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Contingent Valuation of Environmental Assets: Comparison with a Stimulated Market

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Contingent Valuation of Environmental Assets: Comparisons with a Simulated Market

Contingent valuation[1] (CV) has gained credibility from comparisons with other value estimates including those based on travel-cost models;[2] costs and prices of substitutes;[3] and property values.[4] Such comparisons have at least been sufficient to allay fears that CV results are dominated by meaningless noise. In several laboratory experiments, researchers have attempted to get people to behave strategically, yet such behavior has been rare.[5] Attempts to find evidence of strategic behavior in CV studies themselves have failed to find evidence of significant distortions.[6] Still, there are several anomalies that have not yet been adequately explained. First, there have been consistent differences between willingness-to-pay and willingness-to-accept-compensation in excess of differences that are

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1. Contingent valuation employs personal and telephone interviews and mail surveys to ask people about the values they would place on nonmarket commodities if markets did exist or other means of payment such as taxes were in effect. That is, subjects are asked about their willingness to pay or compensation demanded, *contingent* on the creation of a market or other means of payment. All payments and receipts are purely hypothetical.

2. Knetsch & Davis, *Comparison of Methods for Recreational Evaluation,* WATER RESEARCH 125 (A. Kneese & S. C. Smith eds. 1966); Desvouges, Smith & McGivney, *A Comparison of Alternative Approaches for Estimating Recreation and Related Benefits of Water Quality Improvements,* DRAFT REPORT TO U.S. EPA (July 1982); and C. Sellar, J. Stoll & J. Chavas, Validation of Measures of Welfare Change: A Comparison of Nonmarket Techniques, Dept. of Agricultural Economics, Texas A & M Univ. (1982) (mimeo).

3. Thayer, *Contingent Valuation Techniques for Assessing Environmental Impact: Further Evidence,* 8 J. ENVIR. ECON. & MGMT. 27 (1981) and other studies discussed in Schulze, d'Arge, & Brookshire, *Valuing Environmental Commodities: Some Recent Experiments,* 57 LAND ECON. 151 (1981).

4. Brookshire, Thayer, Schulze, & d'Arge, *Valuing Public Goods: A Comparison of Survey and Hedonic Approaches,* 72 AM. ECON. REV. 165 (1982).

5. *See,* e.g., Scherr & Babb, *Pricing Public Goods: An Experiment with Two Proposed Pricing Systems,* 23 PUB. CHOICE 35 (1975); Smith, *The Principle of Unanimity and Voluntary Consent in Social Choice,* 85 J. POL. ECON. 1125 (1977). Marwell & Ames, *Experiments on the Provision of Public Good. I. Resources, Interest, Group Size, and the Free Rider Problem,* 84 AM. J. SOC. 1335 (1979) and Marwell & Ames, *Experiments on the Provision of Public Goods. II. Provision Points, Stakes, Experience and the Free Rider Problem,* 85 AM. J. SOC. 926 (1980).

6. *See* studies summarized in Schulze, d'Arge & Brookshire, *supra* note 3.

explainable by income effects or other theoretically acceptable means.[7] Second, many studies have found that substantial shares of their respondents have reacted in perverse ways to contingent valuation questions. People refuse to answer at rates in excess of refusal rates for more conventional survey questions. When people do respond, substantial shares seem to state values which are implausibly large or small.[8] Third, some bidding game studies have found that responses are influenced by the initial bid.[9] Finally, some studies have found that people give different answers depending on information they receive.[10]

In our view, these anomalies result from the fact that people confronting a CV mechanism do not have well-developed beliefs about how they would behave in real markets for environmental assets. Most people have not previously attempted to express their values for nonmarket goods in monetary terms, and contingent markets are too artificial to provide a sufficient context for developing accurate values. As a result, substantial—though not overwhelming—inaccuracies occur in CV findings.

Our evidence to support this view comes primarily from an experiment involving Wisconsin goose hunting permits. These permits were evaluated using several CV mechanisms and a travel-cost model. They were also evaluated in a "simulated market" where permittees were offered real money not to hunt. The results show that contingent values could easily be in error by 50 percent or more. After describing the experiment and its results, the remainder of the paper explores the reasons for these errors with particular emphasis on the artificiality of CV mechanisms. Several conclusions emerge, including one particularly interesting hypothesis: Our results and those of some other studies seem to show that CV mechanisms tend to underestimate willingness-to-pay and overvalue environmental assets when the criterion is willingness-to-accept-compensation.

