
NATURAL RESOURCES JOURNAL

Volume 23
Issue 3 *Symposium on Environmental Management: The Policy Perspective*

Summer 1983

Contingent Valuation Surveys for Evaluating Environmental Assets

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INTRODUCTION

At least since David Hume,[1] economists and other social scientists have recognized that the simple voluntary process of the market place cannot provide some kinds of goods and amenities in efficient quantities. Where goods are non-exclusive, so that one's use is unrelated to one's contribution toward provision, individuals have the opportunity to act as free-riders. For nonrival goods, i.e., goods where one individual's consumption does not effectively reduce the amount available for another's consumption, ordinary exclusion is insufficient to permit efficient allocation through voluntary exchange.[2] For Pareto-efficiency, a more demanding form of exclusion becomes essential, so that people who do not pay an amount equal to their own personal valuation are excluded.

Samuelson[3] and Bradford[4] established the necessary and sufficient conditions for collective provision of the efficient quantity of a nonrival good. Conceptual work by Maler,[5] Randall and Stoll,[6] and Small and Rosen[7] established Hicksian value measures for changes in the quantity and quality of goods (including the non-exclusive, indivisible or lumpy, and/or nonrival). Thus, potential Pareto-improvements become identifiable,

*This paper (83-1-32) is published with the approval of the Director of the Kentucky Agricultural Experiment Station. Several organizations have supported the research leading to this paper. In particular, the Office of Research and Development, U.S. Environmental Protection Agency, has been a frequent sponsor, and Alan Carlin of that office has provided consistent support and encouragement.

**Randall and Hoehn are with the University of Kentucky, and Brookshire is currently visiting at the U.S. Geological Survey on leave from the University of Wyoming. Considerable developmental work in contingent valuation has been performed by groups of researchers at Wyoming and Kentucky, sometimes working together in formal contractual arrangements but more often working independently while maintaining informal communications. This mix of independent and shared research experiences has led to a substantial convergence of professional judgment among the authors of this paper. Nevertheless, there are a few remaining differences of interpretation; for example, see footnote 50.

1. D. HUME, A TREATISE OF HUMAN NATURE (1739).
2. Samuelson, *The Pure Theory of Public Expenditures*, 36 REV. ECON. STAT. 387 (1954).
3. *Id.*
4. Bradford, *Benefit Cost Analysis and The Demand for Public Goods*, 23 KYKLOS 775 (1970).
5. K.-G. MALER, ENVIRONMENTAL ECONOMICS (1974).
6. Randall & Stoll, *Consumers Surplus in Commodity Space*, 70 AM. ECON. REV. 449 (1980).
7. Small & Rosen, *Applied Welfare Analysis with Discrete Choice Models*, 49 ECONOMETRICA 105 (1981).

and benefit cost (BC) analysis of programs to change the level of environmental amenities may be undertaken.

The most direct method of BC analysis for these kinds of goods requires that individuals reveal their personal valuations to the analyst. Briefly, this method has the advantages of analytical simplicity and broad applicability, but, in so far as stated personal valuations evade interpersonal validation, some economists remain suspicious that misstated valuations may be prevalent. This paper addresses the various contingent valuation procedures which employ this method of analysis. Before critically evaluating these procedures, the paper briefly considers the alternative methods available.

Based on a conceptual framework expounded by, for example, Maler,[8] Rosen[9] and Freeman,[10] economists have developed techniques that use observations in the markets for related goods to estimate the value of unpriced amenities. Value data emerge from real transactions, and hence they enjoy a presumption of validity. Nevertheless, these techniques also suffer disadvantages. Its range of applicability is limited to amenities for which related-goods-markets convey adequate information, and is restricted to the experienced range of provision levels. Such analyses often invoke simplifying assumptions (e.g., weak complementarity, and identical preferences). These assumptions may introduce inaccuracies into the analysis and therefore provoke criticism of the methods.[11] In addition, *ex ante* evaluation of complex, multi-faceted policy initiatives, while not theoretically impossible, requires satisfaction of a demanding set of aggregation conditions.[12]

The realization that the best-known alternative methods are themselves subject to limitations and criticisms is essential to a balanced evaluation of contingent valuation methods. The comparison is not between contingent valuation and a perfect alternative. Rather, it is among techniques which are all imperfect, but in different ways.

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8. *Supra*, note 5.

