NATURAL RESOURCES JOURNAL

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

Summer 1983

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Recommended Citation
H. S. Burness, R. G. Cummings, A. F. Mehr & M. S. Walbert, *Valuing Policies Which Reduce Environmental Risk*, 23 Nat. Resources J. 675 (1983).
Available at: https://digitalrepository.unm.edu/nrj/vol23/iss3/13

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Valuing Policies Which Reduce Environmental Risk

INTRODUCTION

Benefit-cost analysis has become an important part of the Reagan Administration's method for evaluating environmental regulations.[1] The use of such an analysis in evaluating many environmental regulations is limited, however, because of the public goods qualities of the effects of these regulations. For example, cleaner air resulting from air quality standards, or improved public health and safety due to the regulation of toxic waste disposal, do not have the market counterparts capable of producing market established values (prices). Benefit-cost analyses for many proposed environmental regulations are, therefore, impossible since the value of the beneficial effects of the regulation cannot be determined.

The conundrum has resulted in considerable research being focused on ways of valuing public goods. One method of particular interest involves the use of survey techniques and is known as the bidding game or contingent valuation (CV) method. The CV method involves a survey in which a hypothetical market is described to an interviewee wherein a "commodity," such as cleaner air or a safer environment, is to be exchanged. The interviewee is then asked for his/her maximum willingness to pay for this "commodity."

As one might expect, considerable controversy surrounds the reliablity and interpretation of values derived from the CV method.[2] Two points of controversy are of particular importance. The first is whether an environmental effect can be adequately described as a "commodity" to be exchanged in the CV market. The second is whether the hypothetical character of the CV market precludes the derivation of values which reliably reflect the interviewee's preferences between income (other goods) and the environmental "commodity" in question.

This paper deals with the two points given above. These questions are addressed within the context of the authors' efforts to value benefits that might result from Environmental Protection Agency regulations on the disposal of (non-nuclear) toxic wastes. Hypotheses to be tested are de-

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1. Exec. Order No. 12,291, 46 Fed. Reg. 13, 193 (1981).

2. *See* the papers by Bishop and Randall in this issue of the NAT. RES. J.

veloped below, empirical results are discussed, and conclusions are suggested.

THE POLICY BID EXPERIMENT

Some environmental regulations may result in effects which are well defined and which can be precisely described. An example is a regulation having the effect of prohibiting the construction of power plants in the Grand Canyon area, with the resulting preservation of unimpaired visibility in that area.[3] Considerable uncertainty surrounds the effects of many other environmental regulations, however. For example, consider a regulation requiring toxic wastes to be fully contained (they cannot enter the environment) for some given number of years, wherever they are disposed of in the land. Unfortunately, the effects of such a regulation in terms of reducing health/safety risks cannot be quantified due to the uncertainty of factors such as which wastes are, in fact, toxic; adequate methods for their disposal; and the long term implications of a total containment policy.[4] Thus, while the cost for such a regulation might be defined (aside from enforcement costs, the cost of constructing and monitoring waste disposal sites), "benefit" effects cannot be defined and, therefore, valued. Put another way, the "commodity" traditionally used in the CV method—reduced environmental risk in this example—cannot be defined.

For cases where benefits cannot be defined,[5] a method for defining a meaningful commodity to be valued in a CV study is suggested by the recent works of Dr. Talbot Page. In considering the risks in the management of toxic substances, a regulator must consider two potential errors associated with any environmental policy. Page argues as follows:

> The first is the risk of taking precautionary action for a chemical which is safe (a regulatory false positive). The second is the risk of not controlling a chemical which is unsafe, and which would be controlled with better information (a regulatory false negative). In the majority of cases . . . , decisions are made under pervasive uncertainty. A decision to postpone precautionary action until there is better data is just as much a decision under uncertainty as a decision to take precautionary action in the meantime. In fact, the crucial decision is what to do "in the meantime" while uncertainties are far

3. D. S. Brookshire, R. G. Cummings, M. Rahmadan, W. D. Schulze & M. A. Thayer, Experimental Approaches for Valuing Environmental Commodities, draft, final report to the EPA, Report on Grant # CR808-893-01, Wash., D.C., April, 1982.

