

USING CONTINGENT VALUATION DATA TO SIMULATE REFERENDUMS

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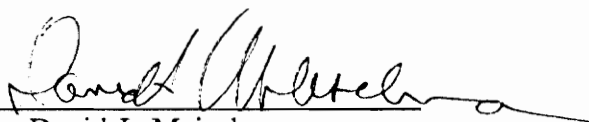
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Thesis submitted to the Faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of

MASTER OF ARTS

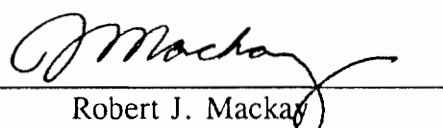
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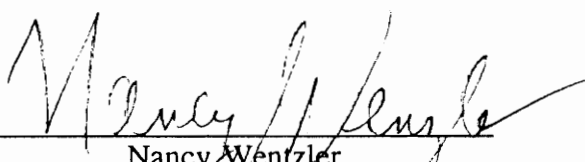
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# USING CONTINGENT VALUATION DATA TO SIMULATE REFERENDUMS

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## 1. Overview and Introduction

Natural resources provide a test of the power of economics to assist policy makers. Since these resources tend to be public goods, the market mechanisms that economists typically use to value goods do not apply. Instead, other means must be used to determine the value of these resources. This problem becomes more important when a policy decision regarding the provision of these goods must be made. These types of decisions have reached the forefront of public policy discussions with the recent interest in the environment, coupled with the fiscal problems facing all levels of government. Policy makers are now being asked to devise policies to preserve or restore natural resources, as well as maintain fiscal restraint. It is more important than ever to evaluate the benefits of policies in order to prioritize the options.

This paper will address the use of economic techniques to answer public policy questions. Specifically, data from the 1983 study of water quality in the Monongahela River are used to simulate a referendum on a policy to clean up the river.<sup>1</sup> The results from this referendum experiment will then be compared to the contingent valuation results reported by Desvousges, Smith and McGivney.

This thesis is organized in the following way. Section 2 contains a review of contingent valuation. Both the theoretical underpinnings and the practical applications

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<sup>1</sup>Desvousges, William H., V. Kerry Smith, and Matthew McGivney, 1983, *A Comparison of Alternative Approaches for Estimating Recreation and Related Benefits of Water Quality Improvements*, Environmental Benefits Analysis Series, Washington, DC: US Environmental Protection Agency.

are covered. Section 3 describes the Monongahela Study conducted by Desvousges, Smith and McGivney. The results from the referendum experiment are contained in Section 4, with a summary and conclusions in Section 5.

## 2. Review of the Contingent Valuation (CV) Method

### 2.1 Theoretical Underpinnings of the Contingent Valuation Method

The contingent valuation method was developed to measure the dollar value of the consumer benefits from some change in the level of a public good. There are several alternative measures of consumer benefits, including consumer surplus, equivalence surplus, and compensating surplus.

Figure 2-1 shows these consumer benefit measures graphically. Curve  $DD$  is the ordinary Marshallian demand curve, which shows how much this consumer will pay for each level of quantity, holding income constant. The change in consumer surplus for a change in quantity is measured by the area under the ordinary demand curve, above the price line, between the original quantity level and the new quantity level. For simplicity, in Figure 2-1 the price is set to zero. The consumer surplus for the change from  $Q_0$  to  $Q_1$  is area  $a+b$ .

Consumer surplus has some problems as a benefit measure. The main problem is that, while the Marshallian demand curve holds income constant, it does not hold utility constant. That is, as shown on Figure 2-1, point  $i$  and point  $j$  represent different levels of utility, and this change in utility is not accounted for in consumer surplus (area  $a+b$ ).

The Hicksian demand curve holds income and utility constant along a given curve. The Hicksian demand curve through point  $i$  is shown as the curve  $H_0H_0$ , and all the points along this curve represent the same utility level  $U_0$ . For a change in quantity from

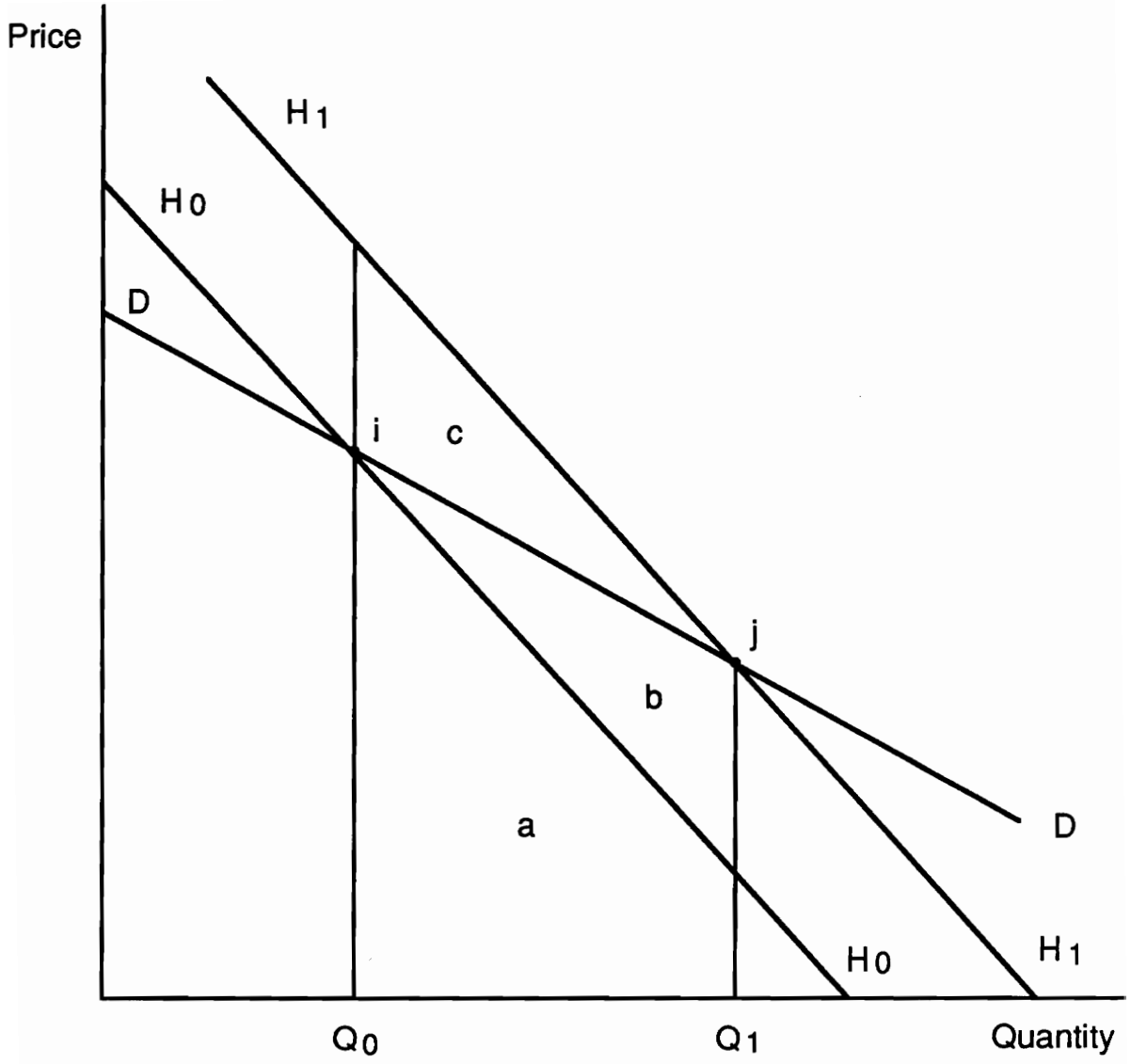


Figure 2-1: Graph of Consumer Benefit Measures

$Q_0$  to  $Q_1$ , the compensating surplus is represented by the area **a**, which is the area bounded by the Hicksian curve through the initial level of quantity ( $H_0H_0$ ). As shown, the Hicksian compensating surplus measure is less than the Marshallian consumer surplus measure. The difference comes from restricting the measure to maintain the same utility level, rather than allowing an increase in utility.