9. Rosen, *Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition*, 82 J. POL. ECON. 34 (1974).

10. Freeman, *Approaches to Measuring Public Goods Demands*, 61 AM. J. ECON. 915 (1979), and THE BENEFITS OF ENVIRONMENTAL IMPROVEMENT (1979).

11. *See*, for example, Maler, *A Note on the Use of Property Values in Estimating Marginal Willingness to Pay for Environmental Quality*, 4 J. ENVTL. ECON. MGMT. 355 (1977).

Other related criticisms of demand based estimation methods (e.g., hedonic price analysis) include those in N. E. Bockstael & K. E. McConnell, *Welfare Measurement in the Household Production Framework* (1982) (unpublished manuscript); Brown & Rosen, *On the Estimation of Structural Hedonic Price Models*, (forthcoming in ECONOMETRICA); and R. Mendelsohn, *The Demand and Supply for Characteristics of Goods* (1980) (unpublished manuscript).

12. J. P. Hoehn and A. Randall, *Aggregation and Disaggregation of Program Benefits in a Complex Policy Environment*, presented at the annual meeting of the Am. Agric. Econ. Assoc. (August 2, 1982).

THE STRUCTURE OF CONTINGENT MARKETS

Economists have developed incentive-compatible devices that erect disincentives for misstatement of personal valuations.[13] Unfortunately, little scope exists for the use of these devices in cases where the goods cannot be delivered and the various direct and side payments collected. Thus, for valuation of many kinds of ambient environmental amenities, a number of contingent valuation approaches have emerged that are seldom strictly incentive-compatible but, on the other hand, are not entirely without incentives for accurate revelation.

Contingent valuation devices involve asking individuals, in survey or experimental settings, to reveal their personal valuations of increments (or decrements) in unpriced goods by using contingent markets. These markets define the good or amenity of interest, the status quo level of provision and the offered increment or decrement therein, the institutional structure under which the good is to be provided, the method of payment, and (implicitly or explicitly) the decision rule which determines whether to implement the offered program. Contingent markets are highly structured, to confront respondents with a well-defined situation and to elicit a circumstantial choice contingent upon the occurrence of the posited situation. Contingent markets elicit contingent choices.

Extensive literature exists on the efficacy of stated attitudes, behavioral intentions, etc., in predicting actual behavior, and the view emerges therefrom that one should be quite cautious in using attitudes to predict behavior.[14] In this literature, however, the term "attitude" appears to cover responses to questions eliciting everything from broad affective notions ("do you care about the environment?") to well-defined behavioral intentions. We reject the idea that negative or inconclusive results with any kind of attitude-behavior pair reflect poorly on the credibility of value data from contingent markets. Rather, we suspect that, for predicting behavior, some kinds of attitudinal information are much more useful than others. Specifically we conjecture that, in terms of reliability in predicting behavior, the following ranking of attitudinal information from poorest to best pertains: affective attitudes, behavioral intentions, and contingent choices.

Turning to the question of incentives in contingent markets, such markets are usually neither strictly incentive-compatible nor devoid of in-

13. Groves & Ledyard, *Optimal Allocation of Public Goods: A Solution to the Free-Rider Problem*, 45 ECONOMETRICA 783 (1977).

14. For two somewhat different interpretations of that literature, *see* Ajzen & Fishbein, *Attitude-Behavior Relations: A Theoretical Perspective and Review of Empirical Research*, 84 PSYCHOL. BULL. 888 (1977); and Schuman & Johnson, *Attitudes and Behavior*, 2 ANN. REV. SOC. 161 (1976).

centives. Thus, experimental work, such as that reported by Vernon Smith, is of interest.[15] In experimental public goods markets with relatively weak incentives for accurate value revelation, Smith finds that most subjects accurately report their personal (induced) valuations. A minority of anti-free-riders counter-balances the minority of free-riders so that group mean and aggregate bids are surprisingly accurate.[16] As Smith observes, if everyone always acts strategically, it is hard to explain the prevalence of flourishing churches.[17]

Recent experiment findings may serve to tie together the "incentive experiments" and "attitude-behavior" results.[18] Respondents faced with two bets—one with the higher probability of winning (the P bet) and the other with the larger maximum payoff (the M bet)—were asked first to indicate which bet they would prefer and later to place money values on the right to participate in each bet. In some cases, respondents would first indicate a preference for one bet but then place a higher value on the other: an apparent reversal of preferences. Two specific results are interesting: (1) reversal was much more common among those who initially preferred the P bet than those preferring the M bet, and (2) when the *expected* payoff of the M bet was larger than that for the P bet, reversals among those who initially preferred the P bet were more than twice as common as nonreversals. It seems that the contingent choice question (the one asking money values for specific bets) elicited the "right" answer more often than the more affective question (which do you prefer?), reflecting a more complete decision process. This finding supports the notion that some kinds of questions elicit more serviceable responses than others, and among the various "attitudinal" questioning devices, contingent choice questions seem to work best.