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7. Several studies with this result were cited in Meyer, *Publicly Vested Values of Fish and Wildlife: Criteria in Economic Welfare and Interface with Law*, 55 LAND ECON. 223 (1979). *See also*, the discussion of this phenomenon by Gordon & Knetsch, *Consumer's Surplus Measures and the Evaluation of Resources*, 55 LAND ECON. 1 (1979).

8. *See* discussion of past studies in Mitchell & Carson, *An Experiment in Determining Willingness to Pay for National Water Quality Improvements*, DRAFT REPORT TO U.S. EPA, Ch. 4 at 49–51 (June 1981).

9. Rowe, d'Arge & Brookshire, *An Experiment on the Economic Value of Visibility*, 7 J. ENVTL. ECON. & MGMT. 1 (1980); Desvouges, Smith & McGivney, *supra* note 2; Mitchell and Carson, *id.* Other studies, summarized in Schulze, d'Arge & Brookshire, *supra* note 3, were unable to establish any effect of starting bids on final bids.

10. Some argue that changing the information may change the product being valued. *See* A. Randall, J. Hoehn & G. Tolley, *The Structure of Contingent Markets: Some Results of a Recent Experiment* 5–6 DEPT. OF AGRICULTURAL ECONOMICS, UNIV. OF KY. (1981) (mimeo). Other studies that have found probable effects of information include Rowe, d'Arge and Brookshire, *supra* note 9; Daubert & Young, *Recreational Demand and Maintaining in Stream Flows: A Contingent Valuation Approach*, 64 AM. J. AG. ECON. 657 (1982); and Greenley, Walsh & Young, *Option Value: Empirical Evidence from a Case Study of Recreation and Water Quality*, 96 Q. J. ECON. 657 (1981).

THE EXPERIMENT

Study Design

Permits are required to hunt Canada geese in an area of 24,600 acres in central Wisconsin known as the Horicon Zone. The permits on which our study focused authorized the bearer to take at most one Canada goose in the zone between October 1 and October 15, 1978. A hunter could legally receive only one such permit, and a total of 13,974 were issued by the Wisconsin Department of Natural Resources. There were no fees charged for the permits.

A random sample of 237 permittees was drawn. Each received a randomly determined actual cash offer to give up his permit. Cash offers ranged in roughly log-linear amounts from $1 to $200. The letter of offer explained that the hunter should mail the researchers either the enclosed check or his permit, postmarked no later than September 29 when the offer would expire. A total of 221 people (94 percent) returned either their check or their permit. On October 5, payment was stopped on the checks that had been mailed to the remaining 16 individuals. Only one had cashed his check ($40). In the analysis the 15 people who neither cashed their checks nor otherwise responded were considered as having refused their offers. For purposes of later discussion, results from this part of the experiment will be designated SMWTS (Simulated Market Willingness-to-Sell). Once the early season had ended, this sample of hunters was surveyed by mail, with a response rate of 80 percent.

At the same time that the sample of hunters was drawn for the actual cash offers, an additional sample of 353 people was drawn for a contingent valuation survey. With an incentive of $5 per questionnaire, 94 percent of this group responded prior to the opening of the hunting season on October 1.

The primary contingent valuation question was worded to sound as much like the actual cash offers as possible, except that the hypothetical nature of the proposed transaction was emphasized. That is, the respondent was asked to suppose that a check for some fixed amount had been included in the survey. The amount offered varied randomly from $1 to $200 as before. Each respondent was asked to state whether he would surrender his Horicon permit for the amount assigned to him. For purposes of later discussion, the results of this part of the experiment will be designated CV Take-It-Or-Leave-It WTS.

A later question asked the subject to imagine that he had not received a Horicon permit, a plausible circumstance since permittees are drawn by lottery when the number of applicants exceeds the number of permits available. But in this case, each respondent was asked whether he would purchase a permit for a given specified price, again between $1 and $200,

if it were possible to do so. The results here will be designated CV Take-It-Or-Leave-It WTP.

