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Is Nonmarket Valuation of Environmental Resources Sustainable?

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Over the past twenty-five years, research on valuing nonmarketed environmental resources has transformed the role played by economic analysis in both characterizing and evaluating environmental policy questions. Current analyses of such policy initiatives must appraise the monetary value of each program's intended outputs, including its effects on nonmarketed environmental amenities. Moreover, this change is not confined to regulatory and public investment decisions. Incorporating environmental costs into planning for additional capacity and scheduling existing capacity for electricity generation has been ordered by the Public Utility Commissions in nineteen states in the United States and is pending or under review in ten others. Equally important, under the concept of natural resource damage liability, nonmarket valuation has brought resource economists into litigation in U. S. Courts and is likely to occupy their attention for some time to come.[1]

The transformation is not limited to environmental policies in the United States. It is rapidly becoming an international phenomenon. In the United Kingdom, for example, Pearce, Markanda, and Barbier's *Blueprint for a Green Economy* has had a major impact on environmental policymaking. These authors' argue that economic performance should be judged based on growth in sustainable income (i.e., income net of the environmental costs associated with production and consumption activities, as well as the depreciation costs arising from the

depletion of both manmade and natural assets).[2] The OECD is now launching a comparable research/policy support initiative. In Australia, the RAC (Resource Assessment Commission) has been established to respond to these very issues. Under the Resource Assessment Commission Act of 1989, the Commission is charged with the responsibility of conducting benefit cost analyses that recognize an expansive view of the values that contribute to judging efficiency in allocating resources. Particular attention is to be given to nonmarket benefits and to questions that involve uncertain long-term consequences.

While the profile of environmental issues increased in prominence during the sustained growth of the late eighties, I believe these concerns will not be relegated to the "back burner" with the current economic downturn. People are convinced that industrialized societies continue to transform the world's environment on an unprecedented scale. Environmental resources are increasingly recognized as assets whose services are no longer readily available. Moreover, this increased awareness of the need to measure their value and incorporate them in our decisions is precisely what we would expect as their scarcity increases.

Thus, the question posed in this paper's title does not express concern over whether interest in the topic will be sustained. Instead, it asks whether resource economics can deliver what it has promised. To answer this question, I propose to use an interpretive review of nonmarket valuation. It is interpretive because the focus is on modeling strategies and general evaluations of performance rather than specifics. Overall, my conclusion on the prospects for nonmarket valuation being able to deliver when "the bills come due" is optimistic but not confident. Four developments contribute to this appraisal. Two are positive and two are not.

Because they are used to organize what follows, my description of each here at the outset will be brief.

On the positive side, environmental economists who develop benefit estimates have become adept detectives. Indirect methods for measuring the value of nonmarketed resources have lived up to Freeman's [1979] promise that nonmarket valuation procedures existed but only awaited the data for implementation.[3] Most economists are comfortable with this conclusion. Not all will be as sanguine about my second positive observation.

Contingent valuation surveys can work in estimating the values people place on some types of environmental resources. This does not mean this direct approach will always work or that it is simple.[4] It is exceptionally difficult, time consuming, and often costly to develop a CVM survey that responds to Fischhoff and Furby's [1988] criteria for defining transactions and to the more general issues identified by Mitchell and Carson [1989]. Economists don't have to rely exclusively on clever reversals of the insights from revealed preference. Their direct involvement in designing interviews can improve the information collected on actual behavior as well as enhance our understanding of how preferences are revealed through contingent behavior.[5]

Turning now to my reasons for caution rather than confidence, each identifies conceptual and empirical issues incompletely resolved in the current literature. Since Krutilla's influential paper "Conservation Reconsidered," resource economists have recognized that some values would not be revealed by behavior. People value aspects of the natural environment and other species even when there are no apparent "uses" made of them. This topic of existence values has enjoyed a curious status in resource economics. Few question its validity for unique

environmental resources or, for that matter, whether large numbers of people possess such feelings. Instead, the debate has focused on whether they are measurable and, if so, whether they are legitimate sources of value to be considered for all commodities.[6]

I am concerned about existence values, but not about their relevance or legitimacy. Instead, I believe they expose a fundamental limitation of using indirect methods for valuing some (and perhaps many) types of environmental resources. Existence values arise from the public good services provided by environmental assets. Recognizing these values highlights the fact that some environmental resources simultaneously produce private and public services. Indirect methods have measured only the value of the private components. We have no reason to believe that jointly available services from environmental assets make separable contributions to people's utility functions. By implicitly treating them as distinct (or assuming the more public component away), we may be seriously biasing the valuation measures recovered from indirect methods.

My second concern is with the literature's focus on valuing a representative person's value for the services of some nonmarketed resource. To date, efforts have stopped with these measures (or the behavioral functions used to derive them). However, to be responsive to any policy issue (whether regulatory or legal), we need to measure how the values of the resources as assets change with the policy or issue being litigated. This requires understanding the geographic extent of the market (i.e., which people have such values) as well as the ability of the asset's ability to continue providing services over time (the most conventional dimension of sustainability discussions). Assumptions about the geographic dimensions of an asset's market are most often the reasons for substantial differences (and even contradictions) between

In developing measures of people's valuation of goods and services, we focus instead on the typical (or representative) individual and the fact that we can observe real values once we have relative prices. If the amounts purchased are also known, then with sufficient variation in these pairs (i.e., prices and quantities), we can develop conventional valuation measures.[7] What is added is some characterization of the Marshallian demand function.

Hicksian measures of consumer surplus for singe price changes (see Hausman [1981] and Vărtia [1983]) and in some cases for multiple price changes (see LaFrance and Hanemann [1988]) can be recovered from such models. Before turning to the case of services available outside traditional markets, it is important to recognize that these procedures do not necessarily imply that we can value other changes in the quality or conditions of access to marketed goods. For example, the values an individual would place on avoiding a change in the level of service offered by the national postal system (e.g., reducing service hours or increasing the delivery time) cannot be readily inferred from demand studies for mail service. The same is true for other quality features of marketed commodities. Even if we can observe behavioral responses to changes in quality, this does not assure that we can recover Hicksian measures of the value of a quality change (see Willig [1978] and Bockstael and McConnell [1987]). Indeed, this issue directly parallels the questions posed in using indirect methods for valuing environmental services.