4. *See* A. METRY, THE HANDBOOK OF HAZARDOUS WASTE MANAGEMENT (1980); also, D. DONIGER, THE LAW AND POLICY OF TOXIC SUBSTANCES CONTROL (1978).

5. This problem is discussed in the case of nuclear waste disposal in R. G. Cummings, H. S. Burness & R. D. Norton, The Proposed Waste Isolation Pilot Project and Impacts in the State of New Mexico, New Mexico Energy and Minerals Dept., Report EMD 2-67-1139, Santa Fe, April, 1981.

> from resolution. The central fact about decisionmaking under uncertainty is the risk of (a false positive) "trades off" against the risk of (a false negative). . . . The essence of the balancing process is a willingess to accept some (false positives) as the unavoidable means of controlling false negatives.[6]

Based on Page's arguments given above, one sees the substance of a well-defined commodity attributable to the proposed regulation which might be used in the CV method. This "commodity" is the regulation itself and the uncertainty surrounding it. This is to say that the effect (commodity) of the regulation which is of interest in the CV method is a hedge against future uncertain threats to health and safety. The CV commodity is then described as just that: a regulation, the need for and effects from which are uncertain, which simply hedges the health "bet."[7] For the CV study described below, the EPA regulation (or policy) with its associated uncertainties, is used as the commodity for which values (or "bids") are elicited. The study is, therefore, described as a Policy Bid experiment.

Turning now to the potential for hypothetical biases in CV bids or values for our policy/commodity, our concern is with the extent to which participants in the CV survey are in fact "willing to pay" their offered bid. In offering a bid, are they cognizant of what they must give up, in terms of savings or other purchases, in order to *actually* pay their offered bid? Have they considered other public goods (other regulations, for example) that they might wish to "buy," purchases which might be precluded by their actual payment of the bid offered for the toxic waste disposal policy/commodity? Affirmative responses to these questions have been assumed in most earlier studies.[8] In this study, we wish to examine the extent to which these assumptions may be viable.

The following techniques were used in an effort to induce interviewees to consider values offered for our policy/commodity in greater depth. All survey participants received an explanation of the general nature of the toxic waste disposal issue, as well as a detailed explanation of our policy/commodity.[9] Three successive values were then elicited from all interviewees:

PC: The "payment card" value: individuals were asked to choose

6. P. Talbot, A Framework for Unreasonable Risk in the Toxic Substance Control Act, California Institute of Technology, Social Science Working Paper 308, Pasadena, CA, 1981, 68.

7. *See* Brookshire, *supra* note 3, chap. 6.

8. *Id.*

9. Space limitations prevent extensive discussion and description of the questionnaire; this information is available from the authors.

their maximum willingness to pay[10] for our commodity from an array of values given on a payment card.

MB: a "maximum bid": after choosing their PC, individuals were asked to suppose that payments of (their) PC were insufficient to implement the policy—Would they pay $1.00 more? Would they pay $2.00 more? This bidding process continued until they would pay no more.

OG: an "other good" bid: after providing the MB value, interviewees were shown a list of "other goods" of a public nature (regulations, policies concerning the environment), and were told that "acquiring" any of these goods might necessitate payment on their part. The individual was then asked if he/she was still willing to pay the MB amount for our toxic waste policy/commodity.

The three values described above were obtained from all survey participants. The interview was limited to the above questions for roughly half of those surveyed (Group A). For the other half of the survey population (Group B), explicit budget information was acquired prior to the allocation of this income to the following expenditure categories: housing/utilities, food, recreation/entertainment, savings, and other. The PC (then MB and OG) value was then elicited, along with the request that the individual indicate the expenditure category which will (necessarily) be reduced upon payment of the offered value.

