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Using contingent valuation to measure the compensation required to gain community acceptance of a LULU: the case of a hazardous waste disposal facility

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ABSTRACT

The contingent valuation (CV) method was used to measure the compensation required for the siting of a hazardous waste disposal facility. Previous studies using the CV method were examined to determine the importance of subjective risk assessment. A CV survey was conducted to measure willingness to accept (WTA) for siting a hazardous waste disposal facility. Results suggested that CV can be used to estimate a reasonable measure of WTA and has great potential for assessing the compensation required to site a hazardous waste disposal facility.

INTRODUCTION

Recent studies call for an integrated approach for the siting of locally undesirable land uses (LULUs) (Inhaber 1992; Swallow, Oplauch, and Weaver 1992). In most studies, compensation plays a key role for the acceptance of a hazardous waste facility in the neighborhood affected by the facility. Inhaber (1992) states that the siting of a facility must be treated like a geometric proof by meeting both necessary and sufficient conditions. The necessary condition is providing information to the public on the hazards of the facility. The sufficient condition is providing economic incentives in the form of compensation to the individuals in the affected area. If both conditions are met, then the facility can be sited.

Swallow, Opaluch, and Weaver (1992) suggest a three-stage approach, from identification of potential sites through acceptance by the host community. In their final stage, host community acceptance, they suggest that the compensation required to site a facility be identified using the contingent valuation (CV) method.

Little research has been done using the CV method for valuing LULU disamenities. To our knowledge, only three major studies have been conducted. Smith and Desvousges (1986a) conducted a CV survey in the Boston area to estimate household demand for distance from a hazardous waste landfill. Roberts, Douglas, and Park (1991) also use a CV analysis to measure the willingness to pay (WTP) to avoid the siting of a municipal waste disposal landfill. duVair and Loomis (1995) use a CV study to measure benefits from alternative risk reductions. Unlike our study, however, all three use a WTP rather than a willingness to accept (WTA) framework.

In our study, we measure WTA to assess the performance of the CV method for estimating the sufficient compensation needed to site a hazardous waste facility. Using a countywide referendum framework, we measure WTA using a dichotomous-choice CV question. We analyze the dichotomous choice using logit analysis with both demographic measures and a subjective risk measure as explanatory variables. Our study shows that the amount of the compensation, subjective risk, and demographic variables all play a role in the acceptance of a siting decision.

THEORY AND METHOD

Compensation plays a key role in the acceptance of hazardous waste disposal facilities. The appropriate way to measure its social costs and the necessary compensation have been debated extensively (Mitchell and Carson 1989), and much of the debate has focused on whether WTP or WTA is the preferred measure. The argument against WTA is that in many studies, it tended to generate high rates of protest responses and what were perceived to be unreasonably high values relative to WTP (Hammack and Brown 1974; Bishop and Heberlein 1979; Brookshire, Coursey, and Schulze 1986). Nevertheless, there are important theoretical bases for the observed divergence between WTP and WTA (Hanemann 1991), and fundamental property right issues must be considered in selecting the appropriate measure. Mitchell and Carson (1986) and Freeman (1993, 181) argue that the most appropriate measure of the siting decision is WTA because ownership of the property rights is usually thought of in terms of the existing neighborhood. This suggests that presenting the circumstances of choice as a referendum, where

the voters decide whether to accept a facility, should limit scenario rejection by respondents. For this reason, we apply the WTA format.

As in previous analyses of hazardous waste policy and noxious siting decisions (Kunreuther and Easterling 1990; Smith and Desvousges 1986a; duVair and Loomis 1995), we model the individual decisions in an expected utility framework, where the uncertainty of an adverse outcome arises from exposure to the facility. The adverse outcome in this case is treated as the perception of one's reduction in health status. Therefore, we apply the WTA framework using a health state approach (Cook and Graham 1977; Viscusi and Evans 1990; Johannesson et al. 1993), which is described in more detail below in the formal model. Following Viscusi (1989), we treat the probability of adverse health outcomes in the expected utility model as a subjective measure of risk, which we calculate using information obtained from each respondent.