The same survey included four other CV questions. Two followed the "open-ended" format which allowed the respondent to fill in his maximum willingness-to-pay and minimum willingness-to-accept-compensation. Results here will be designated CV Open-Ended WTP and CV Open-Ended WTS, respectively. The third described the cost of several recreational alternatives and asked what the respondent thought would be a reasonable price for a goose hunting permit. Results here will be termed CV Reasonable Price. The fourth CV question asked the respondent to state the minimum amount he would have to be paid before he would work rather than hunt geese. The results from this question will be designated as CV Willingness-To-Forego-A-Day's-Pay.

A third sample, this one consisting of 300 individuals, was drawn prior to the 1978 hunting season. This sample was surveyed by mail after the hunting season to develop data for a travel-cost demand estimate. A response rate of 91 percent was achieved, even without a monetary incentive for returning the questionnaire. The estimated value of a permit based on the travel-cost data will be referred to as TCWTP.

The surveys of all three samples asked essentially the same questions. In addition to the usual socioeconomic variables, these questions covered years of hunting experience, commitment to goose hunting, attitudes toward monetary valuation of hunting, hunting equipment owned, attitudes towards goose management in the Horicon Zone, and the like. Statistically significant differences between the three samples were very rare and none appeared to be sufficient to affect comparisons.

Analysis

The response to the take-it-or-leave-it offers in both the simulated and contingent markets were the most difficult to analyze, because they involved dichotomous (yes or no) answers. As a first step, the data were analyzed using a logit model[11] of the form

$$\pi_i = (1 + e^{\beta Y_i})^{-1}$$

where π_i is the probability that the ith hunter will accept an offer to sell his permit or buy one (depending on which part of the experiment is being analyzed); Y_i is a vector of explanatory variables for the ith hunter; and β is a vector of regression coefficients. In Model 1, shown in Table 1, only a single explanatory variable, the natural logarithm of the offer amount (ln Dollars), was used, and the coefficients were estimated by

11. Excellent expositions on the problem of dichotomous dependent variables and the logit model are presented in R. PINDYK & D. RUBENFELD, ECONOMETRIC MODELS AND ECONOMETRIC FORECASTS 632 (1976) and H. THEIL, PRINCIPLES OF ECONOMETRICS 247 (1971).

TABLE 1

REGRESSION ANALYSIS OF SIMULATED AND CONTINGENT MARKETS FOR WILLINGNESS-TO-SELL[a]

	Model 1		Model 2	
Explanatory Variables	Simulated	Contingent	Simulated	Contingent
Constant	3.99**	3.24**	1.72	−.58
	(.66)	(.54)	(.98)	(.81)
ln Dollars	−1.18**	−.74**	−1.16**	−.84**
	(.18)	(.13)	(.18)	(.14)
Commitment			.21**	.40**
			(.07)	(.07)
N	189	306	189	306

[a]Standard errors are given in parentheses.
**Indicates coefficient significantly different from zero at .01 level.

the maximum likelihood method for willingness to sell in both the contingent and simulated markets. The constants and the coefficients for both markets are significantly different than zero at the .01 level. However, it is particularly noteworthy that the coefficient on ln Dollars is much larger in absolute value in the simulated market, indicating that changes in dollar amounts have a stronger effect there. Likelihood ratio tests indicated satisfactory fits in both cases and chi-squared tests indicated that the overall equations were significantly different at the .05 level.

The variable π_i is interpreted as the probability that a randomly selected hunter will agree to sell his permit as a function of the dollar amount offered. As the second step in the valuation process, these probabilities were used to estimate the expected value of a permit. This was $63 for the simulated market and $101 for the contingent market. These numbers reflect a stronger positive effect of increasing the dollar amount on the probability of selling in the simulated market. They also depend on the fact that the models were truncated at the upper limit of the data, $200.

Including additional independent variables in the model produced some additional results of interest. One was that the coefficient on income was consistently small and insignificant. Secondly, several attitude scales were included in an attempt to explain differences in behavior in simulated and contingent markets. An important instance is Model 2 in Table 1, where a variable reflecting commitment to goose hunting was added. "Commitment" aggregated responses to four related items on the questionnaire, using standard social psychological procedures for attitude measurement.

