pay for environmental protection rather than receive compensation to forgo environmental protection. Second, the accuracy of using empirical valuation techniques, such as contingent valuation, to measure WTA has not been well established (Cummings, Brookshire, and Schulze, 1986; Mitchell and Carson, 1989).

WTP for Policy Z is subject to both demand and supply uncertainty. Demand uncertainty arises, for example, if a current resident is uncertain as to whether he or she will reside in Dougherty County in the future. Supply uncertainty, as noted above, arises from the random nature of Q^1. When demand and supply uncertainly are present, the theoretically appropriate measure of WTP is option price (Bishop, 1982; Smith, 1983). Here, option price, OP, is defined as an individual's maximum WTP to ensure the protection of current water quality. An individual valuation model for OP can be specified generally as

$$OP = f(P_w, M, S, \gamma, \eta, Z) \tag{1}$$

where P_w represents the price of water, M represents income, S is a vector of socioeconomic variables, γ is a measure of demand uncertainty, η is a measure of supply uncertainty, and Z = 1 if Policy Z is in effect otherwise Z = 0.

Market Area Definition

Assuming that existing groundwater valuation studies provide estimates of Eq. (1), we can use these equations to estimate option price per individual for groundwater quality protection. To calculate total benefits, option price per individual is multiplied by the relevant population affected by Policy Z. To define the market area, determining all users and potential users of groundwater protected by Policy Z is necessary. In this case study, we are interested in the benefits of groundwater protection to Dougherty County residents. The county political boundary is, therefore, used to identify the number of current users and potential users in Dougherty County. Because nearly all county residents obtain their drinking water from groundwater supplies, all households in Dougherty County face the risk of drinking contaminated water now or in the future.

We also need to consider nonuse values when defining the market area. County residents may be willing to pay to provide uncontaminated groundwater for their future children or grandchildren (intragenerational transfer value). County residents may also be willing to pay to provide uncontaminated groundwater for the benefit of their relatives, friends, and neighbors (intragenerational transfer value) who live in the county. These nonuse values may represent a significant portion of a resident’s option price for groundwater quality protection.

Nonresidents of Dougherty County may also have nonuse values that include existence values for an uncontaminated aquifer. Existence values are likely to be high for unique, irreplaceable natural resources (Krutilla, 1967). Uncontaminated aquifers can be found all over the U.S.; thus, nonresidents are not likely to view an uncontaminated aquifer in Dougherty County as a unique natural resource. In addition, cleaning up a contaminated aquifer may be possible (although the process would likely be time-consuming and costly). Therefore nonresidents may not consider an uncontaminated aquifer as a strictly irreplaceable natural resource. Thus, we assume that existence values for nonresidents are likely to be negligible.

Nonresidents may also be willing to pay to protect groundwater quality in Dougherty County for the benefit of relatives or friends who currently live in the county (itragenerational transfer value) or future residents of the county that they care about, for example, future grandchildren (intergenerational transfer value). We conjecture that nonuse values decline with distance from the county. Our assumptions concerning the magnitude of nonuse values (existence values and transfer values) require empirical validation in original valuation studies before they are widely implemented in benefit transfer studies..

PROPOSED BENEFIT TRANSFER PROTOCOL

Following terminology used in a recent special section on benefit transfer published in *Water Resources Research* (March 1992), we refer to “policy site” as the area to which we want to transfer benefit estimates. A “study site” is an area where an original valuation study has already been conducted to generate benefit estimates.

Before discussing the protocol let us briefly recall the criteria we have outlined for estimating values at the policy site, Dougherty County. We want to obtain WTP estimates of option price, which should allow for both demand and supply uncertainty. The estimates should also be total values that include use and nonuse components. We are not concerned in this particular case study with nonuse values held by individuals who reside outside of Dougherty County.

The increment of water quality to be evaluated starts with the presumption that groundwater at the policy site is currently safe (potable). The increment is the protection of water quality from nitrate and pesticide contamination. The probability of contamination and the time frame of potential contamination at the policy site are currently unknown from secondary data However, if contamination does occur, the potential for human exposure occurs throughout Dougherty County because most households derive their drinking water from groundwater supplies. The market area, therefore, for expanding transfer estimates is the county population.

Our proposed protocol involves two components. The fast is to assess the degree to which existing studies of groundwater benefits correspond to the criteria discussed in the previous two paragraphs and to evaluate the comparability of socioeconomic characteristics of residents of the study sites with residents at the policy site. The second component involves evaluating, in a qualitative manner, the credibility of existing value estimates in terms of economic theory, survey research procedures, statistical analyses, and reporting of research results.