The most readily accepted indirect method for nonmarket valuation provides information that closely parallels a market transaction. Initially proposed in 1947 by Harold Hotelling, the travel cost recreational demand model now occupies a major place in the applied research

defendants' and plaintiffs' assessments in natural resource damage assessments (see Kopp and Smith [1989]) or in any two analysts' benefits transfer studies for the same resource (see Smith [1990a]).

I. Reversing Revealed Preference: The Indirect Approaches

To appreciate the key features of indirect approaches for measuring the values of nonmarketed commodities, we need do little more than focus on the nature of the marginal rate of substitution (MRS) between the nonmarketed environmental service and some numeraire. Because the MRS describes an individual's real value for the last unit he or she consumed of a commodity, it is the natural starting point for recovering preference information. Of course, measurement of monetary benefits does not begin and end with the MRS's for any commodity, whether available on markets or not. The analysis leading to insights about how the relevant MRS is recovered focuses on the intensive margin of choice, while most benefit measurement tasks consider the effects of larger, discrete changes in one or more parameters outside the consumer's control. Thus, information must be added to estimates of the MRS's to develop benefit measures. The exact process will depend on how we characterize people's decisions and what can be observed about them.

Consider first the case of goods exchanging on markets for fixed prices per unit consumed. Under these conditions, one of the first insights of an undergraduate micro class is that each commodity's relative price reveals the consumers' real values. As a rule, we use this insight to describe the efficiency properties of ideal markets by noting that the existence of a single equilibrium price assures equalization of these real values for private goods across people.

programs of resource and environmental economists. It is one of the "success stories" of nonmarket valuation.

The basic insight of the travel cost model is that visitors to a recreation site pay an implicit price-- the cost of traveling to it including the opportunity costs of the time required. Thus, by observing an appropriate quantity measure and these costs for individuals at different distances (along with any entrance fees and related charges), we develop information comparable to that provided by market transactions. In these situations, the information added from theory might correspond to the specification of a demand function. Of course, this strategy relies on a simple formulation of the decision problem that treats implicit prices as parameters akin to market prices and keeps the measure of quantity simple so the relevant MRS is "normalized" through only one set of relative prices.

Advances in the literature have considered both of these assumptions. Once they are modified, the correspondence to marketed goods becomes less direct. Consider two examples. The opportunity cost of travel time arises from an individual's decisions to allocate time among alternative uses, including work. Discretion in both how time can be allocated (i.e., multiple time constraints, see Smith et al. [1983]) and in the prices available for added working time (i.e., kinked budget constraints, see Bockstael et al. [1987]) will influence either the parametric nature of the "implicit prices," the formulation of conventional demand functions, or both. A second class of modifications to the simple travel cost model changes the form of the MRS through the measure of quantity. Early models treated trips to the site as the basic unit of consumption, implicitly viewing time-on-site during each trip as fixed. To the extent this can vary, prices can influence several MRS's. In some cases (see McConnell [1990b]), we can

separate decisions, but this requires that we treat both implicit prices as parameters. Multiple destination trips also make the link between each MRS and a single set of relevant prices more complex. When a trip is described as providing several ways of contributing to a person's utility simultaneously, then the joint increase in marginal value from all of these sources is what is relevant to the trip choice. Using relative prices to describe the incremental value for any one of the goods is not possible in this case.

These complexities aside, the travel cost model has worked well. The judgment that it offers a reliable basis for valuing the services provided by recreation sites can be supported by at least three sets of evidence.

(a) Empirical results for travel cost demand models consistently support the properties implied by theory--that negative own price effects and elasticity properties can be related to the availability of substitutes for a site's services.

(b) Broad consistencies exist between "independent" studies of the demand characteristics of comparable types of recreation sites.[8]

(c) Recent statistical summaries of all available studies' estimates of consumer surplus per unit of use and price elasticity of demand suggest that the findings across studies were influenced by the types of resources involved and by the assumptions made in modeling demands. Moreover, for the latter, the modeling factors found to be influential were consistent with what *a priori* theory had already suggested (see Smith and Kaoru [1990a, 1990b] and Walsh et al. [1990].

A second class of indirect valuation methods uses averting behavior (or household production models) to infer an individual's value for some aspect of environmental quality when

private actions can influence how it is experienced. As with Hotelling's insight, the suggestions to use these actions identified how people allocated resources to modify the amount of some nonmarketed resource they experienced. Because the processes involved in altering the effects of the resource could require capital equipment, materials, energy, and a person's own time, they have been treated as examples of household production functions in the more recent literature.

Four different strategies have developed to formally organize these insights. The two most frequent applications do not lead directly to valuation estimates. Several intermediate steps with corresponding added assumptions must be incorporated with the analysis. Nonetheless, these first steps are usually described as examples of this type of market. They are: (1) physical damage functions (i.e., as approximations to these household production functions) for impacts that, in the case of air quality, can range from air pollution's impact on health to its effects on crops, and (2) reduced form relationships that simply indicate the existence of averting behavior.[9]

The household production function (HPF) framework does not provide new information to nonmarket valuation problems. Instead it offers a rationale for imposing restrictions on preferences so the decisions that can be observed provide the necessary valuation information. The third application of the framework offers several examples of this strategy. When a private good and the nonmarketed service are perfect substitutes, then we have a functional restriction linking the way the two "commodities" contribute to utility. It implies a constant MRS between them. We simply could have assumed this directly. The HPF offers a way to interpret such restrictions. For example, the household can produce a clean environment by purchasing a

device that filters pollutants from the air. This is the rationale for early applications using cleaning expenditures to measure nonhealth benefits of air quality improvements. Mäler's [1974] weak complementarity can also be interpreted as a feature of a household production technology--essentiality of the private commodity--now interpreted as an input to a specific household production activity.[10] Numerous potential combinations of restrictions allow us to use observed decisions to recover these MRSs. Bockstael and McConnell [1983] used weak complementarity between final service flows (the outputs of the HPFs) and nonmarketed goods along with essentiality of one private good as an input to the household production activities to demonstrate how "input" demands (from the household perspective) could be used for welfare measurement even when the "output" demands were not defined in conventional terms. As I indicated at the outset, one way of interpreting the unifying principles of each strategy is that they restrict preferences so that the desired MRS can be linked to an observable set of relative prices (whether actual prices or implicit costs).