These techniques were used to induce individuals to consider trade-offs implied by offering to pay some amount for implementing our toxic waste disposal policy ("buying" the CV commodity). They were asked to focus on their *maximum* willingness to pay, moving from PC to MB. In offering OG, they were asked to consider their bids within the context of other potentially purchasable public goods. Half of the interviewees were asked to consider their offered bids within the explicit context of their actual monthly expenditures and those necessarily reduced in order to pay their offered bids.

Let subscripts A and B on the mean value of PC denote bids/values obtained from individuals in groups A and B. We will be concerned with the following null hypotheses.

	HYPOTHESES	QUESTION ASKED
(H.1)	PC = MB	1. Is the initial payment card bid a maximum willingness to pay?
(H.2)	MB = OG	2. Does introducing other public goods affect the bid?

10. The payment vehicle used here is "higher taxes and/or higher prices for the goods and services that you buy."

(H.3) $PC_A = PC_B$ 3. Does explicit use of the budget constraint affect the PC value?

The CV Questionnaire sketched above was administered to 74 individuals in Albuquerque, New Mexico, and 84 individuals in Houston, Texas, over the period of January 1 through November 20, 1982. At-home interviews were arranged by phone. In Albuquerque, telephone numbers were obtained from a random numbers generator using data from the telephone directory. In Houston, telephone numbers were drawn from telephone exchanges in areas defined by the Research Triangle Institute. Results from these surveys provide the data required for testing the hypotheses given above.

SURVEY RESULTS

Hypotheses H.1–H.3 are to be tested using regression techniques. For hypothesis H.3, for example, the regression equation takes the form $PC = \alpha_0 + \alpha_1 D + \alpha Y + U$ where the dependent variable PC is represented by an $(n+m) \times 1$ vector containing the n starting bids for group A and the m starting bids for group B, D is a dummy variable represented by an $(n+m) \times 1$ vector of n zeros and m ones denoting whether the observation was drawn from group A or group B, Y is the respondent's income, U is random disturbance, and the α_i are parameters. The parameter α_1 is interpreted as the income adjusted "group effect" on PC. That is, if the least squares estimate, α_1, for α_1 is *not* statistically different from zero, then one accepts the hypothesis $PC_A = PC_B$. If α_1 *is* significantly different from zero, D significantly affects the average bid and one *rejects* the hypothesis $PC_A = PC_B$.

Thus, for each hypothesis which compares one WTP (W_i; $i = 1, 2$) value with another, the hypothesis that is statistically tested is H_o: $\alpha_1 = 0$. If t* is the t-statistic for α_1, t_c is the critical value for t, then, for each hypothesis:

$$t^* \geq t_c \longrightarrow \text{reject } H_o \longrightarrow \text{reject } W_1 = W_2,$$

$$t^* < t_c \longrightarrow \text{accept } H_o \longrightarrow \text{accept } W_1 = W_2.$$

A summary of survey results in given in Table 1. Data to be used for testing hypotheses H.1–H.3 are given in Table 2.

As stated above, our primary concern is with the extent to which individuals, when valuing a commodity in a CV study, will go beyond the hypothetical nature of the CV "market" and consider the trade-offs involved in actually paying their offered valuation. That is, do individuals think about their preferences for the CV commodity in terms of income, or other goods and services, which must be given up if they are in fact to pay their offered value?

TABLE 1

SUMMARY OF SURVEY RESULTS

Survey Area/Group	Sample Size	Average Income (000)	Mean Values For PC	MB	OG
Albuquerque	74	$27.4	$13.90	$21.32	$14.20
Houston	84	$44.9	$17.06	$29.62	$17.15

Our experiment proceeded as follows. The payment card value was elicited. In introducing the bidding process (obtaining MB), we asked: are you sure of this (PC) offer? The hypothesis H.1 tested the response for the difference between PC and MB. After obtaining MB, the interviewee was asked to consider his/her bid (MB) within the context of other goods that he/she might wish to "purchase." To obtain the value of OG, we again asked the question: are you sure of this (now, MB) offer? The hypothesis H.2 tested the response for the difference between MB and OG values. In addition to eliciting two sets of responses (in Albuquerque and in Houston) to these "are you sure" questions, we inquired into the effect on CV response of focusing the interviewee's attention on what must be given up, in terms of his/her present consumption/expenditure patterns, in order to "pay" the offered value for our policy/commodity. Hypothesis 3 tests for any difference in offered values between those with (Group B) and without (Group A) this explicit budget information.