PERFORMANCE OF CONTINGENT VALUATION IN EMPIRICAL APPLICATION

From a small and quite recent beginning,[19] the body of reported contingent valuation studies has grown dramatically, and variants on the

15. V. L. Smith, *Experiments with a Decentralized Mechanism for Public Goods Decisions*, 70 AM. ECON. REV. 584 (1980).

16. Nevertheless, there is a caveat. Smith (*id.*) found that as incentives for strategic behavior became stronger and subjects became more familiar with the experimental format, the incidence of strategic behavior increased somewhat.

17. *Supra*, note 15.

18. Grether & Plott, *Economic Theory of Choice and the Preference Reversal Phenomena*, 69 AM. ECON. REV. 623 (1979); and Pommerehne, Schneider and Zweifel, *Economic Theory of Choice and the Preference Reversal Phenomenon: A Reexamination*, 72 AM. ECON. REV. 569 (1982).

19. Davis, *Recreation Planning as an Economic Problem*, 3 NAT. RES. J. 239 (1963) and Randall, Ives, & Eastman, *Bidding Games for Valuation of Aesthetic Environmental Improvements*, 1 J. ENVTL. ECON. MGMT. 132 (1974).

original iterative bidding approach have proliferated. Several kinds of evidence generated by these studies support contingent valuation methods.

First, contingent valuation bids are not random numbers. Many empirical studies show that individual or household bids are significantly related to income, availability of substitute and complement goods, and demographic characteristics. Basic data are disaggregate (usually, at the individual or household level), cross-sectional in nature, and typically generated from small samples. Considering the nature of this data, the proportion of total variation in bid explained usually compares with that in similar cross-sectional data sets.

Contingent valuation results are not only systematic, but are consistent with various types of actual behavior. At the most elementary level, individuals are willing to pay positive amounts in contingent markets for amenities that (their behavior shows) they prefer. Tolley *et al.* found that participation rates in a broad range of outdoor activities varied positively with atmospheric visibility, while the number of television sets in use related negatively to visibility.[20] Assuming, reasonably enough, that improved visibility expands opportunity sets in terms of visibility without diminishing them in any other way, these behavioral changes unambiguously demonstrate that visibility is a commodity (i.e., more of it is preferred to less). The same authors report significant positive valuations for visibility increments expressed in contingent markets.

Where markets in related goods are adequate to permit demand-based valuation of unpriced goods,[21] the possibility exists for direct comparison of value estimates obtained with demand-based and contingent valuation methods. In 1966, Knetsch and Davis[22] reported consistent recreation site values derived from contingent valuation and the travel cost method; several subsequent studies repeated that result. Willingness to pay (WTP) to preserve recreation site amenities was consistent, whether measured by contingent valuation or a site substitution method.[23] WTP for improved air quality in metropolitan areas was consistent, whether measured by contingent valuation or hedonic price analyses.[24] WTP for infrastructure and community facilities in a group of western energy boomtowns was

20. G. S. Tolley, A. Randall, G. Blomquist, R. Fabian, G. Fishelson, A. Frankel, J. P. Hoehn, R. Krumm, and E. Mensah, *Establishing and Valuing the Effects of Improved Visibility in Eastern United States*, Final Report 807768-01-0, U.S. Environmental Protection Agency (in press).

21. *See* text accompanying notes 8, 9, and 10.

22. Knetsch & Davis, *Comparisons of Methods for Recreation Evaluation*, in WATER RESEARCH (A. V. Kneese and S. C. Smith, eds., 1966).

23. Thayer, *Contingent Valuation Techniques for Assessing Environmental Impact: Further Evidence*, 8 J. ENVTL. ECON. MGMT. 27 (1981).