Its expected sign is positive for willingness to sell, indicating that the more committed a hunter is, the less likely he is to agree to sell at any given price. Commitment has the expected sign in both markets and its coefficient is significant at the .01 level in both. However, the coefficient is about twice as large in the contingent market, indicating that it has a much stronger downward influence on the probability of selling when hypothetical dollars are offered than when the dollars are real. This is a result that will prove important in our interpretation of the experiment presented below.

Turning to the willingness-to-pay side, legal constraints on transfer of hunting permits made infeasible a simulated market where hunters could actually buy hunting permits. As a not altogether satisfactory substitute, we propose to apply economic theory to the simulated market experiment results. Consumer theory indicates that maximum willingness-to-pay and minimum willingness-to-accept compensation for any given commodity will be equal except for the income effect.[12] However, the simulated market for goose hunting permits could show no significant effect of income on the decision of whether or not to sell. Thus, willingness-to-pay and willingness-to-sell should be approximately equal for the bulk of the hunters. In probabilistic terms this means that the probability that a randomly selected hunter would buy a permit at a given price is equal to unity minus the probability that he would sell at that price. This has interesting mathematical implications. Letting ψ_i = the probability that the ith hunter will buy at a given price,

$$\begin{aligned}\psi_i &= 1 - \pi_i \\ &= 1 - \frac{1}{1+e^{\beta Y_i}} \\ &= \frac{1}{1+e^{-\beta Y_i}} .\end{aligned}$$

That is, the coefficients for ψ_i are the same as those for π_i, except that the signs are reversed. In Table 2, the first column of numbers is designated as simulated market results, but it does not contain values from a separate simulated market test of willingness-to-pay. Rather, it includes the coefficients of Model 1, Table 1, with signs reversed.

The contingent market, on the other hand, provided direct evidence on willingness-to-pay in the form of responses to hypothetical take-it-or-leave-it offers. These were analyzed in the usual fashion, with coefficients reported in Table 2. Both the constant and the coefficient on ln Dollars are significant at the .01 level, and a likelihood ratio test indicated a

12. *See* Willig, *Consumer Surplus Without Apology,* 66 AM. ECON. REV. 589 (1976).

TABLE 2

REGRESSION ANALYSIS OF SIMULATED AND CONTINGENT MARKETS FOR WILLINGNESS-TO-PAY

	Model 3	
Explanatory Variables	Simulated	Contingent
Constant	−3.99**	1.97**
	(.66)	(.51)
ln Dollars	1.18**	1.22**
	(.18)	(.17)

**Indicates significance at the .01 level.

satisfactory fit. For future reference note the striking similarity of the coefficients on ln Dollars in the simulated and contingent markets. Formal confirmation was provided by a failure to reject, at the .05 level, the null hypothesis that these coefficients were equal. This result proved robust across various other specifications of the model and existed despite the fact that chi-squared tests of the null hypothesis that all coefficients were the same were consistently rejected.

After truncating the model at $200, the expected value of a permit was estimated to be $21. As in the case of WTS, we attempted several multivariate models, but with less success. Income again proved insignificant, and none of the attitudinal variables was significant at the .05 level.

Analysis of the open-ended measures, including WTS, WTP, the reasonable price and willingness-to-forego-a-day's-pay, was much more straightforward. The only major issue was how to treat refusals to answer and extremely high or low values. For purposes of this analysis, all refusals and zero responses were ignored. All responses in excess of $200 were set at $200 to facilitate comparisons with the results of the take-it-or-leave-it offers. Then, simple means were calculated. Open-ended willingness-to-pay was $11; open-ended willingness-to-sell was $68; willingness-to-forego-a-day's pay was $67; and the reasonable price was $11.