MODEL

Suppose that households gain utility from health and income. Solution of the utility maximization problem yields the state-dependent indirect utility function with price terms suppressed

$$U = v(H, y), \quad (1)$$

where U is the reference utility level, H is exogenous health status, and y is income. If indirect utility is additively separable in health and income,(1) let the utility associated with good health be

$$v(H = 1, y) = h(1) + m(y). \quad (2)$$

With poor health, the utility level is

$$v(H = 0, y) = h(0) + m(y). \quad (3)$$

Suppose that without a hazardous waste landfill, households face a perceived probability of good health of [q.sub.1], [q.sub.2] = 1 - [q.sub.1]. With a hazardous waste landfill, the perceived probability of good health is [p.sub.1], [p.sub.2] = 1 - [p.sub.1], [q.sub.1] [greater than] [p.sub.1]. Expected indirect utility without the hazardous waste landfill is

$$E([v.sub.q]) = m(y) + (1 - [q.sub.1])\, h(0) + [q.sub.1]h(1). \quad (4)$$

Expected indirect utility with the hazardous waste landfill is

$$E([v.sub.p]) = m(y) + (1 - [p.sub.1])\, h(0) + [p.sub.1]h(1). \quad (5)$$

The value of avoiding the hazardous waste landfill under uncertainty about health status is the minimum WTA under uncertainty:

$$m(y) + [q.sub.1][h(1) - h(0)] = m(y + WTA) + [p.sub.1][h(1) - h(0)], \quad (6)$$

assuming that accepting the WTA amount allows the landfill to be sited.

A referendum on siting the hazardous waste landfill presents to households the question, "Would you accept $A for [q.sub.1] to [p.sub.1]?" This creates the problem

m(y) + [q.sub.1][h(1) - h(0)] ([less than]) = ([greater than]) m(y + A) + [p.sub.1][h(1) - h(0)]. (7)

If A [greater than] (or [less than]) WTA, then the respondent will vote yes (or no) in the referendum from equation (7). Following subtraction and simplification,

Dv = m(y + A) - m(y) + ([p.sub.1] - [q.sub.1])[h(1) - h(0)], (8)

where Dv is the change in the expected indirect utility function. The interpretation of this function is in two parts. The first, m(y + A) - m(y), is the increase in utility from the compensation offered to the neighborhood. The second, ([p.sub.1] - [q.sub.1])[h(1) - h(0)], is the decrease in utility from the expected change in health status. The change in the expected indirect utility function has several important properties with the assumption of additive separability. With respect to income,

[Delta]Dv/[Delta]y = [Delta]m(y + A)/[Delta]y - [Delta]m(y)/[Delta]y [less than] 0, (9)

if the marginal utility of income is diminishing with additional income. As the subjective probability of health risk changes,

[Delta]Dv/[Delta]([p.sub.1] - [q.sub.1]) = h(1) - h(0) [greater than] 0, (10)

because the probability of poor health is greater after the hazardous waste facility is sited. As the level of compensation changes,

[Delta]Dv/[Delta]A = [Delta]m(y + A)/[Delta]A [greater than] 0, (11)

because the marginal utility of income is positive.

To derive explicit functional forms for estimation, we follow two approaches. The first is the approach used by Hanemann (1984), who suggests specifying explicit functional forms for the indirect utility function and then deriving functional forms for Dv.

Assuming a linear functional form for the expected indirect utility function yields the following utility possibilities:

v(H = 0, y + A) = [a.sub.0] + B(y + A), (12)

v(H = 0, y) = [a.sub.1] + By, (13)

v(H = 1, y + A) = [a.sub.1] + B(y + A), (14)

v(H = 1, y) = [a.sub.1] + By. (15)

Substituting the explicit functional forms of Dv for the implicit form in (8) yields Model 1:

[Dv.sub.1] = a([p.sub.1] - [q.sub.1]) + BA, (16)

where a = [a.sub.1] - [a.sub.0] [greater than] 0 and B [greater than] 0. The median WTA estimate is found by solving for indifference between a yes or no vote: Dv = 0,

WTA = -[a([p.sub.1] - [q.sub.1])/B], (17)

which is positive because ([p.sub.1] - [q.sub.1]) [less than] 0.