24. Brookshire, Thayer, Schulze, & d'Arge, *Valuing Public Goods: A Comparison of Survey and Hedonic Approaches*, 72 AM. ECON. REV. 165 (1982), and E. Loehman, D. Boldt, and K. Chaikin, *Measuring the Benefits of Air Quality Improvements in the San Francisco Bay Area*, final report, SRI Project 8962 (1981).

consistent, whether estimated by contingent valuation or a wage hedonic analysis.[25] Recreation and related benefits of in-stream water quality improvements were consistent, whether measured by contingent valuation, a contingent ranking method[26] or the travel cost method.[27] WTP for goose hunting permits in Wisconsin was broadly consistent, whether measured by a contingent purchase method, travel cost, or cash transactions in an experimental willingness-to-sell market.[28] Demand for visits to the Hancock Tower Observation Deck in Chicago and WTP for atmospheric visibility improvements there compared closely, when measured by contingent valuation, by a time series analysis of visitation data, and by a method relating visitations to the implicit price of visual range.[29]

The results of contingent valuation exercises and other benefit estimation methods are not merely mutually consistent. Where sound theoretical reasons exist to expect modest divergences among results of alternative methods, the sign of the difference between contingent valuation results and those of other methods is predictable from theoretical considerations. Thus, Brookshire *et al.*[30] predicted that the bid-rent function would overestimate WTP for air quality improvements, and found the estimates derived by that method exceeded those from contingent valuation. We argue (see the text accompanying note 40, *infra*) that one of the Bishop-Heberlein findings[31]—that WTP estimated from a contingent purchase method was lower than that derived from cash transactions in an experimental willingness-to-sell market—is predictable on the basis of theoretical considerations.

The performance of contingent valuation in empirical application might be summarized as follows: while contingent valuation exercises have generated some individual bids which do not appear to be serviceable, virtually all competent contingent valuation studies have generated a "solid core" of value information which performs well on the various tests.[32] Given the relatively weak incentives for careful decision making

25. R. E. Cummings, W. D. Schulze, S. Gerking, D. Brookshire, *A Note on Measuring the Elasticity of Wages for Municipal Infrastructure: A Comparison of Survey and Wage Hedonic Approaches* (1982) (unpublished manuscript).

26. Rae, *The Value to Visitors of Improving Visibility at Mesa Verde and Great Smokey Mountain National Park* in MANAGING AIR QUALITY AND SCENIC RESOURCES AT NATIONAL PARKS AND WILDERNESS AREAS (R. D. Rowe and L. G. Chestnut, eds., 1982).

27. W. H. Desvouges, V. K. Smith, and M. D. McGivney, *A Comparison of Alternative Approaches for Estimating Recreation and Related Benefits of Water Quality Improvements*, report to U.S. Environmental Protection Agency, Econ. Analysis Division (1982).

28. Bishop & Heberlein, *Measuring Values of Extra-Market Goods: Are Indirect Measures Biased?*, 61 AM. J. AGRIC. ECON. 926 (1979).

29. Tolley, *supra*, note 20.

30. *Supra*, note 24.

31. *Supra*, note 28.

32. A. Randall, J. P. Hoehn, and G. S. Tolley, *The Structure of Contingent Markets*, presented to the annual meeting of the Am. Econ. Assoc. (Dec. 30, 1981).

in contingent markets, and the possibility for strategic manipulation of responses, the relatively strong performance of contingent valuation methods is perhaps surprising.

In spite of the generally encouraging performance of contingent valuation methods, some doubts remain. First, concerns about sampling bias and enumerator bias arise from time to time. These concerns, however, are best treated as problems common to all survey methods, and controllable with competent research design and management. Second, concern about strategic bias persists in some quarters, despite the paucity of evidence that it actually occurs. Third, something called "hypothetical bias" seems to be of greater concern, although the concept is not well defined. The idea suggests that, because of weak penalties for inaccurate value revelation, respondents may invest only a little time and effort in decision making and, hence, their contingent choices may deviate more than one would hope from the choices they would make in real markets. The concept of hypothetical bias is so poorly defined that Feenburg and Mills,[33] for example, believe it is manifested in high noise levels, while Bishop and Heberlein[34] expect it to be expressed in systematic distortion of mean bids downward for WTP and upward for WTA. Fourth, still others[35] have focused on "information bias" (and a subcategory thereof, payment vehicle bias). With this focus, variations in the materials describing the contingent market may influence the contingent choices. Such responses, however, may not evidence any kind of bias at all. If the various elements of contingent market structure are relevant to the choice problem, information that changes the structure of the market *should* (arguably) change the circumstantial choices made therein. Economists regard the responsiveness of prices to changes in market conditions as a virtue. Surely, contingent values should be similarly responsive to changes in contingent market conditions. Fifth, a repeated and persistent finding by researchers is that estimates of WTP and WTA obtained with contingent valuation diverge to a much greater degree than is predictable from the theoretical analyses of Willig[36] and Randall and Stoll.[37]