An existing study that estimated option prices for improving already contaminated groundwater would not be deemed suitable for benefit transfer in the current case study. A study that does examine the protection of groundwater that is potable would need to meet the criteria of a threat to the same health endpoints as would occur from nitrate or pesticide contamination to drinking water. The quality of the study site valuation estimates should demonstrate linkages between the valuation issue, economic theory, survey design, and statistical analyses. These criteria, as shown below, are not hard and fast rules but subjective guidelines. They serve to demonstrate the complexity of actually conducting a defensible benefit transfer that is an acceptable substitute for a primary data study. The criteria also serve to identify issues that must be addressed to improve future benefit transfers.

BENEFIT TRANSFER DATA SOURCES

"Policy-Site" Data

For benefit transfer, we must have information describing the policy site. Important information to consider includes preferences and motivations for groundwater quality protection, perceptions of contamination risk (or actual risk estimates), availability of substitutes, physical features, basic socioeconomic characteristics of the population, and proportion of household relying on groundwater for drinking water supplies. We discussed physical characteristics of Dougherty County earlier. Table 1 provides information describing the population and households of Dougherty County. We constructed this table using readily available secondary sources (Bachtel, 1991; Salant, 1990; U.S. Bureau of Census, 1983; Hodler and Schretter. 1986).

"Study-Site" Data

We identified three studies in the published literature that estimated individual values for groundwater protection or cleanup. Edwards (1988) estimated option price, using WTP, for protecting potable groundwater from nitrate contamination in Falmouth, Massachusetts. Shultz and Lindsay (1990) estimated option price, using WTP, for protecting potable water from unspecified contaminants in Dover, New Hampshire. Finally, Doyle et al. (1991) estimated option prices, using WTP, for cleaning up contaminated groundwater in a generic city. We provide summary data on each of these studies in Table 2. We refer to these studies hereafter as the Edwards, Shultz, and Doyle studies, respectively.

All studies estimated option prices associated with uncertain future groundwater quality. Edwards and Shultz used dichotomous-choice, contingent-valuation questions in mail surveys to develop their estimates. Doyle used open-ended, contingent-valuation questions applied in focus groups. The Edwards and Shultz studies, therefore, represent original research with relatively large sample sizes-346 and 585, respectively. The Doyle study constitutes a survey pretest with small samples-two focus groups were conducted with sample sizes of 36 and 27.

The first screen we considered in evaluating the suitability of these studies for benefit transfer to Dougherty County was the theoretical construct measured. All three studies estimate option prices for use uncertainty with WTP. Thus, the studies do estimate the desired measure of value for the transfer protocol.

TABLE 1. POPULATION AND HOUSEHOLD CHARACTERISTICS, DOUGHERTY COUNTY, GEORGIA

Total Population (1989)	114,598 people
Number in Age Groups (1989)	
0-4	10,260 people
5-19	33,012 people
20-34	30,514 people
35-49	17,442 people
50-64	13,725 people
65 And Over	9,645 people
Median Age (1980)	26.0
Number of Households (1985)	35,400 households
Average Persons per Household (1985)	2.85
Per-capita Income (1988)	$12,624
Median Family Income (1979)	$17,631
Number of Households Receiving Less than $10,000 Annually (1988)	8,302 households
Median Education Level (1980)	12.2 years
Share of Population 25 Years Old or Over in Education Categories (1980) (%)	
0-8 Years	20.8
High School (1-3 Years)	20.7
High School (4 Years)	29.9
College (1-3 Years)	14.3
College (4 Or More Years)	14.2
Registered voters (1990)	39,707 people
Share of Population Living in Urban/Rural Areas (1980) (%)	
urban Areas	86.6
Rural Nonfarm	13.0
Rural Farm	0.4
Share of Population Living in Different Types of Housing (%)	
Owner-Occupied Housing Units	50.9
Renter-Occupied Housing Units	44.3

(continued)

TABLE 1. POPULATION AND HOUSEHOLD CHARACTERISTICS, DOUGHERTY COUNTY, GEORGIA (CONTINUED)

Mobile Homes	5.6
Housing Units Lacking Complete Plumbing	1.7
Share of Population in Types of Occupations (1980) (%)	
Managerial and Professional Specialties	21.6
Technical, Sales, and Administrative Support	30.6
Farming, Forestry, and Fishing	1.7
Precision Production, Craft, and Repair	12.9
Operators, Fabricators, and Laborers	20.0
Service	13.2
Share of Population in Racial Categories (1990) (%)	
White	48.8
Black	50.2
Other	1.0
Public Water Supply Use (1987)[a]	
Population Served by Public Supply	100,000 people
Public Use Per-capita	187.4 gallons per day
Leading Causes of Death (1989) (%)	
Cancer	22.2
Heart Attack	15.9
Stroke	6.5
Flu and Pneumonia	4.6
Emphysema and Asthma	2.5
Motor Vehicle Accidents	1.9
All Other Injury and Poisoning	6.8

[a]Groundwater provides the source of all public water supplies in Dougherty County.