Assuming a linear functional form for Dv yields Model 2:

[Dv.sub.2] = [[Beta].sub.0] + [[Beta].sub.1]A + [[Beta].sub.2]([p.sub.1] - [q.sub.1]) + [[Beta].sub.3]y, (18)

where [[Beta].sub.1] [greater than] 0, [[Beta].sub.2] [greater than] 0, [[Beta].sub.3] [less than] 0. The median WTA estimate is found by solving for Dv = 0:

WTA = -[[[Beta].sub.0] + [[Beta].sub.2]([p.sub.1] - [q.sub.1]) + [[Beta].sub.3]y]/[[Beta].sub.1]. (19)

The third approach is to specify a linear approximation for Dv with respect to the arguments in (9), (10), and (11) along with other demographic variables. In this case, the resulting function does not correspond to any explicit indirect utility function but does allow a richer interpretation of reasons for response to the referendum election. Assuming a linear functional form with demographic variables included yields Model 3:

[Dv.sub.3] = [c.sub.0] + [c.sub.1]A + [c.sub.2]([p.sub.1] - [q.sub.1]) + [c.sub.3]y + [c.sub.4][x.sub.1] + [c.sub.5][x.sub.2] + [c.sub.6][x.sub.1], (20)

where [x.sub.1] is the age of the respondent, [x.sub.2] is the number of children in the respondent's household, and [x.sub.3] is the education level of the respondent. Solving for Dv = 0 yields the median WTA:

WTA = [[c.sub.0] + [c.sub.2]([p.sub.1] - [q.sub.1]) + [c.sub.3]y + [c.sub.4][x.sub.1] + [c.sub.5][x.sub.2] + [c.sub.6][x.sub.1]]/[c.sub.1]. (21)

THE DATA

To empirically test the predictions of the above models, a WTA scenario was presented to residents of Lawrence County, Pennsylvania, in the spring of 1992 using a mail survey. Lawrence County (population 79,000), a rural area in western Pennsylvania, is located 40 miles north of Pittsburgh and has New Castle (population 28,000) as its largest city. By virtue of its

rural nature and proximity to major industrial centers, it has been targeted several times as a potential site for a hazardous waste disposal facility.

TABLE 1: Means of Demographic Variables (standard deviations in parentheses)

Variable	Sample Mean	Population Mean(a)
Yes	0.494 (.499)	-
A	$1,003.1 (660.1)	-
([p.sub.1] - [q.sub.1])	-.71 (.292)	-
Income ($)	30,512 (16,010)	27,534
Age	52.83 (16.00)	48.34
Child	0.56 (0.93)	0.63
Education	13.6 (2.39)	12.8

a. Population means calculated from the 1990 census data for Lawrence County, Pennsylvania. Income is median household income.

The survey consisted of an initial mailing, a postcard reminder, and a second mailing to nonrespondents. The final response rate was 43%. This response is less than the National Oceanic and Atmospheric Administration panel (NOAA) recommended rate but is within the 40% to 60% range found by Loomis (1987) for CV surveys. In addition, the county demographic means are not significantly different than the sample means (see Table 1).(2)

Implementation of CV requires a description of the change in the amenity, a payment rule, a policy implementation rule, and a behavioral intention question (Mitchell and Carson 1989). In our study, we provided information about the type of hazardous waste a landfill would accept, the amount of monitoring the state would provide, maximum distance from the landfill, and a baseline level of risk (see Appendixes A and B). The WTA question used was a dichotomous-choice referendum question. The dichotomous-choice framework was chosen because of the greater potential for strategic behavior associated with open-ended WTA measures. Mitchell and Carson state that respondents faced with an open-ended WTA question will respond with an "I want the most you will pay" type of response. This biases WTA measures upward. The WTA question was framed using a hypothetical election. Respondents were then given three alternatives: yes, no, and don't know. We follow the NOAA panel (Arrow et al. 1993) recommendation that don't know responses need to be included in CV analysis. The don't know responses are treated as yes responses to provide a conservative estimate of WTA following the recommendation of Mitchell and Carson.(3)