As the preceding paragraph suggests, observed anomalies and claimed discrepancies in contingent valuation results are something of a mishmash. While not all the anomalies and discrepancies can be blithely dismissed, neither should all be taken seriously. Some genuine anomalies

33. D. FEENBURG & E. S. MILLS, MEASURING THE BENEFITS OF WATER POLLUTION ABATEMENT (1980).

34. *Supra*, note 28.

35. Rowe, d'Arge & Brookshire, *An Experiment on the Economic Value of Visibility*, 7 J. ENVTL. ECON. MGMT. 1 (1980); and Schulze, d'Arge & Brookshire, *Valuing Environmental Commodities: Some Recent Experiments*, 57 LAND ECON. 151 (1981).

36. Willig, *Consumer's Surplus Without Apology*, 66 AM. ECON. REV. 587 (1976).

37. *Supra*, note 6.

require explanation. Nevertheless, some claims of discrepancies reflect problems with particular research designs and naive interpretation of results, rather than inadequacies inherent in the contingent valuation method.

THE RESEARCH AGENDA

At the outset, the research agenda in contingent valuation sought to establish, in the face of considerable skepticism, contingent valuation as an acceptable method of non-market benefit estimation (acceptable in the sense that it works about as well as available alternative techniques and is adaptable to at least some valuation tasks that alternative methods cannot handle). That objective has been attained. In addition, the experimental work of others[38] has blunted traditional fears that strategic responses would inevitably dominate data sets of stated personal valuations.

These results have redefined the research agenda. Given the recent proliferation of contingent market structures, and the sometimes conflicting interpretations of evidence that market design influences the results obtained, the current task is to identify and explain systematically the relationship between the structure and performance of contingent markets. In other words, the new research agenda seeks to explain why contingent markets work as well as they do and to elucidate principles which may lead to routine and effective use of contingent markets and to an understanding of their limitations.

BEHAVIOR IN CONTINGENT MARKETS

1. Predictions from Theory

In research currently underway, Hoehn and Randall have made some progress in conceptual modelling of the decision process of an individual responding to contingent valuation exercises.[39] Here we introduce some of their ideas at an intuitive level.

First, however, consider the goal of contingent valuation: the identification of potential Pareto-improvements. Define an *optimal benefit cost (BC) indicator* as one that identifies all proposals which offer potential Pareto-improvements as having positive net value, and all proposals which do not offer potential Pareto-improvements as having negative net value. Because the actual policy environment always seems characterized by budget constraints and an excess of plausibly beneficial proposals, a suboptimal but *satisfactory BC indicator* is defined as follows: one that

38. *See* text accompanying note 15.

39. Initial statements of this work are to be found in J. P. Hoehn, *The Benefit-Cost Evaluation of Multi-part Public Policy: A Theoretical Framework and Critique of Estimation Methods* (1983, unpublished dissertation); and J. P. Hoehn and A. Randall, *Incentives and Performance in Contingent Policy Valuation* (February 12, 1983) (unpublished manuscript).

identifies some of the proposals which offer potential Pareto-improvements as having positive net value, and all proposals which do not offer potential Pareto-improvements as having negative net value.

With these definitions established, consider the factors that might influence bidding behavior of individuals who are motivated to truthfully reveal their valuations. Later, strategic motivations are introduced.

(a) *Bidding behavior of individuals motivated to truthfully reveal their valuations.* First, assume that the decision process leading to stated bids may be incomplete, as respondents limit the time (and, by extension, other resources) they are willing to invest in solving contingent decision problems. For the *compensating* measures of welfare change, the individual must solve the problem: minimize expenditures (PX) subject to the constraint that initial utility is maintained (i.e., $U = U^o$). Given that only one solution, PX*, minimizes expenditures subject to this constraint, an individual failing to identify PX* will settle for some other PX that satisfies the constraint but exceeds PX*. This reduces the stated compensating value measures, i.e., reduces WTP^C while increasing the absolute value of WTA^C.