Sources: Bachtel, D.C. 1991. *The Georgia County Guide*. 10th Ed. Cooperative Extension Service. Athens, GA: The University of Georgia

Hodler, T.W., and H.A. Schretter. 1986. *The Atlas of Georgia*. Athens, GA: The Institute of Community and Area Development, The University of Georgia.

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TABLE 2. EXISTING GROUNDWATER VALUATION STUDIES

Descriptive Variables	Shultz and Lindsay (1990)	Edwards (1988)	Doyle et al. (1991)
Valuation Issue	Protection of potable groundwater from contamination[a]	Protection of potable groundwater from nitrate contamination	Clean up contaminated groundwater
Water Source	Primarily private wells	Primarily public water supply (11% private wells)	50% of public water from groundwater
Probability of Contamination	Not specified	Various probabilities with 5 years time horizon	Various scenarios
Study Site	Dover, NH	Cape Cod, MA	Generic city
Population	4,980	NA[b]	NA
Value Estimated	Option price for use uncertainty (WTP)	Option price for use uncertainty (WTP)	Option price for use uncertainty (WTP)
Valuation Unit	Household	Household	Household
Valuation Method	Contingent valuation	Contingent valuation	Contingent valuation
Valuation Question	Dichotomous choice	Dichotomous choice	Payment card
Survey Format	Mail	Mail	Focus group
Response Rate	59%	78%	NA
Usable "n"	346	585	36, 27[c]
Median WTP	$40/year	NA	$6.8 - $8/month
Mean WTP[d]	$129/year	$363 - S1,437/year	$9.5 - $13.6/month ($114 - $163/year)
Variables Significantly Related to WTP (Direction of Effect)	Land value x = $10,420 (+)	Bequest motivation scale x = 5.2 (+)	NA
	Age x = 52 (-)	Cost of potable water scale x = 3.7 (+)	
	Family income x = $36,533 (+)	Income x = $55,413 (+)	

[a]Type(s) of contamination not specified.
[b]NA indicates that data are not contained in available publications
[c]Two focus groups were conducted.
[d]Standard errors of means were not reported for any of the studies.

The second screen involved the increment in water quality evaluated. Edwards and Shultz estimated values for preventing contamination of groundwater protection, while Doyle estimated values for cleaning up contaminated groundwater supplies. The Doyle study was therefore excluded from further consideration because the valuation issue in Dougherty County is the protection of groundwater supplies that are currently deemed to be safe. Exclusion of the Doyle study on this condition is also reinforced by the fact that the available publication reported a survey pretest using focus groups. Because the reported estimates represent results from a survey in the process of development, generalizing these results to any specific population would not be appropriate.

Although the Edwards and Shultz studies estimated option prices for protection of groundwater supplies, questions remain regarding the probability that the groundwater will be contaminated in the future and the probability that survey respondents will demand safe drinking water in the future. Edwards estimated option prices for supply uncertainty at probabilities of contamination of 0.25, 0.50, 0.75, and 1.00, and the probability of future demand ranged from 0 to 1.00. Edwards specified the probability of contamination for respondents in his survey instrument and assessed demand uncertainty by querying respondents regarding their subjective probability of residing in the affected area 5 years from when they completed the survey instrument. Shultz did not specify the probability of future contamination, nor were respondents' subjective probabilities of future demand measured.

Edwards also specified the time frame for contamination. For example, groundwater would be contaminated in 5 years without remedial action in the case of certain contamination (100 percent). Shultz left this important variable unspecified. Finally, the Edwards study considered a type of contaminant, nitrates, while the Schultz study did not.

In addition nearly all of the households in the Edwards and Shultz study areas derive their drinking water from groundwater supplies. This fact corresponds to the water supply characteristics in Dougherty County. As noted above, neither the probability of contamination nor the time frame of potential contamination of groundwater supplies in Dougherty County is known. If these data become available, the Edwards study provides more valuation data for transfer if the time frame of contamination (5 years) is similar at the policy site.