The Hicksian benefit measure for a decrease in quantity (from  $Q_1$  to  $Q_0$ ) is called equivalence surplus, and it is shown as the area **a+b+c**. Again this area is bounded by  $H_1H_1$ , which is the Hicksian demand curve through the initial level  $Q_1$  with utility level  $U_1$ . The Hicksian equivalence surplus exceeds the Marshallian consumer surplus by the area **c**, because this measure maintains the higher utility level,  $U_1$ .

A contingent valuation (CV) survey attempts to elicit willingness to pay (WTP) values that represent either the Hicksian compensating surplus (for a quantity increase) or the equivalence surplus (for a quantity decrease).<sup>2</sup>

## 2.2 Basic Structure of Contingent Valuation Studies

The purpose of a CV survey is to set up a contingent market for a commodity that is not generally traded in a market. The information from the survey is then used to

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<sup>2</sup>In the past, contingent valuation surveys have asked willingness to accept (WTA) questions, which ask how much the respondents would need to be paid to compensate them for a change in the public good. However, since studies have shown serious problems with WTA responses, this thesis will focus on the WTP format.

estimate the value of the contingent commodity. In order to collect the needed information, a CV survey has three basic parts<sup>3</sup>:

1. a description of the contingent commodity and the structure of the market,
2. *the contingent valuation question, and*
3. *socio-demographic and attitudinal questions.*

The description of the contingent commodity must give the respondents sufficient information about the commodity to allow them to fully evaluate their preferences. This context information contains a description of the good, some baseline level that is currently available, and an indication of possible substitutes. In addition, the description of the market must provide some credible payment vehicle and provision mechanism. That is, the respondents need to understand how the money will be collected, and how it will be applied to the problem. Any lack of credibility here may bias the WTP responses.

The contingent valuation question elicits the respondents' willingness-to-pay for the contingent commodity. The goal of these questions is to collect value information without biasing it. There has been considerable research into the impact of the format of the WTP question on the valuations elicited. The Desvousges, Smith, and McGivney work, which will be discussed later, is one such study.

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<sup>3</sup>Mitchell, Robert C. and Richard T. Carson, 1989, *Using Surveys to Value Public Goods: The Contingent Valuation Method*, Washington, DC: Resources for the Future.

There are several question formats that have been used in the past. The most general format is the **open-ended** question. In this format, the respondents are asked how much they are willing to pay, and their answers are not restricted in any way. However, since the commodities valued by CV studies are typically not traded in markets, respondents often have difficulty determining a value without any assistance. Therefore, other formats have been developed to reduce the respondents' burden. However, giving more assistance to respondents may also bias the responses.

One alternative is a **bidding game**, in which an initial offer is made by the interviewer. Then, if the respondent agrees to pay that amount, a higher bid is offered. Similarly, if the initial bid is rejected, a lower bid is offered. This process continues until the maximum willingness to pay is determined. While this format does provide respondents with some assistance in researching their preferences, studies have shown that the initial bid offered in the game exerts a large bias on the values obtained.<sup>4</sup>

**Payment cards** are an attempt to provide some assistance to the respondent without the bias problems of the bidding game. A payment card presents the respondents with an array of dollar amounts, and the respondents can choose an amount on the card, or the respondents can choose another number if they desire. This mechanism provides some range of numbers for the respondent to consider. A variation of the payment card

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<sup>4</sup>Boyle, Kevin J., Richard C. Bishop, and Micheal P. Welsh, 1985, "Starting Point Bias in Contingent Valuation Surveys," *Land Economics* vol. 61, pp. 188-194.

Smith, V. Kerry and William H. Desvousges, 1986, *Measuring Water Quality Benefits*, Boston: Kluwer-Nijhoff.

is to provide benchmarks on the cards that show how much the average household pays for other public goods, such as highways, defense, and public education. These benchmarks are intended to give the respondents a basis for comparison.<sup>5</sup>

A more recent development in question format is **dichotomous choice**. These questions ask if the respondent is willing to pay a specified amount, much like the first round of a bidding game. The offer bids, however, are varied across respondents. The respondent answers either "Yes" or "No," and that is all. Then, using econometric techniques, the mean and median willingness to pay are calculated from these Yes/No responses.<sup>6</sup> The supporters of dichotomous choice argue that this question format makes the valuation task easier for the survey respondent. Instead of having to determine a dollar amount, the respondents only has to determine if their value is at least as much as the offer bid. However, since this technique is relatively new, it remains largely

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<sup>5</sup>Mitchell, Robert C. and Richard T. Carson, 1981, "An Experiment in Determining Willingness to Pay for National Water Quality Improvements," draft report to the U.S. Environmental Protection Agency, Washington, D.C.

Mitchell, Robert C. and Richard T. Carson, 1984, *A Contingent Valuation Estimate of National Freshwater Benefits: Technical Report to the U.S. Environmental Protection Agency*, Washington, DC: Resources for the Future.

Both of these studies use benchmarked payment cards.

<sup>6</sup>Bishop, Richard C. and Thomas A. Heberlein, 1979, "Measuring Values of Extra-Market Goods: Are Indirect Measures Biased?" *American Journal of Agricultural Economics* vol. 61, no. 5, pp. 926-930.

Hanemann, Michael, 1984, "Welfare Evaluations in Contingent Valuation Experiments with Discrete Responses," *American Journal of Agricultural Economics* vol. 66, pp. 332-341.

Cameron, Trudy Ann, 1988, "A New Paradigm for Valuing Non-Market Goods Using Referendum Data." *Journal of Environmental Economics and Management* vol. 15, pp. 355-379.

untested. Some preliminary work shows that this technique may induce yea-saying, where respondents say "Yes" to the offer to please the interviewer. Also, since dichotomous choice questions are really just one-round bidding games, the offer bids used may exert a starting point bias, much like bidding games do.<sup>7</sup>

The socio-demographic and attitudinal questions, the last component of a CV survey, collect information about the respondents that can be used in regression analysis of the WTP responses. These data allow the researcher to check the validity of the WTP responses by determining whether expected systematic relationships exist between WTP values and personal characteristics. For example, if the contingent commodity is water quality on a recreation river, the researcher's *a priori* expectation would be that boaters and anglers would have relatively higher values than non-recreators. This expectation can be tested using multivariate analyses with the personal characteristic data.

### 2.3 Potential Biases in Contingent Valuation Surveys

No introduction to CV studies would be complete without some discussion of the potential biases associated with asking these sorts of questions. Mitchell and Carson (1989) give a full accounting of all the commonly cited CV biases.<sup>8</sup> This section will

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<sup>7</sup>Desvousges, William H., F. Reed Johnson, Richard W. Dunford, Kevin J. Boyle, Sara P. Hudson, and K. Nicole Wilson, 1992, *Using Contingent Valuation to Measure Nonuse Values: An Experimental Evaluation of Accuracy*, Research Triangle Institute Monograph.

<sup>8</sup>See Chapter 11 of Mitchell and Carson (1989) for a full cataloging of the forms of measurement bias in contingent valuation surveys.

give a brief overview of those biases that tend to be of major concern, as well as citations of studies that have tested for them.