Results relevant for our "are you sure" questions are summarized in Table 3. In the Albuquerque survey, respondents in Group A were unsure of their value. Further, they were not "sure" (they changed this bid) when

TABLE 2

DATA FOR TESTING HYPOTHESES

Hypotheses	Value of α_1 (t-statistic) in: Albuquerque	Houston
H.1 PC = MB	7.43 (2.058)	12.70 (2.790)
H.2 MB = OG	−7.13 (−1.779)	12.92 (−2.718)
H.3 $PC_A = PC_B$	.60 (.146)	6.47 (1.607)

TABLE 3

OVERVIEW OF THE VALUATION PROCESS IMPLIED*

STEPS IN THE VALUATION PROCESS	RESPONSES TO QUESTIONS: Albuquerque	Houston
1. Obtain Payment Card Value		
"Are You Sure of Your Bid?" (Hypothesis H.1)	NO	NO
2. Obtain Maximum Bid		
"Are You Sure of Your Bid?" (Hypothesis H.2)	NO	NO
3. Introduce Other Goods		
"Does Explicit Consideration of Income/Expenditures Affect Individual Valuations?" (Hypothesis H.3)	NO	NO

*Response implied from analysis of t-statistics for the α_i coefficients given in Table 2.

asked to consider other goods. One may interpret this result as suggesting some difficulty on the part of respondents with the hypothetical nature of the CV market: when asked to focus more sharply on trade-offs implied by their offered payment, respondents changed their bid. The potential for using the budget information technique for breaking the "hypothetical barrier" in CV analysis failed in the Houston experiment and in Albuquerque. The budget technique (step 4 in Table 3) did not seem to affect the offered value.

Thus, except in cases where budget information was used, individual valuations changed with each effort to induce the individual to consider the implications of their offered value: the bidding process changed (increased) the offered value; consideration of other goods changes (decreased) the offered value (Table 2). This instability in valuations as the respondent received additional information makes suspect the notion that individuals viewed their offered values outside of the hypothetical context of the CV "market."

CONCLUDING REMARKS

The above empirical results and their interpretations must necessarily be viewed as tentative at this stage of the authors' research. The reader should note that interpretations were intentionally exaggerated in an effort

to focus attention on key conceptual issues of relevance in attempts to analyze potential biases (particularly hypothetical bias) in public goods valuation drawn from the CV method. For example, the instability of valuations obtained in the Houston survey may reflect considerations unrelated to hypothetical bias per se. Two of the possible biases are preference characteristics thus far unidentified in our analysis and an interviewee's lack of understanding of the policy/commodity offered in the CV process.

With these caveats in mind, one may consider implications of results in Tables 1–3 for estimates of individual maximum willingness to pay for the implementation of government policy designed to hedge against environmental risk. For households with annual incomes of $40,000 and $25,000, bids in Albuquerque were $10.39 per month and $9.79 per month, respectively; corresponding bids in Houston (for the same income level) were $28.30 and $20.35 per month, respectively.[11] Even at the lower range of $10.00 per month, however, substantial social benefits might be attributed to policies designed to reduce environmental risk, notwithstanding uncertainties surrounding such risks. With about 70 million households in the United States, annual benefits could be approximately $8.4 billion.

The potential for significant hypothetical bias, as well as other biases, in public goods valuations from survey methods remains an important issue. Results reported here support, as well as contradict, conclusions from earlier work which focus on such biases.[12] Continued interest and research in this area are clearly warranted, given, first, the importance of the public goods issue and, second, the lack of apparent alternatives to some form of the survey method in deriving valuations for large classes of public (environmental) goods.

11. From Table 2, income was a significant determinant of the bid in Houston, but not in Albuquerque.

12. Brookshire, *supra* note 3, chap. 6.