The travel-cost model involved the definition of eleven concentric zones of origin around the Horicon Zone.[13] Travel costs included the variable

13. It must be acknowledged that most practitioners of the travel-cost method now prefer to disaggregate to the individual level, rather than using the more traditional zonal approach. *See* Brown & Nawas, *Impact of Aggregation on the Estimation of Outdoor Recreation Demand Functions*, 55 AM. J. AG. ECON. 246 (1973). However, goose hunters were not free to choose the number of hunting visits they would make to the Horicon Zone. Once one goose was taken, the individual hunter could no longer hunt Canada geese there until the next year. This severely constrained the number of trips for each individual, and a model based on individual observations was not successful. Hence, a zonal model was applied.

costs of transportation (i.e., gas, oil, tires, and repairs) for various classes of vehicles as reported by the U.S. Department of Transportation[14] plus an imputed value of travel time at 50 percent of the hourly income rate, following procedures advocated by Cesario.[15] The proportion of vehicles in each size class was estimated from survey data. Average distances and travel times from the zones of origin were based on data provided by the Wisconsin Department of Transportation. Survey results indicated that nearly all the goose hunting trips involved day trips only, so that allowances for overnight costs were not required. We also learned that the most common substitute for goose hunting is duck hunting. Since duck hunting is widely available in Wisconsin, it was determined that substitute prices could be deleted from the model without great concerns about omitted variable bias.

After trying various functional forms, the following equation was chosen as fitting the data best:

$$V_j = \underset{(.45)}{-.67} + \underset{(9.2)}{84.9}\ (TC_j)^{-1}$$

where V_j = hunting visits per thousand population from the jth zone, found by expanding sample values to the population.

TC_j = the travel cost from the jth zone, including an imputed value for travel time.

These coefficients were estimated using weighted least squares to correct for the inherent heteroskedasticity of zonal models.[16] The numbers in parentheses are standard errors and indicate that the coefficient on travel costs is significant at the .01 level. Inclusion of attitudinal variables and income produced no additional results worth mentioning, with aggregation being an obvious potential problem.

Points on the estimated demand function were then calculated by multiplying each V_j by the zonal population. The area under the demand curve was slightly over $450,000 or $32 per permit.

Summary of Value Results

Table 3 summarizes the value estimates. It shows that CV estimates range from $11 to $101. While these results are "in the same ballpark," the differences are still striking. Furthermore, if the simulated market and travel-cost results are used as rough standards for comparison, it is clear

14. U.S. DEPT. OF TRANSP., COST OF OWNING AND OPERATING AN AUTOMOBILE (1976).

15. Cesario, *Value of Time in Recreation Benefit Studies*, 52 LAND ECON. 32 (1976).

16. *See* Bowes & Loomis, *A Note on the Use of Travel Cost Models with Unequal Zonal Populations*, 56 LAND ECON. 465 (1980).

TABLE 3

VALUES OF A PERMIT ARRANGED IN DESCENDING ORDER[a]

CV Take-It-Or-Leave-It-WTS	$101
CV Open-Ended WTS	$ 68
CV Willingness-To-Forego-A-Day's-Pay	$ 67
SM WTS	*$ 63*
TC WTP	$ 32
CV Take-It-Or-Leave-It WTS	$ 21
CV Open-Ended WTP	$ 11
CV Reasonable Price	$ 11

[a]Definitions:
CV = Contingent Market Value
SM = Simulated Market Value
TC = Travel-Cost Value
WTS = Willingness-to-Sell (accept compensation)
WTP = Willingness-to-Pay

that some of the CV results contain substantial errors. Simulated market and contingent market take-it-or-leave-it willingness-to-sell are the most comparable because of their parallel construction. Here CV appears to have overestimated the value of a permit by 60 percent. While CV Open-Ended WTS and Willingness-to-Forego-A-Day's-Pay come out much closer to the simulated market value, there are problems with interpretation which will be discussed in the next section. Whether the simulated market or travel cost estimate is used as the standard, the CV willingness-to-pay measures appear to underestimate substantially the value of a permit. Further examination of the results may help to identify the reasons for these differences.