A large set of biases come under the heading of *Implied Value Cues*. These biases affect the response to the WTP question by cuing the respondent to a certain range of value responses. They are usually a result of the framing of the WTP question. The most commonly cited form of an implied value cue is starting point bias from iterative bidding games. In this case, the value used to begin the bidding exerts an influence on the final WTP amount. This bias may result from yea-saying, which is a tendency for respondents to say "yes" in order to please the interviewer (or to end the drill).<sup>9</sup> A similar bias, range bias, occurs when the survey indicates a range of acceptable values, as done with a payment card. The position of the bids on the card indicates the extreme bids, as well as a notion about the mean acceptable bid.<sup>10</sup> A more fundamental problem has been characterized as importance bias, where the mere act of asking questions about some commodity places an importance on that good that may have not previously existed. This problem may be enhanced by using benchmarked payment cards which compare the

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<sup>9</sup>Roberts, Kenneth J., Mark E. Thompson, and Perry W. Pawlyk, 1985, "Contingent Valuation of Recreational Diving at Petroleum Rigs, Gulf of Mexico," *Transactions of the American Fisheries Society* vol. 114, no. 2, pp. 214-219.

Mitchell, Robert C. and Richard T. Carson, 1985, "Comment on Option Value: Empirical Evidence from a Case Study of Recreation and Water Quality," *Quarterly Journal of Economics* vol. 100, no. 1, pp. 291-294.

Boyle, Bishop, and Welsh (1985)

Smith and Desvousges (1986)

<sup>10</sup>Mitchell and Carson (1981, 1984)

commodity with other public goods (such as police protection, public schools). By comparing the commodity with these other goods and services, the survey may induce the respondent to feel that the contingent commodity must be worth a similar amount.<sup>11</sup>

Other biases can result from the description of the contingent market. *Scenario misspecification* occurs when the respondent does not respond to the scenario that the researcher intended to specify. These problems arise when either the commodity or the context is confusing or unbelievable. One form of commodity misspecification, known as part-whole bias, exists when the respondent values a larger or smaller good than intended in the survey. For example, the researcher may intend for the respondent to value wetlands in North Carolina, and the respondents may give a value for wetlands in the entire country. In this case, the WTP values represent a larger commodity than intended in the survey.<sup>12</sup> Another potential bias in WTP values from a poorly specified commodity is probability of provision bias, which occurs when the scenario is not credible to the respondent. If the respondents do not believe that the good could actually be provided according to the scenario, they may discount their WTP values to account for this risk. For example, if the scenario states that the Federal government will be collecting the money and establishing a new bureaucracy to assure provision of water

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<sup>11</sup>Slovic, Paul, Baruch Fischhoff, and Sarah Lichtenstein, 1980, "Response Mode, Framing, and Information-Processing Effects in Risk Assessment," in Robin M. Hogarth, ed., *Question Framing and Response Consistency*, San Francisco: Jossey-Bass.

<sup>12</sup>Tversky, Amos, and Daniel Kahneman, 1982, "The Framing of Decisions and the Psychology of Choice," in Robin M. Hogarth, ed., *Question Framing and Response Consistency*, San Francisco: Jossey-Bass.

quality, respondents may discount their values to account for their mistrust of the Federal government's efficacy. The lower values do not reflect the value for the good itself. Instead, it reflects some net benefit value, with any negative value for bureaucracy netted out of the total value of water quality.

Context information can also cause bias if it is not clear and properly defined. The payment vehicle should provided a credible way for funds to be collected. Payment vehicle bias arises when the vehicle chosen interferes with the valuation of the commodity either be lacking credibility or by inducing values. If an income tax conjures up a credibility problem, that payment vehicle may bias the results. Also, if the survey uses an admission fee for a payment vehicle, respondents may be induced to give amounts that are typical of admission fees, regardless of their actual value for the commodity.<sup>13</sup>

The above overview of the most commonly cited biases shows that the task of asking contingent valuation question is a difficult and complicated one that must be approached with care.

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<sup>13</sup>Greenley, Douglas A., Richard G. Walsh, and Robert A. Young, 1981, "Option Value: Empirical Evidence from a case Study of Recreation and Water Quality," *Quarterly Journal of Economics* vol. 96, no. 4, pp. 657-672.

Mitchell and Carson (1981)

Daubert John T., and Robert A. Young, 1981, "Recreational Demands for Maintaining Instream Flows: A Contingent Valuation Approach," *American Journal of Agricultural Economics* vol. 63, no. 4, pp. 666-676.

### 3. Description of the Data

#### 3.1 Objectives of the Desvousges, Smith and McGivney study

In 1981, Desvousges, Smith, and McGivney undertook a study of water quality benefits in the Monongahela River in Western Pennsylvania. The study was funded by the U.S. Environmental Protection Agency (EPA). The objective of the study was to test the performance of various benefit estimation techniques. The results were then used by the EPA in policy decisions regarding benefits measurement. Later, Smith and Desvousges authored a book containing the results of the EPA study.<sup>14</sup> In that book, Smith and Desvousges list several policy issues that provided the motivation for this study. These issues include:

- "Effluent guidelines issues that require limits on specific industrial discharges.
- Water quality standards issues where states designate uses for water bodies and develop criteria to achieve the uses.
- Advanced treatment issues where the Federal government provides financial assistance to construct municipal treatment plants that require advanced technologies.
- Combined sewer overflow issues where Federal assistance is provided to deal with municipal runoffs that create pollution problems.
- The use of benefit cost analysis to rank the nation's estuaries for cleanup funds."<sup>15</sup>

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<sup>14</sup>Smith and Desvousges (1986)

<sup>15</sup>Smith and Desvousges, (1986) p. 4.

This study represented one of the most thorough and carefully executed contingent valuation studies to date. Some of the most notable improvements in the technique are:

- increased sample size,
- rigorous experimental design,
- professional sample design,
- professionally trained interviewers, and
- thorough analysis and documentation of results.

### 3.2 Description of Site

The survey was administered in the winter of 1981. The survey area consists of five counties of southwestern Pennsylvania: Allegheny, Greene, Fayette, Westmoreland, and Washington. These counties contain the reach of the Monongahela River within the state. The target population within this region consisted of households, with group quarters excluded. Only adult household members (over 18 years of age) were eligible for the interview, and one adult was selected from each sampled household.

The Monongahela River provides substantial recreational opportunities for residents of nearby counties. It is especially popular for power boating and fishing. As a result of the heavy recreational usage on the river, investments, both public and private, have been made in the area. Boat launching ramps, fishing piers, marinas,

and parks have been developed along the river. Pennsylvania has also undertaken fish stocking programs to keep the fish levels high for recreational fishing. Near water recreation, including picnicking and camping, is also popular along the Monongahela.

### 3.3 Survey Administration

This survey was administered in a personal interview format, with each interview lasting approximately 35 minutes. These interviews were conducted November 13 through December 20, 1981, resulting in 301 completed interviews.

Households were sampled using a single-stage, stratified cluster sample. The five county area was divided into sampling units, known as clusters. Each cluster represented approximately seven households. These clusters were then stratified into three distinct strata: (1) Pittsburgh, (2) not in a place,<sup>16</sup> and (3) a place other than Pittsburgh. From these strata, fifty one clusters with an average of 7.78 households were selected. From these 397 sampled units, 301 interviews were completed. After excluding households that were ineligible, the response rate comes to 80.59%.

Table 3-1 shows some characteristics of the respondents in this study.

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<sup>16</sup> A place is defined by the Bureau of the Census to be any incorporated place of at least 2,500 in population.