Finally, we can include the nonmarket services as arguments in full expenditure/cost models for describing individuals' behavior. These types of applications might seem less restrictive than the set just discussed where specific links are identified. In this group, we might argue that the data are allowed to "tell their story." However, the specification of the estimating models amounts to precisely the same types of restrictions, except in these cases the marketed goods are often broad aggregate categories and it is difficult to use economic intuition in formulating hypotheses. One response has been to apply the HPF argument in developing price indexes for those sets of marketed commodities thought to be affected by the nonmarketed service (see Math-Tech [1982] and Gilbert [1983] as examples). Of course, these strategies involve

imposing separability restrictions together with a specific structure on the role of the nonmarketed service.[11]

The marginal rate of substitution is also the preference information recovered from the last indirect method--hedonic models. When applied to housing, the hedonic framework redefines a market and the conditions for equilibrium so that heterogeneous but closely related private goods are each assumed to be "considered" by buyers and sellers before agreeing to exchange conditions.

The story is now well known--specifying the characteristics serving to distinguish closely related but nonetheless heterogeneous commodities and recognizing that equilibrium means an absence of incentives for arbitrage. Under these circumstances, not one price but a set of prices that all relate to the commodities' characteristics defines the equilibrium. With a large enough number of different commodities, this equilibrium is characterized by a price function. The prospects for using this insight in nonmarket valuation arise because some of these characteristics may be "delivered" because of location. In other words, they are site specific. Market participants must be aware of this specificity and share a common basis for recognizing it if these characteristics are to influence the prices.

The empirical track record of the last two methods (i.e., averting and hedonic models) is not as extensive as that of travel cost models. The household production/averting models have been limited by the information available. Damage functions linking air pollution to mortality or morbidity rates have been reasonably successful when their goal is interpreted as establishing a linkage between exposure to pollutants and health responses. However, measures of the extent of their effects remain controversial.

The evidence on both expenditure system models with environmental variables and partial equilibrium models based on specific theoretical restrictions (e.g., perfect substitution or weak complementarity) is too limited for general conclusions. Only four studies can be identified as attempting some expenditure model with environmental quality variables.[12] Recently, more limited partial equilibrium studies with observations of the same households' behavior over time has led to some reasons for modifying the conventional framework, at least when it is applied to some types of adjustments. More specifically, my recent findings with Desvousges and Payne (see Smith, Desvousges and Payne [1991]) on people's mitigation decisions to reduce their exposure to radon, an indoor air pollutant, seem to indicate that a framework assuming marginal adjustments--balancing incremental gains against incremental costs--is not well suited to these types of household decisions. Respondents sought to purchase "safety." They wanted to "fix-the-problem" rather than evaluate tradeoffs at one or more margins that would reveal the MRS our models hypothesized. If these findings are supported in further study, they imply that some averting behavior only serves to identify bounds for people's values.

The record with hedonic property value applications is more extensive. When considering the most frequent application, air pollution and property values, a clear negative relationship is evident. To date, attempts to develop a summary of the values implied by these models have been modestly successful in developing summaries. To date we have established that finding a significant relationship between air pollution and housing prices is related to how the study was undertaken--what might be described as the "quality" of the research (see Smith and Huang [1991]). However, this meta-analysis has not been as successful as a comparable effort based on the travel cost demand models (see Smith and Kaoru, 1990a) for at least three

reasons. First, fewer studies have been completed. Second, those completed evidence substantial differences in the measures used for the pollutants involved. Thus, it is more difficult to define a common increment to the valued "commodity." Finally, the theoretical structure underlying the MRS link to the slope of the hedonic price function is more complex than what we generally assume for the travel cost demand model. We might expect greater correspondence between the estimates of people's values for a commonly defined change in air pollution. These benefits cannot be measured from the hedonic estimates alone. Recovering behavioral functions from the point estimates of their MRS's is more difficult in this case because each individual's budget constraint is nonlinear. Prices are no longer parametric to the decision process.[13]

Overall experience with the indirect methods confirms Freeman's [1979] early appraisal--nonmarket values can be measured with choices outside of direct markets. Nonetheless, implementing the valuation process has identified new needs. In particular, if benefit estimates for nonmarket environmental resources are to become a systematic part of the types of regulatory and decisions, the focus of applications must change. We must shift our attention from single-purpose applications or demonstrations of new methods to studies that seek to measure nonmarket values within a consistent protocol. That protocol must recognize the need to serve a general role that responds to the needs of a wide variety of applications. Under this perspective, the next generation of valuation research should treat benefit estimates as serving a role comparable to the price indexes developed for measuring the cost of living and the "price" of aggregate groups of commodities.

In some cases, like the travel cost methods, the literature is close to being able to assemble a first-round set of estimates and to develop this protocol.[14] The large volume of past experience with the model and the fact that structure closely resembles the price/quantity pairs of market transactions are probably the reasons why this class of studies is closer to practical implementation. The others are not. Once the conceptual issues associated with using the hedonic model for valuation were understood, applications shifted to new areas. We do not have the extensive accumulated experience with repeated applications of the method for comparable problems. No clear policy mandate existed for developing them. Findings from averting behavior models are at an earlier stage in development and implementation experience.

Two aspects of the next steps required to respond to the current menu of policy needs with these models are especially important. First, more than one method could be used to value the services involved for some environmental resources. For example, travel cost demand and hedonic property value models might reflect the values of improvements in water quality for recreational purposes. Similarly, averting behavior and hedonic models could be used to measure the value of changes in air pollution. We have some insights into how to relate these estimates for special cases,[15] but no attempt has been made to use these linkages as consistency requirements in estimating or judging the convergent validity of the results (as it has in the use of contingent valuation methods to value nonmarket resources).

Second (and perhaps more important to evaluating whether the measures accurately reflect people's values for these resources), averting behavior, hedonic property value, and travel cost models measure what might be described as the privately "capturable" aspects of the environmental services being valued. This follows because each method must "link" the

nonmarket service to a private purchase decision. For some aspect of environmental quality to be measured within a travel cost demand model, it must be a weak complement to the recreation sites used. With the hedonic framework, the location conveys the amount of air quality experienced, and this is what affects prices. Air quality may be experienced in other ways. While this will not affect the price function, it will influence the specification of the MRS. Moreover, to the extent that environmental services have public good aspects and that this "publicness" has value in addition to the private aspects, all the indirect methods will not reflect these values. These public good services offer another way of describing the role of nonuse values as will be discussed below.