For the *equivalent* measures, the problem is to minimize PX subject to $U = U'$ (i.e., that utility is constrained to the subsequent level). The decision problem is now two-fold: first, compute U' for the "with proposed policy" situation and then solve for PX* subject to $U = U'$. An individual failing to reallocate within the "with proposed policy" opportunity set so as to maximize utility will identify some other level of utility lower than U' and thus underestimate the expenditure required to satisfy $U = U'$. As before, imperfect solution of the expenditure minimizing problem results in some estimated expenditure greater than PX*. The two effects are opposite in direction, leading to ambiguous results for the equivalent measures: they may be under- or over-estimated.

There are several additional factors which may influence bidding behavior: individual risk aversion in the event of uncertainty as to how the proposed amenity change will affect the opportunity set; randomly distributed individual biases in the perception of policy effectiveness, about an unbiased population mean perception; and unfamiliarity with the concept and use of markets in traditionally unpriced amenities.[40] All of these considerations would tend to reduce $\widehat{WTP}$ and increase $\widehat{WTA}$ (where $\widehat{WTP}$ and $\widehat{WTA}$ are population mean estimates of true WTP and WTA).

(b) *Strategic Behavior.* Assume individuals seek to transmit whatever valuation information benefits themselves, regardless of its truth. The

40. Caution and reluctance in the use of unfamiliar markets applies to cash-transactions markets as well as to contingent markets. For this reason, we argue that Bishop and Heberlein's (*supra,* note 28) $\widehat{WTA}$ from a (institutionally unusual) cash-transactions market is likely overestimated, just as their $\widehat{WTP}$ from a contingent market is likely underestimated.

individually-optimal bidding behavior depends on the perceived structure of the contingent market. Three basic structures seem to cover most of the important possibilities.

(i) Suppose each individual assumes his actual payment will be equal to, or directly proportional to, his stated bid. Individuals who desire both to have the policy implemented and to minimize their payments would choose a strategy contingent upon what they assume about the behavior of others. Those who assume the bids of others will be sufficient to ensure implementation of the proposal may choose to free-ride and state a zero bid. Those who assume their own positive bids will increase the chances of implementation may state positive bids less than or equal to $\hat{WTP}$. For WTA one would for analogous reasons expect $\hat{WTA} \leq$ stated bids $< \infty$.

(ii) Suppose the respondent assumes that all will pay an amount equal to per capita project cost, and the decision rule is to implement the project if a majority responds favorably at that stated cost. Thus, the decision criterion is perceived as a voting criterion. In this situation, an individual cannot do better for himself than to "vote" YES at per capita cost no higher than $\hat{WTP}$ and NO at higher per capita costs. Similarly, false revelation of $\hat{WTA}$ for strategic reasons would be unproductive to the individual.

Note that the iterative bidding routine involves repondents stating YES/NO to costs or prices posited by the enumerator. Further, Randall and his colleagues have often used formats of the type "if the proposed program would cost you $X, would you approve or disapprove it? (accept or reject, etc.)."

(iii) Suppose the respondent assumes that all will pay the per capita project cost, and the public decision rule is to implement the project if the sum of stated bids exceeds the total project cost. This situation is difficult to analyze. The simplest case (and, incidentally, the one considered by Brookshire, Ives, and Schulze[41] assumes, *inter alia,* that each individual thinks everyone but himself is bidding truthfully, and each individual has some information about the distribution of preferences across individuals. Under these assumptions, those who suspect their true bids deviate from the mean would report bids exaggerating the deviation, so as to influence the mean toward their true bid. Clearly, such behavior increases the variance of stated bids. For commodities, because WTP bids can be no less than zero but have no well-defined upper limit, the mean bid might be biased upward. Statistical techniques for correcting this bias exist, however. Because the sample of bids is censored at zero, those methods which estimate the means of uncensored distributions from

41. Brookshire, Ives, & Schulze, *The Valuation of Aesthetic Preferences,* 3 J. ENVTL. ECON. MGMT. 325 (1976).

the information contained in the censored distribution are applicable.[42] Hence, this kind of strategic behavior is unlikely, given appropriate statistical analysis of bids, to mislead the researcher as to mean $\hat{WTP}$.

(iv) In summary, examination of selfish strategies reveals little scope of strategic behavior which would lead to mean stated $\hat{WTP}$ bids (corrected, in case iii) exceeding mean $\hat{WTP}$, or mean stated $\hat{WTA}$ bids less than $\hat{WTA}$.