Table 3-1: Characteristics of Respondents

Characteristic	Mean	Std. Dev.	N
Dummy = 1 for boat owners	0.16	0.36	301
Dummy = 1 for those who participated in outdoor recreation in the last year	0.56	0.50	301
Numerical rating of Monongahela River: 0 = lowest, 10 = highest	3.81	1.99	221
Length of residence	6.81	1.00	301
Years of education	12.75	2.07	263
Race (1 = white)	0.90	0.30	300
Income	19,538	13,184	260
Age	47.82	18.34	301
Sex (1 = male)	0.36	0.48	301

### 3.4 Questionnaire Design

As discussed in Section 2, contingent valuation surveys establish a contingent market for the commodity to be measured. In the Monongahela survey, the contingent commodity is improvements in water quality in the Monongahela River. The survey uses a payment vehicle of higher taxes paid directly by taxpayers as well as higher prices paid indirectly by consumers. The contingent market in this survey asks respondents for the total amount each respondent would be willing to pay for water quality changes, known as the "option price." The amount reflects both current and future option use of the resource. The respondent is then asked to specify how much of that total amount reflects actual use of the river. This amount is then interpreted as a measure of **consumer surplus** from use. The remainder of the option price is interpreted to be the **option value**, which reflects the value of future, potential use.

Within each questionnaire, the respondent was asked to give a value for three different proposed changes in water quality. In order to make the changes clear to the respondents, the interviewers used a "Water Quality Ladder," as shown in Figure 3-1. The first valuation question asks the for the value of preventing the quality from deteriorating from the current level, Level D, to the next level down, Level E. At Level D, the water is acceptable for boating, but no recreation is possible at Level E. Next, respondents were asked for the value of moving from Level D to Level C,

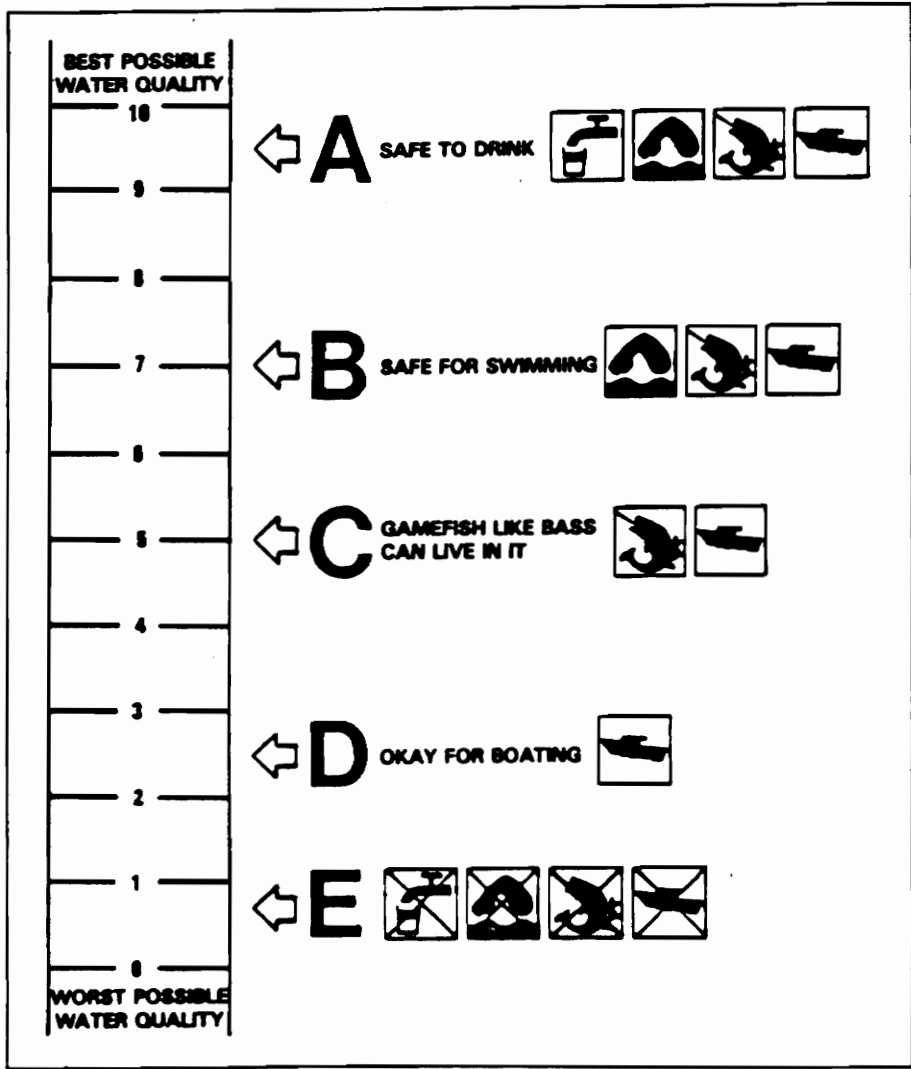


Figure 3-1: Water Quality Ladder

which is acceptable for sport fishing. Finally, respondents gave a value for moving from Level C to Level B, where swimming is acceptable. Therefore, for each of the 301 completed questionnaires, there are up to three option prices.<sup>17</sup>

In order to test for any bias from the question format used, the Monongahela study used four different formats, which were randomly assigned to independent samples of respondents<sup>18</sup>. These mechanisms are:

- Iterative bidding game, \$125 starting bid, \$10 increments,
- Iterative bidding game, \$25 starting bid, \$5 increments,
- Open ended direct question with a payment card, and
- Open ended direct question with no suggestion of an amount.

Smith and Desvousges found significant differences in WTP values across the formats. The questionnaires are identical across the versions, with the exception of the phrasing of the valuation question. Therefore, if the values differ across the versions and the samples are comparable, the question formats may be giving different information to the respondents. In the years since they conducted this original work, however, there have been some advances in statistical techniques.

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<sup>17</sup>Because of skip patterns, not all respondents answered all 3 valuation questions. Therefore, the following analysis addresses only changes from D to E, which was asked of all respondents.

<sup>18</sup> For a more complete discussion of various question formats, see Section 2.

Section 3.5 below uses some of the newer techniques to test for differences across formats.

### 3.5 Impact of Question Format on WTP Responses

Typically, the data collected from contingent valuation questions are not normally distributed. Instead, there is a large mass of responses at \$0, with the rest of the responses locating at particular amounts (i.e., \$10, \$25, \$100). Given these characteristics, the standard t-test for differences in univariate means is inappropriate because it assumes a normal distribution.

Instead, non-parametric tests are more appropriate. These methods allow tests for differences across treatments without assuming a given distribution. These tests are appealing for willingness to pay data because these data tend to violate normality assumptions. Table 3-2 shows the results of two common nonparametric tests.

The first panel of Table 3-2 contains the results of the Wilcoxon Rank Sum Test.<sup>19</sup> This test is designed to determine if two samples are drawn from the same population. It first sorts the two samples as a single data set in ascending order. If the two samples were indeed drawn from the same population, the data points from each sample should be fairly well dispersed through the sorted data set. Then, each observation is assigned a rank, ranging from one to the total number of observations. The test statistic is calculated by comparing the sum of the ranks of the observations

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<sup>19</sup>For two sample comparisons, this test is the same as the Mann-Whitney test.

Table 3-2: Non-Parametric Tests for Differences Across Versions of the Questionnaire

Wilcoxon Test for Differences in Medians  
(Probability Values Given)

Probability Value	\$125 Bidding Game	\$25 Bidding Game	Payment Card
Open Ended	0.01 ***	0.05 **	0.04 **
\$125 Bidding Game		0.02 ***	0.20
\$25 Bidding Game			0.44

Permutations Test for Differences in Means  
(Probability Values Given)

Probability Value	\$125 Bidding Game	\$25 Bidding Game	Payment Card
Open Ended	0.01 ***	0.54	0.10 *
\$125 Bidding Game		0.00 ***	0.22
\$25 Bidding Game			0.01 ***

\* = Significant at the 10% level  
 \*\* = Significant at the 5% level  
 \*\*\* = Significant at the 1% level

from each original sample. Often, this test is considered to be a test for differences in medians.