II. Structured Conversations: The Direct Approaches

The fastest growing literature in nonmarket valuation involves using contingent valuation surveys (designated as CVM for the contingent valuation method) to elicit how people would respond to hypothetical changes in some environmental resources. These surveys can involve direct valuation questions, discrete take-it-or-leave-it questions, and ranking, quantity, bidding, or double-bounded formulations. While the initial suggestion to use surveys was made about the same time as Hotelling's proposal for the travel cost approach by Ciriacy-Wantrup [1947], concerted applications of the method did not begin until nearly twenty-five years later.[16]

CVM research has proceeded through three general phases of activities. With the exception of Davis's thesis [1963], the first set of work was initiated in the early 1970s and was largely experimental. While each study addressed a specific policy issue, the samples were small, and the analyses tended to focus on the potential for biases due to the strategic incentives,

the information presented, the hypothetical nature of the task, the bidding approach to questioning, etc. The sampling did not conform to standard practices of survey research. Nonetheless, a growing need for this type of information, success in these survey applications (or what some economists might interpret as an absence of sufficiently clever detective work), and persistence in these early efforts focused ever increasing attention on CVM findings.

Because mainstream economists remain skeptical of the insights that can be derived from people's response to hypothetical questions, the objections to CVM crystallized around two general questions: is CVM reliable, and is it accurate? The next stage in CVM research addressed these questions in a variety of ways. Before considering each in turn, it is important to recognize that neither question can be answered outside the controlled setting of a simulation experiment and in the case of CVM, this would require what we do not have--some model of how people answer questions.

We will never know the "true" values people place on any commodity--marketed or nonmarketed. As a result, research has focused on judging a wide range of indirect gauges of the validity and reliability of CVM findings. Six types of evaluations have been undertaken including:

(1) comparison of indirect and CVM estimates of the value of some change in an environmental resource;

(2) use of constructed markets in which commodities not usually sold were offered for sale and the results compared with CVM estimates for the same commodity.

(3) evaluation of CVM for measuring the demand for actual marketed commodities of programs in comparison with actual demands.

(4) test/retest comparisons of the stability of CVM estimates from the same sample over time;

(5) creation of laboratory experiments in which hypothetical and actual sales of commodities were undertaken; and

(6) surveys of purchase intentions and actual sales of commodities.

Table 1 cites examples of each type of study and summarizes the overall findings in each category. For the most part, they support the CVM estimates as being "comparable" in performance to the alternative approach providing the reference point (or standard) in each case. In some cases, the two estimates might be judged to be significantly different, but they could still exhibit a strong causal relationship. Why have analysts been content with an apparently weak level of correspondence? The answers are best illustrated by examples, and I will use studies from three types of comparisons described in Table 1.

The first of these is the direct versus indirect estimates of the values of some nonmarketed good. The first such comparison by Brookshire et al. [1982] used a hedonic property value model and contingent valuation for valuing air quality.[17] In their example, estimates derived from the hedonic should provide an upper bound on the CVM results, and they did. Implicitly, the motivation for these comparisons was to "evaluate" CVM. The indirect results were often used as the criterion for validity when what was actually being judged was the degree of convergence in two methods' estimates of a reasonably close concept. As experience with these comparisons has increased, there is now growing appreciation that adapting the indirect method to provide the comparison can also raise issues. In the Brookshire et al. study, for example, at least three questions can be raised. First, and most important, the

CVM used photos to describe air quality conditions, and the hedonic used technical measures of the concentrations of particulate matter and nitrogen dioxide. The analysts had to specify connections between the two ways of presenting the air quality change, and the comparison is condition on this maintained assumption.

Second, the CVM elicited annual payments, while the hedonic is cast in terms of sales prices for homes as assets. Annualizing the change in asset value requires assuming how the individual perceives the discount rate and time horizon involved in this contract. Independent of concerns over CVM, significant questions have been raised with the correspondence between consumers' intertemporal decisions and what conventional economic models maintain.

Finally, the air pollution readings used in the hedonic property value study are those most closely linked to the location of the houses involved in the study, and this is what the model requires. Yet we would expect that each person's MRS for air quality relative to the numeraire would be related to all the ways it is experienced and not simply the exposure at home. Thus, the extrapolation from a point estimate of this MRS to the value of an incremental change in air pollution will depend upon how other sources of exposure enter this utility function.

Concerns over implementing the indirect method are not confined to this first comparison. My evaluation of CVM versus travel cost with W. H. Desvousges and A. Fisher (see Smith, Desvousges and Fisher [1986]) exhibits a comparable set of judgments to develop the comparison. Of course, as Mitchell and Carson [1989] noted, this is in the nature of these approaches to evaluating "convergent validity." My point here is that it must affect how we interpret the findings. Lack of a close correspondence is not necessarily reflecting a flaw in CVM. Indeed, in the case of the Monongahela comparison, the largest source of discrepancy

came from using an inappropriate specification for the generalized travel cost model and not from the CVM estimates.

Changing the commodity from environmental amenities like air or water quality to private goods does not alter the general point. It will influence how the assumptions can matter. For example, the Dickie, Fisher and Gerking [1987] study of strawberry sales found that demand curves based on hypothetical sales were not significantly different from models using actual sales. But, if the criteria were changed to the predicted demands for strawberries for the two models, the conclusions would depend on the treatment of outliers. What is not mentioned in this discussion is that the relevant variance in the random variables(s) being compared also changes. So that large numerical differences may not indicate statistically significant differences. Rather they may simply reflect the quality of our models. Again these points are not the result of the design (i.e., asking quantities) or the specific commodity used (i.e., pints of strawberries). They highlight the role of analyst judgment and the stochastic nature of our information.