In the survey, $A randomly ranged from $100 to $2,000. These amounts were chosen from a preliminary pretest using an open-ended WTA question.(4) Follow-up questions on the survey were used to identify protest responses. Respondents' subjective risk perceptions were also obtained. In the context of health problems, a perceived risk question was stated as, "How likely do you feel a 'problem' would arise at some future time (20 to 30 years) from a hazardous waste landfill?" The Likert scale ranged from 1 = not at all likely, to 5 = very likely. This question, by construction, attempts to measure a general perception of potential risk from the facility. To convert the Likert scale into probabilities of health changes, we coded the scale in .25 increments, where [p.sub.1] = 1 for not at all likely, to [p.sub.1] = 0 for very likely; [q.sub.1] is always assumed to be 1. Thus, ([p.sub.1] - [q.sub.1]) ranges from 0 to -1.(5)

It is important to note that this measure of subjective risk may not capture respondents' perceived ability to control private risks through averting behavior. Although individuals may not have the same degree of control over hazardous waste risks as other risks in their lives, they can take a number of protective measures. For example, Smith and Desvousges (1986b) found that people (particularly if they were younger and had access to more information about hazardous waste) did undertake averting actions such as purchasing bottled water and installing water filters to avoid hazardous waste risks. Presumably, individuals will undertake averting behavior if it is perceived to be less costly than the losses associated with bearing the risk; therefore, individuals who can avoid harmful exposures earlier and/or at a lower cost should have a lower WTA and be more likely to accept a given amount of compensation. As Bartik (1988) and Courant and Porter (1981) have shown, the costs of averting behaviors are likely to be only a component of total damages associated with environmental risks; nevertheless, they can serve to reduce the magnitude of total damages.

EMPIRICAL RESULTS

We use the logit technique to identify determinants of the yes/no votes. We code the yes votes as 1, and the no votes as 0, so that the probability of a yes response to the referendum on siting the hazardous waste landfill is positively related to the change in indirect utility. We report the means of both the independent and dependent variables in Table 1.

The determinants of the probability of a yes response are found by estimating the models in equations (16), (18), and (20). To estimate the logit specifications, we use the LIMDEP software package (Greene 1995). In all three specifications, all coefficients are of the predicted sign, and all but education and number of children are significantly different from zero (see Table 2). The results of these specifications are internally consistent according to the theoretical validity criterion. Considering the Hanemann specification (Model 1), we find that the probability of a yes vote is positively related to the amount of the offer and to the perceived decrease in health risk from the hazardous waste facility. Both coefficients are of the expected sign and significantly different from zero. The coefficient on the health risk variable is negative and significant even though, as we have indicated, it may not capture individuals' perceived ability to reduce private risks through averting behavior. The point estimate of the median household WTA is $1,414 using mean characteristics. Using the technique of Cameron (1991), the 90% confidence interval for Model 1 is $852 to $1,976.

Considering the linear change in expected indirect utility function (Model 2), the probability of a yes vote decreases with increases in income. This result is consistent with diminishing marginal utility of income. Respondents who have more income are less influenced by the compensation for the hazardous waste facility. The probability of [TABULAR DATA FOR TABLE 2 OMITTED] a yes vote also decreases with increases in the risk change and with reductions in the offer. The point estimate of median WTA is $1,415, using this specification with a 90% confidence interval from $563 to $2,267.

Considering the linear demographic specification (Model 3), we find that offer, income, and risk are all significant and of the expected sign. The coefficient on age is also negative and significant. As mentioned previously, Smith and Desvousges (1986) found that older people were less likely to engage in averting behavior with respect to protecting themselves from hazardous waste risks, which may help to explain this finding.