The first panel of Table 3-2 gives the probability values of the Wilcoxon test statistic for each comparison of treatments. As shown, four of the six comparisons are statistically significant at the five percent level or below, indicating statistically significant differences in those comparisons.

The second panel of Table 3-2 gives the results from the Permutations Test, which is a non-parametric test that is analogous to the standard two sample t-test. It uses the value of the observation as the score. The test statistic is calculated by comparing the average scores from each of the two samples. Instead of using the normal distribution as a basis of comparison, as done with a standard t-test, the permutations test uses the data to generate a distribution for comparison.

Table 3-2 shows the probability values associated with the permutations test for the six comparisons. As shown, four of the six are statistically significant at the ten percent level, or below. Therefore, in those four cases, the samples of WTP were not drawn from the same population.

Another approach for assessing the significance of the impact of the question format is to use multivariate analysis. In a regression model, dummy variables capture any impact of the question format on WTP, and it allows us to control for differences in demographic characteristics and attitudes among the respondents.

As discussed above, the responses to contingent valuation questions are not typically normally distributed. Therefore, Ordinary Least Squares (OLS) is not appropriate for estimating models with WTP responses as the dependent variable. Instead, a Tobit model should be used to take into account the large mass of responses at the lower bound of the distribution.<sup>20</sup>

Table 3-3 displays the results from a Tobit regression on these data. Dummy variables capture the effect of question format. The \$125 bidding game is the omitted category. It was chosen because that format seemed to have the most influence, so it will show the starkest contrasts.

As shown by the large chi-square statistics, each of the three included version is negative and strongly significant. These coefficients confirm that the responses from the \$125 bidding game (the omitted version) are significantly higher than the responses from the other question formats, holding all other factors constant.

Additionally, the Tobit results show that the responses to these WTP questions are systematically related to several other characteristics of the respondents in a logical fashion. The significant positive coefficient on income indicates that respondents with higher incomes tended to give higher WTP responses, which is

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<sup>20</sup>The Tobit model assumes that the dependent variable is normally distributed, but that some portion of the distribution is unobservable. In this case, any WTP values less than zero are unobservable, so the distribution is truncated at zero and the unobserved values cluster at zero. While Tobit is an improvement over OLS for these data, it is not perfect. WTP data tend to be non-normal in the tails of the distribution, and these "fat tails" are not addressed by using Tobit.

Table 3-3: Results from Tobit Analysis of WTP Responses

Variable	Coefficient	Chi-Square	
Intercept	-11.645	0.43	
D - PAYMENT CARD	-35.239	5.41	**
D - OPEN ENDED	-58.984	13.21	***
D - \$25 BIDDING GAME	-61.351	16.77	***
INCOME	0.001	4.38	**
SEX	19.144	2.77	*
COUNT OF PRO- ENVIRONMENT ATTITUDES	10.092	6.05	***
D - USE OF RIVER IS IMPORTANT	24.652	3.96	**
D - OPTION TO USE AND EXISTENCE ARE IMPORTANT	42.355	8.92	***
Log Likelihood	-890.322		

\* = Significant at the 10% level

\*\* = Significant at the 5% level

\*\*\* = Significant at the 1% level

consistent with expectations for a normal good. The attitude variables also yield results consistent with *a priori* expectations. Respondents who indicated a higher number of pro-environment attitudes gave higher WTP bids.<sup>21</sup> Also, those respondents who felt that their use of the river for recreation was an important factor in determining their value for water quality gave higher WTP values. Another dummy variable captures those respondents who felt that having the option to use the river in the future was important, as well as just knowing that the river was being maintained.<sup>22</sup> This coefficient is also positive and significant. One interesting result is that the coefficient for the users of the river is smaller than the coefficient for the non-use components.

The combination of the non-parametric tests and the Tobit results show that the question format indeed matters for valuation estimation. The results for the \$125 bidding game are especially strong.<sup>23</sup> The results presented here lead to the same

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<sup>21</sup>This variable is constructed from the responses to a series of questions that asked the person if several phrases described him/her. The phrases are:

- An outdoors person
- An environmentalist
- Someone who is against nuclear power for electric plants
- Someone who is concerned about water pollution
- Someone who is willing to pay the cost required to control water pollution

<sup>22</sup>These components of value are often referred to as "option value" and "existence value," respectively.

<sup>23</sup>With the exception of the non-parametric comparisons between the \$125 bidding game and the payment card format, the statistics show that the high starting bid game exerts a strong positive influence on the willingness to pay values.

conclusions as the tests performed in the original work done by Smith and Desvousges. Those conclusions were instrumental in the subsequent suspicion of the iterative bidding method as a useful means of eliciting valid willingness-to-pay values.

## 4. Voting Simulation

### 4.1 A New Interpretation of the Contingent Market

The data collected in the Monongahela study provide an opportunity to simulate several different campaign scenarios. By interpreting the different question formats as different types of information available to voters, we can use the data to analyze the effect of information on voting behavior.

Each of the four question formats provides the respondent with differing signals. As shown in Section 2, these signals exert some effect on the willingness-to-pay values given by the respondents. This section will investigate the effect these signals exert in a voting context.

To transform these data from a contingent valuation exercise to a referendum simulation, we must provide a new interpretation of the contingent commodity, the contingent market, and the question formats. First, the commodity (water quality on the Monongahela River) is re-interpreted as a policy up for a referendum, rather than a commodity to be traded in a contingent market. The contingent valuation survey asks respondents how much they would be willing to pay through higher prices and taxes for maintaining the water quality in the river. In the referendum scenario, the respondents are asked if they would vote for a policy that would use higher prices and taxes to maintain the river's water quality. In this case, the increase in prices and taxes is estimated to be 0.2% of the household's annual income.

When a referendum is presented to the public, it is typically accompanied by some sort of campaign. This campaign is used to provide information for the voters. The four question formats from the CV survey can represent four different types of campaigns, characterized by different doses of information given to the voting public.

#### 4.2 Campaign Scenarios

Using this new interpretation, we can describe the question formats in terms of campaign information. This information can be characterized according to the two factors: the degree of focus and the implied value cue. The degree of focus indicates if the information gives a strong indication of the referendum's value or if it is weak and diffuse. An implied value cue provides the voter (respondent) with a cue to how much the campaigner (researcher) thinks the commodity is worth. Table 4-1 summarizes these characteristics for the four question formats.

The \$125 bidding game represents a campaign where there is very strong, focused information indicating that the policy has a high value. The \$25 bidding game gives information with the same strength and focus, but it indicates that the policy is of relatively low value. In both bidding game campaigns there is little, if any, dissenting information available to the voter. The payment card format is analogous to a campaign with a large volume of information, but it is fragmented and contradictory. This type of information only gives an indication of the range of

Table 4-1: Information Provided by Different Question Formats

Question Format	Degree of Focus of the Information	Implied Value Cue
Format 1: Iterative Bidding - \$125 Starting Point	Highly Focussed	High Value
Format 2: Iterative Bidding: \$25 Starting Point	Highly Focussed	Low Value
Format 3: Open Ended with Payment Card	Diffuse	Brackets Value
Format 4: Open Ended without any aids	No Information	No Value Cue

possible values. Finally, the open-ended question is akin to a campaign with no information about the value of the policy. The voter is left to determine his vote with no real signal from the campaign.