In addition, nitrates are the primary type of contaminant threatening groundwater supplies in the Edwards study and in Dougherty County. The Edwards study also seems the most appropriate study to consider for benefit transfer because of the level of detail provided in the measurement of individual values for the increment in groundwater quality evaluated. The limitations of the survey design in the Shultz study raise significant questions regarding the suitability of this study for benefit transfer.

The Edwards study has another advantage over the Shultz study in that a larger sample size was used and a higher response rate was obtained. The usable number of observations ("n") is nearly 70 percent larger in the Edwards study. The response rate of 78 percent for the Edwards study implies that his valuation can be applied to the population survey with more confidence than the Shultz results with a 59 percent response rate. This issue is relevant for benefit transfer because of concern over nonrespondent bias.

The Edwards study provides only descriptive statistics on income and the mean, $55,413. Shultz presented more descriptive statistics. The average income of respondents to the Shultz study was $36,533 and the average age was 52. They also reported data on land and house values, number of years living in the study area, knowledge of groundwater contamination, sex, and education. Average income at the policy site was $42,517 in 1989, and the average age was 47. Thus, income at the policy site falls between the reported income for the two study sites. Residents of the policy site are 5 years younger than residents at the Shultz study site.

Edwards estimated a bid equation in which income had a significant and positive effect on estimated option prices. Given this result, we speculate that the Edwards option prices might overestimate the benefits of groundwater protection at the policy site. Shultz estimated a bid equation in which option prices increased with income and decreased with age. Both of these variables were significant predictors of option price. Because residents of Dougherty County, on average, have higher incomes and are younger than residents of the Shultz study site, we speculate that the Shultz study might underestimate the benefits of groundwater protection at the policy site.

Our first priority in developing estimates for benefit transfer was to take data from Dougherty County and use study site equations to develop estimates for the policy site. This approach implicitly assumes that the preferences of Dougherty County residents are the same as those of individuals at the study sites. An additional implicit assumption is that option prices only vary because of differences in the distributions of explanatory variables between the study sites and the policy site. This assumption may or may not be true and should be tested in studies formally designed to validate benefit transfer estimates. We consider this type of transfer because it allows us to adjust transfer estimates for differences in the population characteristics shown to significantly influence values.

Transferring estimated equations is not possible because data for the explanatory variables are not available at the policy site. For example, Edwards' equation includes a variable that measured respondents' subjective rating of the cost-effectiveness of their water supply. Data on this variable are not available for Dougherty County residents. Shultz included variables measuring respondents' knowledge of groundwater pollution. These data are also not available at the policy site.

Given the above considerations and because we are attempting to accomplish a benefits transfer, we had to step back and transfer the estimated mean values. Shultz estimated a single mean of $129 annually per household. Edwards, on the other hand, developed multiple estimates of option price. Unfortunately, his reporting of these estimates in his journal article was not clear; estimated values are only presented graphically or as aggregate benefit estimates. Using his aggregate benefit estimates for his Case II in Table III (p.485) of his paper, we can work backwards to derive the estimates of individual values he used in these calculations. These annual values per household range from $363 when the probability of contamination is 25 percent to $1,437 when the probability of contamination is 100 percent. Intermediate values of $723 and $1,081, respectively, apply for intermediate probabilities of 50 and 75 percent. These estimates that vary with the probability of contamination are the reason we suggest that the Edwards study provides more information for accomplishing benefit transfer at the policy site when the probability of contamination is unknown. If these data were available for Dougherty County, the Edwards estimate could be manipulated to reflect the appropriate probability of contamination. We must, of course, keep in mind that the time frame of contamination in the Edwards study was 5 years.

Finally, we can make a crude comparison of the Shultz and Edwards studies. Given that the income effect in both equations was positive and average income in the Shultz study was less than the average in the Edwards study, we propose that the Shultz estimate should be less than the Edwards estimate. We make this comparison by using the average income from the Edwards study to recalculate the estimated mean from the Shultz study using the estimated option price equation. Because Edwards did not report data for other variables in his equation, we assume they are the same across studies for this comparison. The revised Shultz estimate is $361 per household annually, approximately the same as the Edwards estimate of $363 for protection from a 25 percent probability of contamination.

If we assume that preferences are comparable across study sites, the magnitude of the revised estimate implies that respondents in the Shultz study may have applied, on average, a subjective probability of contamination of 25 percent. At the very least, it appears that the Shultz study provides a lower bound value for protecting groundwater benefits. The Edwards study provides estimates that vary with the probability of contamination so transfer estimates can be refined to meet the needs in Dougherty County when the actual probability of contamination is identified.