The number of children and education both have coefficients that are insignificantly different than zero. The point estimate of the median WTA is $1,404, using this specification with a 90% confidence interval from $1,167 to $1,641.

One criticism of using the CV technique to measure WTA centers on the inability of individuals to accept the underlying assignment of property rights or payment/compensation vehicles. When individuals do not accept the property rights or the vehicle, individuals may respond with a protest response. To analyze this criticism in the context of our study and to further test the validity of WTA, we look at protest responses for both an open-ended WTP question and a dichotomous-choice WTA question.

In the previous analysis, we did not exclude protest respondents. Using follow-up questions to the WTA referendum, we find that 14% of all respondents are protest respondents. Protest responses were identified as twofold: respondents who voted "no" stated their reason as "states do not have the right to site hazardous waste facilities," and respondents who voted "don't know" answered, "I disagree with the question." (See the Appendix for the full range of follow-up questions.) Excluding the protest responses from the WTA logit lowers the WTA from $1,415 to $1,054. The $1,054 is theoretically more appropriate as a measure of welfare because it is based on individuals who accept the property rights assignment. It is only appropriate, however, as a compensation measure if individuals who protest the property rights are not likely to vote.

A follow-up question to the CV section of the survey is used to test voter likelihood. The question is, "If the above proposal requires a special election in May to approve the locating of the landfill in your county with the tax reduction, how likely would you vote in the election?" The scale ranged from 1 = will not vote, to 5 = will definitely vote. In a comparison of means, we found that individuals who protest the property rights are just as likely to vote in the election as the nonprotest sample. We included these individuals in the analysis because protest votes are not identified and discarded in an actual referendum election.

Although the study was not designed to compare WTP and WTA, we asked an open-ended WTP question to gauge the level of protest to the alternative property rights (see the Appendix for the survey question). We admit that the WTA and WTP questions are not directly comparable and

the open-ended WTP question may facilitate protest responses. Nevertheless, we find that our comparisons are suggestive.

Only 22% of the respondents answered with a positive WTP amount, and 78% responded with a zero WTP amount. Of the total responses, 3% were nonprotest zeros where respondents answered a follow-up question with, "Hazardous waste landfills are safe." Therefore, 75% of the total respondents answered with protest responses to the WTP question. Of the protest responses, 50% were protests to the tax vehicle: "I pay too much in taxes already." An additional 25% of the protests were protests of the WTP property rights: "The State does not have the right to choose where to locate hazardous waste landfills." The remainder of the respondents failed to answer the question because of a lack of information: "I am not sure how tax increases or hazardous waste landfills affect my household."

These results suggest that, in the context of a siting decision, a WTA compensation vehicle may lead to fewer protests than the WTP tax vehicle. Individuals may find it difficult to accept the concept that they must pay higher taxes to keep a facility out of their neighborhood. Individuals appear to be more likely to accept the concept of tax reductions for allowing a facility in their neighborhood. This analysis supports the Mitchell and Carson (1986) conjecture that individuals reject the property rights being assigned at the state government level and accept the property rights as being collectively held by the community surrounding the facility.

CONCLUSIONS

We have argued that WTA is the appropriate measure for identifying the compensation necessary to site LULUs. The WTA and WTP measures are not theoretically or empirically equivalent and should not be used interchangeably. When attempting to gain community acceptance for siting a LULU, the property rights should be assigned to the community, with WTA the appropriate measure.

Our results show that the CV method can be used to estimate reasonable measures of WTA. Using a referendum election format and tax reduction vehicle, CV-WTA results are internally consistent. There is little evidence of massive protest responses with the WTA question, suggesting that the implicit property rights of a LULU siting decision are consistent with WTA and perhaps inconsistent with WTP.