HUMAN BEHAVIOR IN CONTINGENT MARKETS

The Central Role of Artificiality

In attempting to understand human behavior in CV studies, the artificiality of the social context is particularly interesting. Prior to being confronted by an interviewer or mail survey, subjects may never before have attempted to express how they feel about environmental assets in monetary terms. While constrained utility maximization is a useful construct, conversion of utility into monetary terms in the real world may involve repeated market transactions over time, consultation within peer groups, assessment of the markets for complements and substitutes, consultations within the household, and references to consumer information. It is questionable whether the interviewer or questionnaire designer can fully compensate for the lack of such experience and information in the

limited time and space available. Hence, subjects are forced to deal with a situation which seems quite artificial from their point of view in comparison to situations where they normally arrive at monetary values. While the researcher hopes they will follow the same mental processes they would use in real markets, the social context within which contingent valuation occurs may be so artificial that people will be unwilling or unable to do so.

That artificiality plays a dominant role is consistent with the anomalies noted in the introduction. When people are not clear in their own minds about how they would behave in a real market, a logical reaction is to refuse to answer CV questions, particularly in a mail survey where refusal does not entail an uncomfortable face-to-face confrontation with an interviewer. Other respondents may react by stating zero willingness to pay or by setting implausibly high (even infinite) requirements for compensation. Responses are likely to be sensitive to information which economic theory indicates ought to be irrelevant. Information provides a place to anchor responses. We also suspect that the large differences between CV willingness-to-pay and CV willingness-to-accept common in so many studies are rooted in the artificiality of contingent markets. To see how, let us return to the goose hunter experiment.

Relevant Results from the Goose Hunter Experiment and Other Studies

Since the simulated market involved actual money in exchange for actual goose hunting opportunities, it was less artificial than the contingent market. Thus, the resulting behavior ought to be closer to what would happen in a real market. Model 1 indicated that increasing the dollar amount increased the probability of selling in both markets. That coefficients were quite significant and consistent in sign with expectations is encouraging. It means that the responses in this type of contingent market were not composed of mere noise. But people responded more strongly to real than to hypothetical dollars, forcing CV Take-It-Or-Leave-It WTS ($101) to exceed substantially the comparable simulated market figure ($63). One has to wonder why.

Differences in the impact of commitment seem to point the way to at least a partial answer. While dollars had a weaker effect in the contingent market, commitment had a stronger effect. The stimulus of real dollars, which the subject can actually spend, is simply more powerful than the hypothetical dollars presented in a questionnaire. In the latter case, other variables such as commitment played a larger role in the decision. Additional analysis—not presented here to save space—showed that opposition to monetary valuation of wildlife and the importance of hunting as a social activity also influenced behavior in the contingent market, but

not in the simulated market. In plain words, "money talks" and real money "speaks louder" than hypothetical money.

Additional evidence along these lines can be drawn from informal observations during the experiment. People seemed to give the actual cash offers much more serious consideration. With the $5 incentive, the response to the CV survey was very swift. People were spending a couple of hours on the survey and then returning it promptly to meet the deadline. Because the response rate for the actual cash offers was much slower, we called about 15 of the subjects to determine why and found that most were holding back their responses to give the offer more thought.

One resulting hypothesis worth future investigation is that people respond as they do to contingent markets because of uncertainty. This may lead them to state answers which imply conservatively high requirements for compensation, amounts at which they are relatively certain they really would sell. They could even recognize the possibility that they might sell at lower amounts, but still give conservative answers in order to "play it safe." After all, they would not want to tell people from the government or the university that they would sell at a given price if they might not. The result would be an upward bias in CV willingness-to-sell. A real market (or even a simulated market) gives people stronger incentives to thoroughly explore their preferences and constraints.

Our argument here has much in common with what the literature has termed "hypothetical bias."[17] However, to the extent that they exist in reality, information bias, starting point bias, vehicle bias, instrument bias, and item non-response bias,[18] as well as hypothetical bias, are closely related. All stem from the artificiality of contingent markets. Also, we agree with Randall, Hoehn and Brookshire[19] that the term "bias" has sometimes been used too loosely in the earlier literature. Random error alone is not sufficient to establish a bias. Evidence from our experiment does seem to indicate that, *ceteris paribus,* CV mechanisms tend to overestimate willingness to sell, but they also show that other things may not be equal.