#### 4.3 Analysis of Votes

As discussed above, the contingent commodity has been recast into a policy of levying a tax to finance the preservation of water quality at level D, rather than having it slip to level E.<sup>24</sup> The tax will be proportional to income, and it is expected to cost 0.2% of a household's annual income. Using this proportion, the expected cost for each respondents can be calculated, based on reported income. Then, assuming that the reported WTP bids are accurate reflections of the respondents value for preserving water quality at level D given the structure of the valuation question, we can determine if each respondent will accept or reject the policy under the given campaign. If the reported WTP is greater than or just equal to the expected cost for that respondent, the respondent would vote for the policy. By transforming respondents' WTP bids into referendum votes, we can tally the votes and determine if the policy passes under the different campaign scenarios. Table 4-2 below shows the percent of respondents voting "Yes," by question format.

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<sup>24</sup>See the Water Quality Ladder (Figure 3-1) in Section 3 for an explanation of the levels of water quality.

Table 4-2: Proportion of Yes Votes Under Different Campaign Scenarios

Campaign Scenario (WTP Question Format)	Percent Voting "Yes"
Campaign 1: Highly Focussed, High Value Cue (\$125 Bidding Game)	66.7%
Campaign 2: Highly Focussed, Low Value Cue (\$25 Bidding Game)	39.2%
Campaign 3: Unfocussed, Bracketed Value Cue (Payment Card)	45.8%
Campaign 4: No Information, No Value Cue (Open Ended)	26.2%

As shown in Table 4-2, the results vary as the type of information varies. Taking Campaign 4 (from the open-ended question format) as the baseline, the proportion of yes votes increases when information is provided to the voter. This result is especially strong when the two extreme campaigns are contrasted. Under Campaign 4, with no information given to the voter, only 26.2% of the voters approve the referendum. Conversely, under Campaign 1, the scenario with the most intense, high value information, 66.7% of the voters vote yes. The proportion more than doubles, and this scenario is the only one where the referendum passes.

Chi-square tests are used to test for differences in proportions, and the results are presented in Table 4-3. This test shows that for four of the six comparisons tested, the difference in the proportion of yes votes is statistically significant. The two comparisons that are not statistically different are Campaign 2 (\$25 Bidding Game) versus both Campaign 4 (Open Ended) and Campaign 3 (Payment Card). For the rest of the comparisons, the degree of information significantly affects the proportion of yes votes.

#### 4.4 Dichotomous Choice Estimation

As discussed in Section 3, a recent trend in contingent valuation surveys is to ask a referendum-type question, often referred to as a dichotomous-choice question. In this question format, the respondents are asked if they would be willing to pay a

Table 4-3: Chi-Square Tests for Differences in Proportions of Yes Votes

Chi-Square	Campaign 1 (\$125 Bidding Game)	Campaign 2 (\$25 Bidding Game)	Campaign 3 (Payment Card)
Campaign 4 (Open Ended)	15.11 ***	1.76	3.72 *
Campaign 1 (\$125 Bidding Game)		7.71 ***	4.37 **
Campaign 2 (\$25 Bidding Game)			0.44

\* = Significant at 10% level  
 \*\* = Significant at 5% level  
 \*\*\* = Significant at 1% level

given amount for the contingent commodity. The respondents then answer either "Yes" or "No," but they are not required to give a dollar amount. Then using statistical techniques, aggregate willingness-to-pay measures can be calculated.

After transforming the Monongahela data into a referendum context, this data can be used to estimate a dichotomous-choice model. From this model, we can determine the median willingness-to-pay. This value corresponds to the median voter's preference. In a voting context, this median represents the value that, if offered in a referendum, would cause the referendum to just pass.<sup>25</sup> By using the dichotomous choice estimation procedure, we can see if that median changes across the different campaign scenarios (question formats).

Dichotomous choice models are estimated using a probit technique. The yes/no response (the votes in this context) serve as the dependent variable. The offered bid, which is the cost of the policy in this case (0.2% of income), is one key independent variable. In addition, socio-demographic characteristics and attitudes are used to explain the probability of voting for the policy. The results from the model estimated with the Monongahela data are shown in Table 4-4 below. The model is estimated for all four campaign scenarios pooled. Ideally, we would estimate each campaign separately, allowing all of the coefficients to vary. However, when the data set is partitioned into four subsets, there are not enough degrees of freedom to get

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<sup>25</sup>This interpretation of the median is only accurate if the preferences are single peaked. See Black, Duncan, 1948, "On the Rationale of Group Decision Making," *The Journal of Political Economy* vol. 56, pp. 23-34.

Table 4-4: Dichotomous Choice Estimation Results

Variable	Coefficient	T-Statistic	
Intercept	-2.271	-2.59	***
D - Campaign 3 (Payment Card)	-0.760	-2.48	***
D - Campaign 4 (Open Ended)	-1.031	-3.14	***
D - Campaign 2 (\$25 Bidding Game)	-0.958	-3.05	***
Cost of Referendum (0.2% * Income)	-0.025	-4.63	***
Education	0.202	2.74	***
Count of Pro-Environment Attitudes	0.202	2.38	**
Count of Values that are Important (Use, Option, Existence)	0.182	1.61	*
D - Participated in Outdoor Activities in Past Year	0.480	2.01	**
Log Likelihood	-88.81		
Chi-Square	61.74		
Percent Correctly Predicted	75.3%		

\* = Significant at 10% level

\*\* = Significant at 5% level

\*\*\* = Significant at 1% level

significant coefficients. By including dummy variables for the versions, the intercept can vary but the slope coefficients remain constant across the versions.

The coefficients in a probit equation are proportional to the marginal probabilities. In other words, the coefficients show which variables exert a relatively strong or weak influence on the probability of voting yes. As shown in Table 4-4, the coefficients on the version dummies are highly significant and negative. (As in the Tobit analysis above, the \$125 bidding game is the omitted version.) The negative sign indicates that, for example, a voter in the campaign devised from the payment card format is less likely to vote for the referendum than a voter in the \$125 bidding game campaign. That is, voters are more likely to vote "Yes" when faced with a campaign where the information has been highly focussed with a strong message.

As expected, the coefficient on the Cost of the Referendum variable is negative and significant. Thus, as the cost increases, the probability of voting for it decreases. The other variables show that higher educated people are more likely to vote yes, as are people with pro-environment views. The probability of voting yes also increases with the number of types of values that are rated important. Also, respondents that participated in outdoor recreation in the year prior to the survey are more likely to vote yes.

The three statistics included at the end of Table 4-4 are measures of goodness of fit. The percent correctly predicted shows how accurately the model predicted yes

and no votes. This model predicted correctly 75.3% of the responses, which is quite high for these types of models.

The median willingness-to-pay for each campaign scenario can be calculated from the results of this dichotomous choice model. Since there are not enough data points to estimate the model for each campaign separately, the impact of the campaign can only be a shift. That is, it only enters the calculation as a change in the intercept.

The general formula for the median is:

$$(1) \quad Median_{Campaign} = (Intercept + \beta_{Campaign} + \sum \beta_i \bar{X}_i) / -\beta(Bid)$$

Thus, to get the median for Campaign 4 (Open Ended), first multiply the coefficients for the socio-demographic and attitudinal variables by their respective means. Then, take the sum of those products, and add to it the intercept and the value of the Campaign 4 dummy variable. This sum is then divided by the absolute value of the coefficient on the Cost of the Referendum. Table 4-5 shows the value of the medians for each of the campaigns, calculated in this manner.