My analysis with Dale Whittington and several coauthors (see Smith et al. [1991])used the need to value public drinking water supplies in rural Pakistan to compare the results derived from the experience with past connection decisions for earlier systems versus that derived from a double-bounded CVM survey designed to elicit maximum annual tariffs for the water system. After developing economic models relevant to each type of data, we estimated the implied values for comparable water systems and evaluated their correspondences. Estimates based on CVM were closely related to those from the indirect model (in this case a random utility model, RUM, describing connections). However, the estimates were 1.71 times the values derived with the RUM framework when alternative water supplies were good and 2.97 when they were poor.

To implement the RUM models, we had to make a number of important qualifying assumptions about how people made these decisions and what they "received" from the connections. These will influence how closely estimates from the model can be expected to match the CVM findings.

Nonetheless, these differences will surely seem "large." It is important to put them in some perspective. How much would we expect prices for the same commodity to vary in the same city across stores? Over ten years ago, Pratt, Wise, and Zeckhauser [1979] reported evidence on this issue as part of a study of information and market equilibria. The ratios of maximum to minimum prices for the same commodity or service range from 1.11 to 6.67 for the fifty commodities they investigated. Eighteen have ratios that are 2.0 or greater. Of course, this does not prove that CVM estimates are "as good as" a market price. Several economic reasons can be used to explain the disparities observed the Pratt et al. study. Instead, it highlights again the importance of modeling judgments for the interpretation of any economic data. These judgments are important because in these earlier approaches to validation, each model was applied to different people and, in the indirect vs. direct case, different characterizations of the environmental resource that the analyst judged to be comparable. Use of private commodities in simulated or actual markets offers one way to reduce the influence of these judgments. It does not reduce the importance of the model's characterization of how people's differences contribute to explaining differences in their values.

The last set of comparisons attempted to reduce the influence of both by dealing with the same commodities and the same people. Two studies fit this description--the Kealy, Montgomery and Dovido [1990] comparison of purchase intentions with actual decisions for

chocolate bars and prevention of additional damages to the Adirondack region aquatic system from acid rain, and the Seip and Strand [1990] evaluation of membership decisions in a prominent environmental group in Norway. While the Kealy et al. study has several types of comparisons, the one relevant here is the authors' comparison of first-period stated intentions with second-period choices when confronted with the same decision. Differences between intentions and choices for both the private and the public goods were significant.

While this is potentially important, especially since it involves the same people, the authors do not indicate whether the implied values for each good would have been different based on the two different responses. This is the standard usually identified as having most interest. Moreover, the study relies on an implicit maintained assumption that there was no change in participants' circumstances between the two situations. This later consideration is likely to be most important to the private good (i.e., the candy bar).

The Seip and Strand analysis finds a disparity between statements of intentions to join the group with actual membership decisions. However, the experimental control, small size of their sample, changes in type of interview format (in person, to mail, then to telephone), and the nature of the commodity used all contribute to the conclusion that the study should not be given serious weight in evaluating CVM.

What conclusions can be drawn from these comparisons of CVM versus other alternatives? I believe the record demonstrates that some forms of CVM do provide theoretically consistent and plausible values for some types of environmental resources. The types of commodities need not be limited to the narrow set defined by Cummings, Brookshire, and Schulze's [1986] reference operating conditions. However, we are far from identifying the

characteristics of the commodities where it will be successful and the attributes of the people who will exhibit inconsistent behavior between hypothetical and actual decisions. A somewhat stronger conclusion is offered in Mitchell and Carson's [1989] and in Bishop's recent appraisals.[15]

My reason for cautious optimism follows from what we know about the choice-based methods in comparison to CVM. With the indirect methods, we have a model of how people make these types of decisions. When controlled evaluations of the influence of modeling judgments have been conducted, the results indicate the models applied with the "conventional" approximations do reflect people's values for nonmarketed goods and services, but often with larger errors.

In the case of the travel cost based methods, Kling's [1988] and Kling and Weinberg's [1990] sampling studies found the performance of travel cost demand or RUM estimates (both as approximations of some unknown underlying set of preferences) will depend on the nature of people's decisions as reflected in the samples involved. For example, the average error as a fraction of the measure of consumer surplus ranged from 9 to 107 percent. The performance of any method depended on exactly how it was applied and on the proportion of corner solutions in the sample providing data for the recreation demand or RUM models.

Cropper, Deck and McConnell's [1988] analysis of the performance of alternative specifications for hedonic price functions in estimating the marginal prices for housing characteristics exhibits a more widely dispersed range of errors when compared with the marginal values of these attributes at the equilibrium assignments of houses to people (i.e., from

under one percent to over 150 percent as the ratio of the average error to the mean true marginal price).

Thus, in both cases, the estimated errors induced by the judgments underlying conventional practices with the indirect methods that have been evaluated could easily be as large as the discrepancies that have been observed between estimates derived from CVM (where comparable modeling judgments are required to recover valuation estimates) and the indirect methods. In short, the record does not indicate that CVM is any worse than the indirect methods. Skepticism about CVM must then arise because economists persist in maintaining a fundamental distrust of asking the subjects about how and why they made their decisions. This type of attitude is usually attributed to Samuelson's early concerns over the feasibility of measuring people's values for public goods. However, the record reveals otherwise. Like Ciriacy-Wantrup, he was hopeful that survey methods could be designed.[19]

III. How Do Existence Values Affect the Verdict on Nonmarket Valuation?

When Krutilla [1967] first identified the possibility of existence values, he developed the argument in terms of decisions that might irretrievably alter a unique natural environment. He recognized that we could conceptualize the ways these assets contribute to people's well-being by describing the services they provide. Some of them are used through *in situ* consumption. Other types of services do not require the consumer to come to the site or otherwise "reveal" his or her preferences.

Early conceptual literature in this area sought to develop his arguments in three ways. First, these values are from people for elements of their natural environment. They are not

inherent to the resources being valued, as has been suggested by some ecologists. Second, because they are not confined to people who never use a resource, analytical research has focused on defining existence values in ways that distinguish them from use values (see McConnell [1983], Smith [1987], and Freeman [1990]). Usually, this has characterized a resource's contribution to utility as involving some services available by visiting (or using) the resource and a second, somewhat vaguely defined contribution made by an asset measure for the resource. The importance of this distinction arises in recognizing that *in situ* use will not be available when this asset measure is below some threshold. The threshold is the analytical construction linking the two ways the asset contributes to utility. Third, because these values initially were regarded as fundamentally different than use generated benefits, some of the early discussion focused on the motives (i.e., bequest and stewardship) that might assist in understanding them.