In particular, the open-ended WTS figure of $68 seems at first glance to contradict our argument. However, there may have been a countervailing bias here. About 4.6 percent of those returning the questionnaire left this item blank and 25.8 percent indicated zero. Those responses contrast sharply with the simulated market where none of the 31 indi-

17. This term dates back at least to Rowe, d'Arge & Brookshire, *supra* note 9 at 6. *See also* Thayer, *supra* note 3, at 32 and Schulze, d'Arge & Brookshire, *supra* note 3, at 148.

18. Item nonresponse bias is discussed in Mitchell & Carson, *supra* note 8, at Ch. 4 at 49. Other biases are defined in Schulze, d'Arge & Brookshire, *supra* note 3, at 155–59.

19. Randall, Hoehn, & Brookshire, *Contingent Valuation Survey for Evaluating Environmental Assets,* 23 NAT. RES. J. 635 (1983).

viduals offered $1 sold and only 10 percent of the 29 people offered $5 sold. It therefore seems unlikely that 26 percent of those in the CV sample would give their permits away free. An alternative interpretation would be that substantial numbers of these people meant to say that their permits were "not for sale." If our upper limit of $200 is substituted for all zeros (but not for the blanks) the mean increases to $99.

As another measure of willingness-to-accept-compensation, the Open-Ended-Willingness-To-Forego-A-Day's-Pay at $67 was also interesting. This must be interpreted with care, however, because it is a value per *day,* while the other values are per *permit.* On the average, permittees hunted two different days, but each "day" actually involved only about half a day of hunting, since hunting is best in the morning. Presumably some hunters who participate at the average rate would only miss one full eight hour day of work, but this would be infeasible for those who have to travel longer distances. Interpretation of the result is further clouded by not knowing whether those who hunt on more than one day regard this as a benefit of holding the permit or as a cost of having poor luck on earlier trips. Item non-response problems and zero answers may have caused difficulty here as well. Slightly less than 6 percent refused to answer the question, 13 percent put zero, and 7 percent indicated that they would not take off work regardless of the wage rate. It is also worth noting that despite the similarities in mean values between this measure and the CV Open-Ended WTS, the correlation between the two measures was 0.17, indicating that respondents do not consider them to be identical questions. Still, questions of this type deserve additional research.

Turning to the willingness-to-pay side, it must be reemphasized that simulated market WTP was impossible to obtain as part of our experiment. Still, there are two benchmarks for comparison to CV results. The first is $63, based on the theoretical argument made previously for equality between willingness-to-pay and williness-to-accept. The second is the travel cost value of $32. By both standards, all three contingent WTP measures (which range between $11 and $21) appear to be low. Furthermore, the logit analysis of the take-it-or-leave-it responses may have been somewhat misleading in indicating $21. The raw data show a rapid decline in positive responses as the proposed price of permits increases: 88 percent at $1, 64 percent at $5, 30 percent at $10, 19 percent at $20, and only an occasional acceptance at prices greater than $20. Had the occasional outlier at higher amounts been deleted, CV Take-It-Or-Leave-It WTP would have been substantially less than $21. Comparisons with the simulated market value and the travel-cost estimate would lead one to conclude that our CV mechanisms underestimated true willingness to pay by a substantial amount.

Some other studies can be cited for further support. Knetsch and Davis[20] arrived at roughly comparable amounts from a CVWTP measure and a travel-cost model. However, had their travel-cost model contained any substantial allowance for the value of travel time—as most investigators now agree is essential—their travel-cost estimate would probably have been much higher. Sellar, Stoll and Chavas[21] also compared travel-cost and CV estimates. They found travel-cost estimates were roughly of the same magnitude as CV estimates using a logit framework comparable to ours, while an open-ended willingness-to-pay format produced much lower results. Again there was no allowance for the value of travel time. A study by Brookshire[22] compared CV willingness-to-pay for air quality improvements in the Los Angeles Basin with property value differentials. Theory would lead one to expect actual willingness-to-pay to be less than property value differences since people willing to pay more could move. The comparisons were consistent with this expectation, with CV estimates substantially lower. This finding is consistent with our hypothesis that CVWTP values are biased downward, although not constituting positive evidence per se.