(c) *The net effect of non-strategic and strategic influences.* For compensating value measures, consideration of the predictable effects of incomplete optimization, imperfect knowledge, unfamiliar markets, and strategic false revelation leads to an unambiguous result: contingent markets can be expected to yield bids in the ranges $0 \leqslant$ stated $\hat{WTP}^C \leqslant WTP^C$ and $WTA^C \leqslant$ stated $\hat{WTA}^C \leqslant \infty$. Using compensating value measures, benefits are measured as WTP^C and costs as WTA^C. Therefore, we conclude (on theoretical grounds): *Contingent valuation, in a compensating value framework, provides a satisfactory BC indicator.*

No such claim can be made for contingent valuation in an equivalent value framework for two reasons: first, with perfect measures of WTP^E and WTA^E, the equivalent framework nevertheless identifies some changes which are not potential Pareto-improvements as having positive net benefits;[43] and second, there is no unambiguous prediction of the effects of the influences discussed in part (a), above, on the signs of any deviations between stated and true WTP^E and WTA^E.

(d) *Aggregate benefits of complex policy packages.* Hoehn and Randall[44] report the following theoretical findings, which have implications for empirical work. The benefits of a complex policy package (B) are, in general, not equal to the sum of the independently estimated benefits (ΣB_i) of its components. While B conceivably could exceed ΣB_i in special cases, ΣB_i is more likely to overstate B. Consider the sequential implementation of policy components. For some particular policy component (i), its benefits (B_i) are typically smaller the later it occurs in the implementation sequence.

2. *Empirical Evidence*

The above conjectures, based on traditional economic-theoretical analyses, may contain the seeds of many fruitful hypotheses concerning the performance of contingent markets. Consideration of the psychological

42. Tobin, *Estimation of Relationships for Limited Dependent Variables,* 26 ECONOMETRICA 24 (1958), Amemiya, *Regression Analysis When the Dependent Variable is Truncated Normal,* 41 ECONOMETRICA 997 (1973), and Olsen, *A Least Squares Correction for Selectivity Bias,* 48 ECONOMETRICA 1815 (1980).

43. Randall and Stoll, *supra,* note 6.

44. *Supra,* note 12.

processes in which individuals clarify their objectives ("research their preferences"[45]) and make contingent choices suggests a further source of hypotheses.

The present authors have barely scratched the surface. To make a small beginning, consider the following hypotheses:

a. Reported $\hat{WTA}^C$ will exceed reported $\hat{WTP}^E$ by an amount equal to or greater than that suggested by the pure theory of economic surplus.[46] This hypothesis emerges from considerations developed above and corroborated repeatedly in the empirical literature.

b. Considering that uncertainty, unfamiliarity with the market, and limited investment in making contingent decisions are among the reasons we predict $0 \leqslant$ reported $\hat{WTP}^C \leqslant WTP$, anything which facilitates use of the contingent market will tend to stabilize and increase reported $\hat{WTP}^C$. Additional useful information and devices that encourage the respondent to take more time to research his/her preferences, iterate toward a decision and/or decompose the bidding decision into a series of more manageable steps, would have this predicted effect.

c. Reported $\hat{WTP}^C$.for more precisely defined policy proposals more nearly approaches WTP^C and is more stable in the face of influences, such as those considered in b, immediately above.

d. Reported $\hat{WTP}^C$ obtained with iterative YES/NO bidding devices will exceed that obtained with checklists, one-shot contingent purchase questions, or questions directly asking "maximum WTP?".

e. Reported $\hat{WTP}^C$ for a single policy component introduced alone exceeds that for the same component valued as the last part of a sequentially-introduced package of policies.

A set of hypotheses concerning reported $\hat{WTA}^C$, analogous to b through d but with predicted influences of opposite sign, can also be derived from theoretical considerations. Unambiguous predictions concerning reported $\hat{WTP}^E$ are considerably more elusive.

Randall *et al.*[47] (henceforth RHT), Brookshire *et al.*[48] (BCRST), and Sorg and Brookshire[49] (SB) conducted case studies permitting initial tests of hypotheses b through e.

Hypothesis b. BCRST introduced explicit considerations of the re-

45. D. S. Brookshire, R. G. Cummings, M. Rahmatian, W. D. Schulze, and M. Thayer, *Experimental Approaches for Valuing Environmental Commodities*, draft final report for Methods Development in Measuring Benefits of Environmental Improvements, U.S. Environmental Protection Agency, Grant #CR 808-893-01 (1982).