Although it is difficult to make direct comparisons because of the different empirical approaches, our results do appear to be consistent with some non-CV empirical studies on WTP for hazardous waste reduction. For instance, in the McClelland, Schulze, and Hurd (1990) hedonic study, which is the only one that explicitly calculates the effect of a subjective risk variable on the disamenity value, the estimate of the mean increase in housing values (with respect to a situation in which there are no risk beliefs) is $1,711 before a hazardous waste site is closed and $837 afterwards. Our estimate of WTA, which incorporates the mean risk beliefs of our sample, is not unreasonably larger than these values; however, it is difficult to draw any firm conclusions from this due to the nature of these subjective risk measures and the different approaches used to measure them.

To illustrate a policy decision, suppose that to gain community acceptance, our results are used to compensate residents of Lawrence County for accepting a LULU. With 34,500 households in the county, our results suggest that the compensation required would be $36 million annually, excluding protest responses, and $48.8 million including protest responses - a large dollar amount but one that might be feasibly generated with tipping fees.

Due to the relatively low response rate and inherently hypothetical nature of the CV study, our results should be interpreted with caution. Nevertheless, they are generally supportive of CV as a meaningful and potentially useful tool for estimating the compensation required to site a LULU. As such, CV has the potential to improve the efficiency of siting decisions, which have long been divisive in communities faced with such decisions. Future research in this area should particularly address the intracounty siting decision and how compensation levels may depend on the distance from the site. Related to this are aggregation issues and the extent of compensation in the surrounding area. The role of other counties, either as potential beneficiaries and sources of compensation or as alternative locations for the LULU, should also be examined. In addition, research should analyze alternative measures of subjective risk and how they relate to the WTA compensation for a LULU.

APPENDIX A

Information Sheet Provided to Respondents: Some Information on Hazardous Waste

The U.S. Environmental Protection Agency (EPA) and the Pennsylvania Department of Resources (DER) define hazardous waste as substances that are in the following four categories:

Ignitable - highly flammable

Corrosive - capable of corroding metal

Reactive - explosive or capable of creating toxic fumes

Toxic - harmful or fatal if swallowed

In Pennsylvania, there are more than 2,000 listed hazardous wastes. Manufacturing industries produce most of this waste. Examples include pickle liquor from the steel industry, waste from refining petroleum, and wood preservatives. The state of Pennsylvania produces 19 million tons of hazardous waste each year. Of this waste, 800,000 tons need to be disposed of in commercial facilities. The steel industry produces half of the hazardous waste in Pennsylvania.

Hazardous waste threatens human life, human health, or the environment when improperly stored, treated, or disposed. The state of Pennsylvania has strict regulations on the operation of hazardous waste landfills. The state closely checks hazardous waste landfills with quarterly inspections, groundwater inspections, and unannounced inspections. These inspections make sure all regulations are followed. If hazardous waste landfills follow all regulations, then they are considered safe.

APPENDIX B

Contingent Valuation Survey Portion: A Hypothetical Hazardous Waste Proposal

Suppose the state was considering locating a hazardous waste landfill that collects waste from western Pennsylvania industries in one of the following counties: Clarion, Lawrence, or Mercer.

1. Suppose the state proposes to locate the hazardous waste landfill in Clarion County and it accepts hazardous waste from your counties' industries. Would you be willing to pay an increase in state income taxes to (a) compensate people in Clarion County for accepting hazardous waste generated in your county and (b) keep a hazardous waste landfill from locating in your county?

VERY WILLING VERY UNWILLING TO PAY INCREASED 1 2 3 4 5 TO PAY INCREASED TAXES TAXES

What is the maximum you are willing to pay in increased state income taxes to keep a hazardous waste landfill from locating in your county?

_____ DOLLARS

If you answered a ZERO amount, which of the following BEST describes why?

1. THE STATE DOES NOT HAVE THE RIGHT TO CHOOSE WHERE TO LOCATE HAZARDOUS WASTE LANDFILLS.

2. HAZARDOUS WASTE LANDFILLS ARE SAFE.

3. I PAY TO MUCH IN TAXES ALREADY.

4. I AM NOT SURE HOW A TAX INCREASE OR HAZARDOUS WASTE FACILITIES AFFECTS MY HOUSEHOLD.

Suppose the state proposes to locate the hazardous waste landfill in your county. In return, the state proposes to compensate people by reducing state income tax by $A per family in your county per year. Would you be willing to accept this proposal?