Our experiment does not clearly indicate what forces lead to this apparent bias. We did try including commitment and a host of other attitudinal and socioeconomic variables in the logit equation but nothing seemed to help predict the probability of buying. The result that the coefficients on ln Dollars in both equations are not significantly different suggests that changing the dollar amount had similar effects in both types of markets.[23] The bias appears to be "across the board." We suspect that people used the contingent market as a forum for telling us that they do not wish to pay very much for anything they were currently getting free. Uncertainty may also have played a role. The conservatism that we previously hypothesized would cause people to overstate willingness-to-sell might also cause people to understate willingness-to-pay.

That the CV Reasonable Price and CV Open-Ended WTP produced identical means of $11 may be significant. One might suppose that most people's "reasonable price" would be less than their maximum willingness-to-pay, but this difference did not show up on our CV survey. Perhaps people answer Open-Ended WTP questions with amounts they would not mind paying, rather than their maximums. However, even this seemingly

20. *Supra* note 2.
21. *Supra* note 2.
22. *Supra* note 4.
23. This does not mean that the logit functions are parallel, however. Differentiation of the logit equation quickly shows that its slope is a function of both the constant and the coefficient on ln Dollars.

obvious interpretation is clouded by the fact that the responses of the subjects to the two measures are correlated only at 0.2 (significant at .01 level). Surely, if people were simply giving us their reasonable price instead of maximum WTP, the correlation would be higher. Also, item nonresponse and zero-response problems may have affected the results. For Open-Ended WTP, 31 percent answered zero or put down no answer. For the Reasonable Price, the figure was 18 percent.

CONCLUSIONS

First let us reemphasize that our contingent valuation mechanisms seemed to produce meaningful—albeit inaccurate—economic information. In the take-it-or-leave-it cases the price variable was the only one that was always significant in predicting both CVWTS and CVWTP. The direction of the relationship between ln Dollars and the probability of acceptance always had the expected sign and were always significantly different than zero at the .01 level. In a world where public policy would otherwise be made in total ignorance of the economic values of environmental assets, such contingent values may be useful.

Still, our results by no means justify complacency about the accuracy of CV techniques. Hunters valued the permits between $11 and $101 depending on the mechanism. That is no small difference. We fear that too many previous studies have used only one or two techniques and justified the results by suggesting that they were "reasonable." Had we done so for goose hunting permits, $11 would have seemed "reasonable," yet comparisons with our simulated market and travel-cost estimates indicate that the true value could be larger by a factor of three to six! Notice that this occurs even though goose permits are already a well-defined commodity in consumers' minds and can be associated with monetary values through hunting stamp and license fees and charges for access to private land. In cases involving more vaguely defined changes in environmental quality, the added degree of artificiality could well lead to larger inaccuracies.

Perhaps other CV techniques would have been more accurate than those we used. Our work required techniques amenable to mail surveys. Some would argue that personal interviews yield more accurate results because of greater flexibility in the amount and nature of the information that can be provided to subjects and because of opportunities for iterative bidding. Interviews may indeed provide opportunities to help subjects more fully explore preferences and constraints in order to predict more accurately how they would behave in real markets. Our concern is that such interview procedures would be superimposed on inherently artificial contingent markets. Doing so may cause subjects to base answers even

more on the information received and other aspects of the interview situation and less on the relevant economic parameters. Only further empirical work can determine which basic approach is correct.

Thus, we conclude with a plea for further research. All papers such as this are prone to engage in such pleas, but our case is a special one. Contingent valuation has to involve some of the most difficult measurement problems ever faced by economics. At the same time, the stakes are high. Nonmarket environmental assets are under ever increasing economic pressure, and things with unknown economic values tend to be assigned zero or very low economic values in public decision processes. If this void is to be filled with credible economic information, much more needs to be known about when CV techniques will work well and when they will not; the extent to which CV willingness-to-pay measures in general have a tendency toward downward bias and CV willingness-to-accept measures, an upward bias; whether such biases—to the extent that they exist—stem from respondent uncertainty or other forces; which CV techniques work best and why; and a host of related questions. Dealing with these issues will require research of high quality that looks beyond the normal boundaries of economics to its sister social sciences. More research has great potential to help minimize errors in CV results and to properly interpret them in environmental decision making.