As shown in Table 4-5, the median voter's willingness-to-pay follows the pattern shown in previous analyses. The median for Campaign 1 (\$125 Bidding Game) is larger than all of the others. This result can be interpreted to mean that in a campaign with consistent, high intensity information indicating that the policy is of

Table 4-5: Medians Calculated from Dichotomous Choice Model

Campaign Scenario	Median
Campaign 1 (\$125 Bidding Game)	\$62.31
Campaign 2 (\$25 Bidding Game)	\$51.98
Campaign 3 (Payment Card)	\$54.29
Campaign 4 (Open Ended)	\$53.08

high value, the cost can be high and the referendum will still pass. In this case, if the cost is up to \$62.31, the referendum will pass. Costs above that will exceed the median voter's WTP, and he/she will reject the referendum. The other three campaign scenarios result in medians of \$52 - \$54, implying that the cost must be lower under these scenarios for the referendum to pass. These results indicate that the presence of strong information with a high implied value cue can affect the median voter's value. This result is not surprising given that collecting information is a costly activity. If all the information available is consistent, and it all indicates that the referendum has a high value, it is logical that the information would influence the decision of the voters. The voters use that information instead of undertaking costly information gathering.

#### 4.5 An Analysis of Non-Voters

Another aspect of the contingent valuation results that can be analyzed in a referendum context is the existence of protest responses. Protestors are respondents who refuse, for one reason or another, to reveal their preferences. Instead, they give a zero response to the WTP question. Follow-up probes show that these people actually do have some positive value for the commodity, but they are rejecting the valuation mechanism. To make the analogy with a voting model, protestors can be thought of as non-voters. In a referendum, potential voters who do not participate are in effect rejecting the voting mechanism. They may in fact have an opinion, but they

are refusing to reveal it. This analysis will show if the level of non-voting (protesting) is sensitive to the amount of information available to the voter (respondent). Also, the impact of non-voting on the referendum outcome will be investigated.

In the Monongahela data set, 80 of the 301 completed interviews are classified as protest responses. These respondents were identified according to their response to a follow-up question after the WTP question. People who gave a zero bid were asked:

We have found in studies of this type that people have a lot of different reasons for answering as they do. Some people felt they did not have enough information to give a dollar amount, some did not want to put dollar values on environmental quality, and some objected to the way the question was presented. Others gave a zero dollar amount because that was what it was worth to them.

Which of these reasons best describes why you answered the way you did?

Of these reasons, only two responses are considered valid. These two valid reasons for a zero bid are:

- That is what it is worth to me.
- That is all I can afford (an "Other" response offered by respondents).

Table 4-6 shows the number of protestors, for the various question formats and reasons given by the respondent. As shown on the last row of Table 4-6, the open-ended question format has a larger percentage of protestors than any of the other three formats. This result is not surprising since the open-ended question is

Table 4-6: Reasons for Zero Bids, by Question Format

Reason For Zero Bid	\$125 Game	\$25 Game	Payment Card	Open Ended	Total
Not enough information	2	0	1	1	4
Cannot place dollar value	0	2	4	9	15
Objected to way question was presented	0	1	0	0	1
Government waste or misuse of tax dollars	1	2	2	0	5
Industry pollutes so they should clean it up	0	3	3	2	8
Taxes are too high already	2	1	2	3	8
Does not affect the respondent	0	0	1	0	1
Other	5	5	1	5	16
No reason given	8	3	3	8	22
<b>Total</b>	<b>18</b>	<b>17</b>	<b>17</b>	<b>28</b>	<b>80</b>
Percentage of Total Bids	25.0%	21.8%	22.7%	36.8%	26.6%

considered the most difficult to answer. These results show that the alternative formats do result in fewer protests. Table 4-7 shows chi-square tests for differences in the proportion of protests across versions. The proportion of protestors is significantly higher for the open-ended format than for both the \$25 Bidding Game and the Payment Card.

In the work done by Smith and Desvousges, the protest bidders were dropped from the analysis, as has been done so far in this analysis. However, recent work has proposed that multivariate analyses be used to predict the willingness-to-pay for protestors.<sup>26</sup> As done above in Section 3, a Tobit model is estimated for non-protestors (See Table 3-3). Then, the coefficients from this model are used to generate predicted values for the protestors by applying the estimated coefficients to the corresponding values for those variables for each protestor. Any predicted values that are less than zero are converted to zero since we do not observe any negative willingness-to-pay values.<sup>27</sup> In the Monongahela data set, predicted WTP values can be generated for 66 of the 80 protestors. The other fourteen have missing data in at least one of the variables needed to calculate the predicted WTP. Some key variables and the estimated WTP values for the protestors in this data set are shown in Table 4-8.

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<sup>26</sup>McClelland, Gary, William Schulze, Donald Waldman, Julie Irwin, and David Schenk, 1990, "Sources of Error in Contingent Valuation," unpublished mimeo.

<sup>27</sup>This technique for calculating predicted values from a Tobit model is consistent with Maddala (1983).

Table 4-7: Chi-Square Tests for Differences in Proportion of Protests by Version of Questionnaire

Chi-Square	\$125 Bidding Game	\$25 Bidding Game	Payment Card
Open Ended	2.42	4.21 *	3.63 *
\$125 Bidding Game		0.22	0.11
\$25 Bidding Game			0.02

\* = Significant at 10% level

\*\* = Significant at 5% level

\*\*\* = Significant at 1% level

Table 4-8: Key Information and Predicted Willingness-to-Pay for Protestors

CAMPAIGN <sup>1</sup>	INCOME	OFFER BID	ESTIMATED WTP	VOTE
1	7,500	7.50	106.88	YES
1	2,500	2.50	38.69	NO
1	.	.	.	.
1	42,500	42.50	129.43	YES
1	12,500	12.50	99.13	YES
1	37,500	37.50	19.58	NO
1	.	.	.	.
1	12,500	12.50	27.97	YES
1	12,500	12.50	32.74	YES
1	7,500	7.50	-10.72	NO
1	27,500	27.50	122.32	YES
1	7,500	7.50	-23.53	NO
1	17,500	17.50	116.98	YES
1	2,500	2.50	63.42	YES
1	7,500	7.50	22.92	YES
1	32,500	32.50	73.78	YES
1	27,500	27.50	135.12	YES
1	17,500	17.50	-13.43	NO
2	22,500	22.50	-28.21	NO
2	2,500	2.50	-44.52	NO
2	22,500	22.50	63.79	YES
2	.	.	.	.
2	.	.	.	.
2	.	.	.	.
2	12,500	12.50	-46.35	NO
2	17,500	17.50	0.36	NO
2	22,500	22.50	18.21	NO
2	42,500	42.50	-28.86	NO
2	12,500	12.50	-59.16	NO
2	32,500	32.50	41.11	YES
2	12,500	12.50	33.71	YES
2	27,500	27.50	31.94	YES
2	7,500	7.50	40.60	YES
2	12,500	12.50	-12.71	NO
2	17,500	17.50	71.54	YES
3	.	.	.	.
3	27,500	27.50	119.12	YES
3	12,500	12.50	-21.68	NO
3	22,500	22.50	-11.58	NO

<sup>1</sup> Campaign 1: \$125 Bidding Game      Campaign 2: \$25 Bidding Game  
 Campaign 3: Payment Card              Campaign 4: Open-Ended

Table 4-8: Key Information and Predicted Willingness-to-Pay for Protestors  
(continued)