In conclusion, three published groundwater protection studies provide a very thin library for conducting a benefits transfer. Two of these studies, however, measured values conceptually consistent with the desired welfare measures for the policy site. The design of the Edwards study and the variety of welfare estimates provided. we believe, makes it superior to the Shultz study for accomplishing the benefit transfer. However, using available data we suggest that Edwards' estimates might overestimate values at the policy site and Shultz's estimate might underestimate values. We suggest using both of these studies in the benefit transfer to provide bounds on the potential benefits of groundwater protection in Dougherty County.

VALIDITY CHECK

This case study provides a unique opportunity to perform a validity check of the benefit transfer estimate(s). A contingent valuation study was recently conducted to estimate household option price, via WTP, for groundwater quality protection in Dougherty County (Sun, Bergstrom, and Dorfman, 1992). The original benefit estimates reported by these researchers for the policy site can be compared to the estimates generated from the study sites. Such a comparison, as suggested by Boyle and Bergstrom (1992), can offer insight into the validity of benefit transfer techniques and suggest areas for improvement

The mean option price from the Sun, Bergstrom, and Dorfman (1992) study for a 50 percent probability (subjective probability of respondents) of contamination within a 5 year time-frame was $641, with a 95 percent confidence interval ranging from $493 to $890. A direct comparison with the Edwards study data reveals an estimate of $723, within the confidence interval. As noted above, we did expect the Edward& estimates to exceed values for Dougherty County, but the difference does not appear to be sufficient that a rigorous test of the null hypothesis of no difference in the estimates would be rejected. The available information in the Edwards study is not sufficient for us to modify the option price estimates for the policy site.

We proposed that the Shultz study provides a lower bound estimate, and this value of $129 per household annually falls below the lower bound of the 95 percent confidence interval. Adjusting the Shultz estimate for the higher average income and lower average age at the policy site results in an estimate of $353 per household annually, still below the lower bound of the 95 percent confidence interval.

This validity check demonstrates that the Shultz study provides a low estimate of option price at the policy site. Improved reporting in the Edwards study would have allowed us to modify his estimates using data from Dougherty County. In turn, the transfer estimate may have been a closer approximation to the reported value estimate from the Sun, Bergstrom, and Dorfman (1992) study.

IMPLICATIONS

Brookshire (1992) proposes a continuum when benefit transfer may be applicable. Scoping studies to develop "ball park" estimates of potential damages or benefits are at one extreme. Studies ultimately resulting in the expenditure of public or private funds are at the other end of the continuum. The analyses presented here fit in the realm of scoping studies. That is, are the potential benefits of better estimates large enough to justify a complete benefit analysis? The answer depends on the purpose of the study and its role in reaching decisions. In a sense, a scoping study is a crude benefit-cost analysis to determine the necessity of a full blown analysis.

If we were conducting a benefit transfer whose results were going to be used in a policy analysis that fell between the extremes on the Brookshire continuum, our experience working with the information available in the publications for the groundwater case study would motivate us to take three additional steps to improve the analysis. First, we would attempt to obtain the original data from the researchers to do some reestimation. We would also try to obtain data from secondary data sources for each study site. For example, the Shultz study includes property evaluations in their analysis, but these data were not included in the Edwards analysis. In turn, we would try to collect average property valuation data for residential units from municipal authorities in Falmouth, MA. Finally we would conduct a very small and inexpensive survey at the policy site, Dougherty County, to obtain data used in the analyses at the study sites but not available from secondary sources for Dougherty County. Examples, as noted above, are respondents' subjective evaluations of the cost-effectiveness of water supplies and respondents' knowledge of groundwater contamination.

With these suggestions, we imply that benefit transfer is not always fast and inexpensive. But it can save scarce monetary and time resources by avoiding an extensive primary data collection effort. However, we firmly believe that back-of-the envelope calculations, as we have done in the current paper, are not a suitable substitute for conducting a thorough analysis using the available secondary data

Our analysis contributes to the growing body of literature demonstrating that benefit transfer is a feasible analysis procedure. But we do not suggest that all of the problems with benefit transfer analysis are solved and that future research to improve the validity and reliability of benefit transfer estimates is not warranted. To the contrary, we are just beginning to open the doors of a new area of investigation that can have significant implications for conducting original valuation studies as well as for conducting benefits transfers.

In closing we would like to make a plea for improved reporting of valuation studies in journal articles and in other publications so that the study procedures and results will be more useful for benefit transfers. This request requires researchers and researchers to view their reports as more than end products: they are data for future benefit transfers and meta-analyses, for example. Recognizing these important uses can substantially enhance the returns to the initial research investment.

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