The most important motivation for the current intensity of research on existence value in the United States has been their role in natural resource damage assessments. These evaluations require firms held responsible for releasing hazardous waste or oil into the environment and injuring one or more natural resources to pay damages. Natural resource damages were initially defined to exclude existence values. However, a federal district court decision reviewing the proposed rules for defining and measuring damages held the proposed guidelines to be inconsistent with congressional intent and required them to be rewritten to include nonuse values. According to the court, while the values "...may represent 'passive' use, but they nonetheless reflect utility derived by humans from a resource, and thus, *prima*

facie, ought to be included in a damage assessment" (U. S. Court of Appeals, District of Columbia [1989], p. 67).

In some respects, all of this discussion has missed a fundamental insight into existence values identified by McConnell's [1983] initial discussion of them. We can envision them as arising from pure public good services provided by environmental assets. This is not simply a semantic distinction. It implies that we do not need to rethink consumption or explore motives underlying existence values. Instead, research must explore how the services underlying existence values relate to the services supporting use and how the contributions arising from one natural resource "aggregate" with those from others.

As a rule, resource economists have argued that CVM offers the only method to measure them.[20] Thus, attitudes toward existence value and CVM have been closely entwined. Recent research using contingent valuation supports a reorientation that focuses on the services underlying existence values. For example, the so-called part/whole, embedding, or super-additivity problem arises because it is difficult to describe changes in types of environmental services. These difficulties may stem from individuals' perception of the services they receive. This perception may involve the degree of publicness of the services or an assumed linkage between different types of resources' services.

Two potentially important parallels can be drawn with recent developments in the modeling of public goods. The first draws upon extensions to the literature on altruism that distinguishes a private or "warm-glow" effect versus a public or pure altruism effect of charitable contributions (see Andreoni [1989, 1990]). The private contribution in many respects parallels the use values while the altruism is analogous to existence values. The usefulness of

this analogy, however, is limited by the technology that usually is assumed to connect each individual's private contributions to the public good or pure altruism effect. In most of this past research, the specification is described by a simple summation. For perceptions of services underlying existence values, this is unlikely to be reasonable. And this is where a second, different aspect of the literature on public goods needs to be incorporated into the modeling of nonuse values.

The motivation for this other research is to consider how the public good technology linking private actions to the public good influences the incentives for free-riding. Nonetheless, I believe that the issues considered in the process may have direct relevance to understanding the connections between use and existence values. For example, in an important extension to this work, Hirshleifer [1983] identified that incentives for free-riding would vary with changes in the technology connecting private actions to the public good. If the aggregation rule linking private to public was based on the minimum of all individuals' actions (Hirshleifer's "weakest link" social composition function), there would be little incentive to free-ride. A rule based on the maximum of all individuals' actions would provide the most incentives. Summation falls in the middle.

The services underlying existence values might be considered to arise from one of these types of aggregation functions. They need not be confined to people's use of a single resource but could include multiple resources grouped within specific types of resources. Thus, one individual's existence values for a particular type of resource might remain unchanged over broad ranges of modifications to one or more "components" of that resource, provided the changes did not alter the ability to sustain some minimum level of use--a minimal service flow.

Unlike the technologies underlying privately produced private or public goods, these functions are probably best considered as descriptions of how each person perceives each class of natural resources underlying existence values. They may well explain why people's values do not appear to change with different descriptions of the composition or degree of inclusiveness of a resource in CVM studies. If the relevant aggregator function focuses on either of the extremes in the distribution of services provided by a class of resources, changes in intermediate components will not affect these extremes. Thus, they would not imply changes in the perceived services of the aggregate or composite resource underlying a person's existence values.

These conceptual proposals do have implications for extending nonmarket valuation methods to include existence values. First, they imply that focusing on a single resource with attempts to explain each respondent's motives for valuing it may not provide stable estimates. A more profitable strategy might seek to explore how each respondent evaluates the change in the resource and how the resource contributes to the services underlying his (or her) use and existence values. To the extent existence values do arise from a composite of the services from multiple environmental resources, this process may help to understand diverse responses to proposed changes across different types of resources.

Second, focusing on services highlights an issue overlooked in the valuation partition in the current analytical literature on existence values. Use values may well depend on the level of services associated with the existence values. This is recognized in the earlier literature only at the point where the threshold level of the resource precludes any use-related services. My point here is that the connections may well be more pervasive. Individuals who perceive high

levels of services underlying existence values may have enhanced values from using the resource. Of course, the opposite effect is also conceivable.

Until there is greater attention to the feasibility of defining these types of services and describing proposed changes in them, the empirical studies required to evaluate the issues are likely to exhibit nonuse values that are highly variable.

IV. Heterogeneous Preferences and the Geographic Extent of the Market

Several factors may have contributed to making the available information on the values people place on the services from nonmarketed resources poorly suited for measuring the value of the resources as assets. Two are especially important. Refinement in the indirect methods for measuring the values people place on nonmarketed resources highlighted the importance of beginning the analysis at the micro or household level. As a consequence, attention has shifted from aggregated models hypothesized to describe a "rate-of-use" of some population to focusing on specific levels of individual use. With this reorientation, the focus has been on the representative individual's value for a resource's services. To acquire the required data (within existing research budgets), the analysis concentrated on surveys of *in situ* users. Thus, we have little basis for knowing how changes in the resource will affect aggregate levels of use.

Second, in the case of CVM surveys, progressive refinement in survey design has encouraged economists to use conventional survey research techniques. This implies that the research will select a representative sample of the population, usually defined based on demographic characteristics. As with using on-site surveys to provide a basis for indirect models, this criterion may not adequately capture how changes in a resource influences the size

and characteristics of the people who actually care about it. Nonresponse to valuation surveys is rarely treated as zero valuation.

The process of translating per-unit values for an asset's services to the value of the asset itself requires that the analyst define the geographic extent of the market. I have borrowed this term from the literature of applied industrial organization where market definition is necessary to judge whether changes in the set of competing firms offers any one of them an opportunity to price profitably. In a setting focused on nonmarket resources, however, we do not have the co-movements in prices (across related commodities or geographic locations) to assist in defining these boundaries. Instead we must answer who cares about the change and how their values vary both with what is changed and with their individual characteristics from other sources.