46. Randall and Stoll, *supra*, note 6.

47. *Supra*, note 32.

48. *Supra*, note 45.

49. C. Sorg and D. S. Brookshire, *Valuing Increments and Decrements of Wildlife Resources—Further Evidence*, report to the U.S. Forest Service, Rocky Mountain Forest and Range Experiment Station (1982).

spondent's budget constraint into contingent markets in several non-market goods. Following a traditional contingent valuation exercise, respondents reported their budget constraints and pre-bid budget allocations among categories of goods, made post-bid budget reallocations to "figure out where the money would come from," and stated a final bid.

In all cases but one, the introduction of the budget constraint and reallocation procedure *increased* the mean reported $\widehat{WTP}$, but the increase was not significant in every case.[50]

Hypothesis c. For a well-defined, local improvement in ambient air quality (BCRST) and an increment in elk herds (SB), the budget constraint and reallocation procedure has insignificant effect on reported $\widehat{WTP}^C$. For a loosely-defined national policy to improve water quality in lakes and streams (BCRST), however, this procedure led to a significant increase in reported $\widehat{WTP}^C$. This provides evidence that reported $\widehat{WTP}^C$ for well-defined goods is more stable than that for loosely-defined policies.

Hypothesis d. Researchers reporting tests of iterative bidding routines versus contingent markets using checklists found that iterative bidding routines increase reported $\widehat{WTP}^C$. In one case (BCRST), the evidence for this effect was weak, but in two others (RHT and SB) it was strong.

Hypothesis e. BCRST and RHT experimented with the sequential introduction of policy components. In every case, the prior introduction of additional components reduced reported $\widehat{WTP}^C$ for the component of interest. In a few of the cases studies by BCRST, this effect was insignificant; otherwise, significant and quite substantial effects were found by BCRST and RHT. Even in the case of the hazardous waste policy, which had generated a controversial result with respect to hypothesis b,[51] the prior introduction of other policy components reduced reported bids (BCRST).

Comment. Those results cannot claim the status of empirical laws. At best, they are tentative and subject to future attempts at corroboration or disconfirmation. We present them at this time because we believe that, along with the conceptual work in the preceding section, they suggest the possibility of a fruitful research agenda concerning the structure of contingent markets.

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50. Among the present authors, Brookshire (who is inclined toward the hypothesis that this kind of step-wise decomposition of the contingent choice problem would stabilize reported bids) is untroubled by this result. Randall and Hoehn (who expect the process to stabilize reported $\widehat{WTP}^C$ and drive it upward toward WTP^C) are troubled by the one case in which the budget constraint procedure reduced reported bids. They note that this case involved a proposed policy (of uncertain effectiveness) to contain hazardous wastes. Since the reference situation was one in which the problem would grow worse in the absence of the policy, one reasonable interpretation of this contingent market is that it generates estimates of WTP^E, not WTP^C.

51. *Id,* and accompanying text.

CONCLUDING COMMENTS

Our purpose has been to establish that empirical contingent valuation research is moving into a new phase. In its first phase, the objective was to show, in the face of considerable skepticism, that contingent valuation "worked" in the sense that (1) it got results and (2) those results were consistent with theory-based expectations and the empirical findings obtained with other techniques. That objective, we believe, has been attained. In so doing, a considerable body of empirical data accumulated, much of it vaguely suggestive of some underlying principles which may govern human behavior in contingent markets.

The next phase, we argue, is a systematic conceptual and empirical exploration of the various influences on the performance of contingent markets. This phase should include rigorous theoretical analyses based on modern microeconomic theory (to elucidate the incentives and costs facing contingent valuation respondents), socio-psychological research into the decision-making process (to evaluate the relevance of concepts such as "preference research"[52] and "mental accounts,"[53] and careful empirical experimentation to test hypotheses rigorously derived from solid conceptual foundations. This research program, if successful, will permit much more insightful interpretation of contingent valuation results, an appreciation of the limits of the technique and, perhaps, the routine design of effective contingent markets for evaluation of a wide variety of proposed projects, programs and policies.

52. *See* Brookshire, *supra*, note 45.
53. *See* Kahneman and Tversky, *The Psychology of Preferences*, 246 SCI. AM. 160 (1982).