1. YES 2. NO 3. DON'T KNOW

If you answered YES to question 3, which BEST describes why?

1. THE TAX REDUCTION APPEALED TO ME.

2. HAZARDOUS WASTE FACILITIES ARE SAFE.

3. HAZARDOUS WASTE FACILITIES CREATE JOBS FOR THE COMMUNITY.

4. HAZARDOUS WASTE FACILITIES NEED TO GO SOMEWHERE.

If you answered NO to question 3, which BEST describes why?

1. THE TAX REDUCTION WAS NOT ENOUGH.

2. THE STATE DOES NOT HAVE THE RIGHT TO LOCATE HAZARDOUS WASTE FACILITIES.

3. THERE WAS NOT ENOUGH INFORMATION ON THE HAZARDS OF THE FACILITY.

4. HAZARDOUS WASTE FACILITIES SHOULD GO SOMEPLACE ELSE.

If you answered DON'T KNOW to question 3, which best describes why?

1. I NEED MORE INFORMATION.

2. I DIDN'T UNDERSTAND THE QUESTION.

3. I AM NOT SURE HOW THE TAX CUT OR THE HAZARDOUS WASTE FACILITY AFFECTS MY HOUSEHOLD.

4. I DISAGREE WITH THE QUESTION.

If the above proposal requires a special election in May to approve the locating of the landfill in your county with the tax reduction, how likely would you vote in the election?

WILL NOT 50/50 WILL DEFINITELY

VOTE 1 2 3 4 5 VOTE

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NOTES

1. Although additive separability is the most restrictive assumption about preferences, we find it useful for comparative statics and empirical specifications. It is also a reasonable assumption when health and all other goods are good substitutes. Health status is treated as exogenous to simplify the analysis and focus only on how individuals view changes in environmental health risk.

2. Harrison and Lesley (1996) suggest that low response rates can be corrected using selectivity bias techniques. Sample bias could lead to biased aggregate willingness to accept (WTA) estimates if nonrespondents are significantly different than respondents on characteristics that are

determinants of WTA (e.g., income) or WTA differs for undetermined reasons. In our study, there are no significant differences between the sample means and the county means. If implementing this approach for actual compensation, a weighting or sample selection correction procedure should be considered to account for sample bias (Whitehead, Groothuis, and Blomquist 1993).

3. See Groothuis and Whitehead (1995) for detailed theoretical and empirical analysis of the "don't know" responses. We find that excluding the middle response from the analysis increases the WTA estimate to $2,871 per household. These results are available on request.

4. Using a group of adult students ranging from age 21 to 60, with a median age of 40, a preliminary questionnaire was tested. A focus group-type discussion followed in which questions were asked about compensation vehicles, subjective probabilities, and questionnaire wording and the level of tax reduction. We conclude that the tax reduction vehicle and amounts were plausible to the respondents.

5. The scope of the hazardous waste policy in our scenario is a change from the subjective probability that a problem might arise in the future to a reduced probability. The strength of this approach is that the researcher gets a handle on what respondents were thinking when they answered the question without influencing the respondents' perception of risk.

We feel that the risk change coefficient that is significantly different from zero does indicate that the question proxies the risk change that respondents are placing a value on, albeit with measurement error. Note that reductions in measurement error should lead to a more precise measure of risk, increasing the t statistic. Similar proxies for measures of uncertainty have been used by Sun, Bergstrom, and Dorfman (1992) for drinking water-related health values and Whitehead (1992) for values of endangered species management programs, among others.

The major weakness of this approach is that WTA estimates would be difficult to transfer to the objective change in risk from the actual hazardous waste policy. Because the major purpose of this article is to demonstrate that it is possible to estimate theoretically consistent WTA values of reasonable orders of magnitude for contentious policy issues, this is not our major concern.

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