Sustainable nonmarket valuation requires greater attention to this problem for two reasons. One is pragmatic, and the other responds to recent criticisms of the theoretical foundations of applied welfare economics (see Blackorby [1990]). The pragmatic motivation is that the extent of the market is probably more important to the values attributed to environmental resources than any changes that would arise from refining our measure of per-unit values. While the greatest attention on evaluating CVM versus indirect methods has focused on whether they are within 50 or 100 percent of each other, what separates different analysts' evaluations of the value of environmental resources is more likely to be their assumptions about who holds these "representative" values.

In the case of natural resource damage assessment in the United States, Raymond Kopp and I recently undertook a detailed appraisal of the assumptions distinguishing plaintiff and defense estimates of the damages associated with the contamination of a five-mile stretch of a

river by mine wastes (see Kopp and Smith [1989]). Estimates by the plaintiff's analysts were more than eighty-four times greater than those of the defense's analysts. Yet closer inspection of the models underlying each aggregate value (as well as the constituent assumptions required to develop an estimate of the present value of the losses) revealed fairly close correspondence in assumptions. Indeed, one analyst for the plaintiff used CVM surveys and estimated that each household would place an annual value of $5.60 on restoring this section of the river. By contrast, estimates by the defendant's analysts' were either larger or comparable on a per household basis--$8.34 annually for fishing and $5.50 for nonwater-based activities.

For use values, the questions seem reasonably straightforward. Economists have simply not had enough data to investigate the question. What is at issue is using the choke price function implied by a behavioral model of use to describe how participation is influenced by a change in the quality of a resource's services. The problems are more complex for existence values, and they must be resolved if nonuse values are to be estimated and consistently treated as a part of the total value generated by environmental resources. While recognition of the importance of developing an analytical framework for describing why people value public goods is increasing, a common theoretical structure is not yet available. Instead, definitions must rely on inductive research that seeks to use survey research to understand why some people will have appreciable nonuse values and others will not.

This discussion of the need to extend theory to characterize who holds different values (whether use, existence, or some composite of the two) for changes in a nonmarket resource reflects the need to represent more adequately the heterogeneity of preferences. Improving our estimates of the values of environmental resources as assets is an important motivation for these

developments. Such extensions would also contribute to a clear response to the growing dissatisfaction with applied welfare economics in evaluating a wide range of policies. Blackorby's [1990] recent Innes lecture provides a careful summary of these criticisms. After describing why the fundamental theorems of welfare economics are unlikely to hold, he observes that this does not imply that we abandon a role for economic analysis in evaluating policy. Instead, policy recommendations in a "second-best" world must acknowledge the close connections between efficiency and equity. These connections imply that the economist cannot avoid making interpersonal comparisons of utility. For Blackorby this amounts to rejecting the Kaldor-Hicks criterion that implies equal weighting and adopting another that pays greater attention to describing how society wishes to weight different people's gains.

I believe that economic analysts are unlikely to move away from the aggregate of willingness-to-pay less costs to summarize the gains from any particular policy. This does not mean Blackorby's arguments are incorrect. Instead, I believe they imply that society's distributional concerns are often not coherent across projects or policies and would not conform to a simple functional representation for interpersonal comparisons. Instead, describing the diversity of gains and losses across people as part of the efficiency information responds to Blackorby's criticism, but it does not require the existence of one specific functional representation of how "society" will evaluate each policy. Social welfare functions are useful abstractions in describing how and why distribution information can be important. Nonetheless, few of the policymakers and analysts who make these arguments would continue by contending that the way to address them is to define a new, largely arbitrary functional specification of how

the "unequal" weights should be applied across people. The presence of both allows the decision maker to use both types of information.

However, doing so will require that the strategies developed for measuring use and nonuse values describe them in ways that acknowledge heterogeneity in preferences. Thus, the stakes involved in responding to the challenges posed by the need to measure the value of environmental resources as assets extend beyond this issue to include reforms in the practices of applied welfare economics in all of its applications.

Approach	Methods	Environmental Resource	Conclusion
Bishop and Heberlein [1986]	Deer hunting permits; purchase and sale of permits in 1983 and 1984 seasons	1983 auction used with 4 different frameworks for accepting bids and changes in them; 1984 single-price offer, take-it-or-leave-it.	Some differences depending on design of auction mechanism; overall judgment was close correspondence.
Dickie, Fisher and Gerking [1987]	Actual vs. hypothetical demand functions	Strawberries offered at different prices.	No significant difference in estimated demands; predicted amounts of strawberries different by more than 100% unless adjusted for outliers and interviewer effects.
Kealy, Montgomery and Dovido [1990]	Discrete choice models and changes in stated and actual purchase decisions	Cadbury chocolate bars as private good and reduction in acidic deposition in Adirondack Lakes as public good.	Significant differences in proportions with stated intentions to purchase and those with actual purchase decisions.
Actual Markets vs. CVM			
Smith et al. [1991]	Random utility model (RUM) to describe the actual connection decisions to public water systems and double-bounded CVM in different areas using same payment vehicle	Piped water supply in rural Pakistan; varied implementation to induce strategic effects in some of the villages used for CVM.	Comparison of estimated values RUM vs. CVM satisfy convergent validity criteria; also WTP function from CVM data predicted connection frequency in areas with available supplies.
Test/Retest			
Loomis [1989, 1990]	Comparison using t-tests and regression models of WTP kids and discrete CVM responses when some individuals questioned at 9-month intervals	Maintain the ecological character of Mono Lake in California by preserving water level.	Both general population survey and sample of on-site visitors exhibited stable CVM responses over time.
Laboratory Experiments			
Brookshire and Coursey [1987]	Comparison of different elicitation methods for CVM question with laboratory experiments; considered both WTP and WTA	Density of trees in an urban park in Fort Collins, Colorado.	Median bids from laboratory comparable to CVM but uniformly smaller with WTP, regardless of CVM elicitation question.
Purchase Intention/Actual			
Seip and Strand [1990]	Comparison of percent stating willingness to purchase membership with actual membership purchases	Commodity described as membership in prominent Norwegian environmental group.	Little correspondence, actual membership decisions much smaller than intentions but significant problems with research design.

Table 1. Evaluations of CVM's Performance: Some Initial and Current Examples

Approach	Methods	Environmental Resource	Conclusion
Comparison--Direct vs. Indirect			
Brookshire et al. [1982]	Hedonic property value vs. iterative bidding CVM	Air quality measured for CVM with pictures displaying visibility differences; for property value using particulated matter and nitrogen dioxide; analyst judgment for match.	Rent gradient exceeded CVM estimate of WTP as hypothesized from theory.
Seiler, Stoll & Chavas [1985]	Travel cost vs. direct question CVM and take-it-or-leave-it CVM	Value of 4 lakes for boating.	No clear relation between travel cost and CVM; but close correspondence to discrete CVM.
Smith, Desvousges, & Fisher [1986]	Generalized and simple travel cost for water quality vs. direct, payment card, and iterative bidding versions of CVM	Water quality measured by dissolved oxygen for travel cost and RFF water quality ladder with CVM.	No clear correspondence with generalized travel cost (GTC), but likely to be fault of GTC model; simple TC for river and user values same order of magnitude; regression results reject 45° line, but indicate link.
Cummings, Schulze, Gerking and Brookshire [1986]	Hedonic wage vs. CVM with direct question format	Value of municipal infrastructure measured by construction, machinery and equipment per capita and in CVM by percentage increases in community's stock--described using specific allocation among fire, police, recreation, water supply, sewage, streets, and roads and general government that respondents were allowed to reallocate.	No significant difference between the two elasticity measures.
Simulated Markets			
Bohm [1972]	Public television programs	Actual payments to evaluate free riding behavior and hypothetical experiments.	Bohm's comparison concluded differences between actual and hypothetical; Mitchell and Carson re-analysis contradicts this when focusing on comparison of individual actual payments to hypothetical.

Endnotes

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1. For a discussion of the evolution of the legal concept of natural resource damage liability under U. S. statutes, see Breen [1989]. Kopp and Smith [1990] include chapters that describe the legal and economic dimensions of natural resource damage assessment.

2. For a good introductory discussion, see Pearce and Turner [1990].

3. For example, Freeman completed his 1979 volume observing that measurement of the benefits from water quality improvements was a good place to begin work noting that: "If asked, I believe that an economist could specify the economic theory and models he would use, the data he would like to have, and the empirical techniques he would apply to the data to obtain measures of benefits" (p. 248).

4. The suggestion that contingent valuation is simple and always available is one that critics of the methods have emphasized (see Phillips and Zeckhauser [1989] and Kahneman and Knetsch [1991] as examples). In fact, this is not the case. Because we as analysts can ask a question does not mean that people will understand it or be able to answer.

5. Psychological input has greatly helped in the design of contingent valuation questions and in framing the key elements of transactions described by these questions. The Fischhoff/Furby [1988] analysis is a good example.

Unfortunately, there seems to be a growing call among psychologists for the tasks of framing questions and defining procedures for eliciting values to be left to them. Fischhoff [1990] expressed this view implicitly in describing the role of psychologists in public policy. He suggested that this involvement began because: "Economists functioning as psychologists have been paid to ask lay people what they would pay for environmental improvements in situations in which industries felt they had to pay too much to achieve those charges" (p. 647). After reviewing recent experiences when psychologists had to set things right, he offers some general lessons for those psychologists confronting public policy. One lesson repeats what seems to be a call for division rather than cooperation between the social sciences that must be involved in collecting people's preference information. He tells the newcomer to "...expect 'amateurs' to try to usurp the need for psychological expertise, replacing our research with their self-serving speculation" (p. 652).

6. For development of the contrasting views see Nelson and Rosenthal [1990], Quiggin [1990], and Smith [1990b].

7. We usually don't address questions associated with distinguishing demand from supply influences on these outcomes because the available data are usually for individuals. In this case, the supply is assumed to be given and largely unresponsive to one individual's actions.

8. This consistency can partially result from the inevitable pretesting and selection effects that the publication process imposes on evidence in professional journals. Nonetheless, broad consistency should probably be interpreted as a form on content validity.

9. See Smith and Desvousges [1986] as an example of this type of analyses.

10. Weak complementarity can be defined using the MRS between the nonmarketed good (that is the weak complement to a private good) and some numeraire. It requires that this MRS will be zero whenever the level of consumption of the private good is zero.

11. For further discussion of the assumptions underlying the household production framework, see Smith [1991a].

12. These include Shapiro and Smith [1981], Mäler [1982], Gilbert [1985], and Shechter [1989].

13. See Palmquist [1988] for a discussion suggesting that we conceptualize pseudo-demand functions for attributes in these cases and Palmquist [1991] for a detailed review of the hedonic framework.

14. See Smith and Kaoru [1990a] for an empirical illustration of the consistency in these findings.

15. See McConnell [1990a] for a discussion of whether they jointly measure the value of amenities and Parsons [1990] for a discussion of the potential for simultaneity in housing and travel cost decisions. This latter argument is similar to Roback's [1982] call for jointly considering property value and wage models in measuring the value of amenities.

16. A notable exception was the work by Davis [1963].

17. Actually, Knetsch and Davis [1966] first reported a comparison of aggregate valuation estimates for recreation sites from travel cost, willingness to travel, and contingent valuation sources.

18. The description of Richard Bishop's appraisal is distilled from recent papers and unpublished correspondence.

19. Samuelson [1958] was more optimistic about the prospects for eliciting people's values for public goods from questioning them than the literature generally has implied. After discussing the difficulty with market mechanisms for public goods, he offered two examples of ways to deal with allocation decisions involving public goods. In the second, he seems to endorse a form of CVM with attention to strategic incentives by proposing that analysts

"Interrogate people for their tastes with respect to public goods in such large homogenous groups as to give each respondent the feeling that his answer can be a 'true' one without costing him anything extra" (p. 1235).

20. Larson [1990] has recently noted that direct specification of public goods in an expenditure or indirect utility function can (with specific parametric assumptions) allow nonuse values to be recovered. This is provided that initial specification identifies (through market transactions in other goods) all the parameters for the nonmarketed good.

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