CAMPAIGN	INCOME	OFFER BID	ESTIMATED WTP	VOTE
3	7,500	7.50	-39.53	NO
3	7,500	7.50	-14.80	NO
3	37,500	37.50	90.81	YES
3	22,500	22.50	80.42	YES
3	27,500	27.50	72.67	YES
3	17,500	17.50	17.02	NO
3	32,500	32.50	65.78	YES
3	12,500	12.50	11.10	NO
3	.	.	.	.
3	22,500	22.50	67.62	YES
3	2,500	2.50	60.22	YES
3	32,500	32.50	64.91	YES
3	17,500	17.50	-16.63	NO
4	17,500	17.50	69.07	YES
4	37,500	37.50	-2.73	NO
4	.	.	.	.
4	27,500	27.50	45.53	YES
4	32,500	32.50	24.97	NO
4	37,500	37.50	22.88	NO
4	.	.	.	.
4	.	.	.	.
4	22,500	22.50	61.32	YES
4	7,500	7.50	-58.64	NO
4	7,500	7.50	38.13	YES
4	22,500	22.50	49.38	YES
4	12,500	12.50	43.18	YES
4	2,500	2.50	-63.69	NO
4	.	.	.	.
4	2,500	2.50	-46.12	NO
4	7,500	7.50	-7.42	NO
4	22,500	22.50	41.35	YES
4	.	.	.	.
4	7,500	7.50	0.59	NO
4	17,500	17.50	18.73	YES
4	7,500	7.50	-53.87	NO
4	2,500	2.50	-59.79	NO
4	27,500	27.50	-12.83	NO
4	.	.	.	.
4	27,500	27.50	71.13	YES
4	.	.	.	.
4	27,500	27.50	-0.03	NO

After WTP values are calculated for the protestors, their votes for or against the referendum can be determined. These votes are interpreted as the vote each respondent would have given if he/she had voted instead of protesting. The vote breakdown for protestors is shown in Table 4-9, along with the vote breakdown for the data set with protestors excluded, and the total data set.

As shown in Table 4-9, the inclusion of estimated votes for protestors is not enough to radically change the voting pattern witnessed across the four campaign scenarios. Protestors are split across yes and no votes in much the same proportion as the non-protestors.

Table 4-9: Calculated Vote Breakdown for Protestors

Question Format	Vote	% Estimated Votes for Protestors	% Excluding Protestors	% Including Estimated Votes for Protestors
Campaign 1: \$125 Bidding Game	Yes	75.0	66.7	68.7
	No	25.0	33.3	31.3
Campaign 2: \$25 Bidding Game	Yes	42.9	39.2	40.0
	No	57.1	60.8	60.0
Campaign 3: Payment Card	Yes	53.3	45.8	47.6
	No	46.7	54.2	52.4
Campaign 4: Open Ended	Yes	42.9	26.2	31.7
	No	57.1	73.8	68.3

## 5. Conclusions

This thesis looks at contingent valuation data collected in 1981. The survey asked for willingness-to-pay values for water quality on the Monongahela River in Western Pennsylvania. The survey design utilizes four different question formats:

- Open-ended with payment card,
- Open-ended without payment card,
- Iterative bidding game with \$25 starting point, and
- Iterative bidding game with \$125 starting point.

Using multivariate (Tobit) analysis and nonparametric tests, this thesis shows that question format influences willingness-to-pay, which is consistent with the findings of Desvousges, Smith and McGivney (1983). Specifically, the multivariate results show that the \$125 bidding game leads to statistically significantly higher WTP values. Similarly, the Wilcoxon Test shows that the \$125 bidding game results in a significantly higher median than the open-ended format and the \$25 bidding game. The same results arise with the Permutations Test.

This thesis also addresses the effect of information in a referendum context. Using this contingent valuation data, a referendum on using a tax of 0.02% of income for maintaining water quality in the Monongahela River is constructed. Four different campaign scenarios, corresponding to the four different question formats, are compared. Each scenario reflects differing doses of information, ranging from high

implied value-highly concentrated information to no implied value-very diffuse information.

Under the four different campaign scenarios, votes for the referendum are tallied. The campaign associated with the \$125 bidding game, one with the highest value cue and the most focussed information, results in passage of the referendum with 66.7% voting yes. The referendum does not pass in any of the other scenarios. A Chi-square test for differences in proportions of yes votes does reveal statistically significant differences among the campaigns. The proportion of yes votes from Campaign 1 (derived from the \$125 bidding game) is significantly higher than any of the other three campaigns.

Using dichotomous-choice estimation techniques, the median willingness-to-pay can be calculated under each of the four campaign scenarios. Assuming single peaked preferences, this value reflects the value at which the referendum will pass. As expected, the median for Campaign 1 is much higher than the other three, implying that the referendum will pass even at a higher cost. The median for Campaign 1 is \$62, while the medians for the other three campaigns range from \$52 to \$54.

The last section of this thesis addressed the question of non-voters. In contingent valuation surveys, there are typically respondents who give a \$0 response because they are rejecting the valuation exercise, not because they have no positive value for the commodity. These respondents are identified with follow-up probe questions. These protestors are akin to non-voters. Non-voters may indeed have an

opinion on the referendum, but they reject the voting mechanism. With the exception of the Campaign 4 (open-ended format), the proportions of protestors are relatively similar, ranging from 22% to 25%. However, the campaign derived from the open-ended format results in a higher proportion of protestors with almost 37%. A Chi-square test shows that this proportion of non-voters for Campaign 4 (Open-ended) is significantly higher than the proportion for Campaign 2 (\$25 bidding game) and Campaign 3 (Payment Card).

Using Tobit equations estimated for the valid willingness-to-pay data, WTP values can be calculated for the protestors. Then, comparing these estimated WTP values to the offer bid (0.02% of income), a vote can be derived for the non-voters. However, the inclusion of these imputed votes in the referendum tally does not change the outcome.

Taken together, the analysis in this thesis show that information has a marked effect on respondents. As Desvousges, Smith, and McGivney showed in their work, question format influences WTP responses. Since different question formats transmit different levels and types of information to respondents, this result is not surprising. This result can then be generalized to a referendum context. Voters use information to assist in decision-making. Since gathering information is costly, they use the information made available to them by the campaign, and that information influences their decisions in predictable ways.

## BIBLIOGRAPHY

1. Bishop, Richard C. and Thomas A. Heberlein, 1979, "Measuring Values of Extra-Market Goods: Are Indirect Measures Biased?" *American Journal of Agricultural Economics* vol. 61, no. 5, pp. 926-930.
2. Black, Duncan, 1948, "On the Rationale of Group Decision Making," *The Journal of Political Economy* vol. 56, pp. 23-34.
3. Boyle, Kevin J., Richard C. Bishop, and Micheal P. Welsh, 1985, "Starting Point Bias in Contingent Valuation Surveys," *Land Economics* vol. 61, pp. 188-194.
4. Cameron, Trudy Ann, 1988, "A New Paradigm for Valuing Non-Market Goods Using Referendum Data." *Journal of Environmental Economics and Management* vol. 15, pp. 355-379.
5. Daubert John T., and Robert A. Young, 1981, "Recreational Demands for Maintaining Instream Flows: A Contingent Valuation Approach," *American Journal of Agricultural Economics* vol. 63, no. 4, pp. 666-676.
6. Desvousges, William H., V. Kerry Smith, and Matthew McGivney, 1983, *A Comparison of Alternative Approaches for Estimating Recreation and Related Benefits of Water Quality Improvements*, Environmental Benefits Analysis Series, Washington, DC: US Environmental Protection Agency.
7. Desvousges, William H., F. Reed Johnson, Richard W. Dunford, Kevin J. Boyle, Sara P. Hudson, and K. Nicole Wilson, 1992, *Using Contingent Valuation to Measure Nonuse Values: An Experimental Evaluation of Accuracy*, Research Triangle Institute Monograph.
8. Greenley, Douglas A., Richard G. Walsh, and Robert A. Young, 1981, "Option Value: Empirical Evidence from a case Study of Recreation and Water Quality," *Quarterly Journal of Economics* vol. 96, no. 4, pp. 657-672.
9. Hanemann, Michael, 1984, "Welfare Evaluations in Contingent Valuation Experiments with Discrete Responses," *American Journal of Agricultural Economics* vol. 66, pp. 332-341.
10. Maddala, G.S., 1983, *Limited-Dependent and Qualitative Variables in Econometrics*, Cambridge University Press.

11. McClelland, Gary, William Schulze, Donald Waldman, Julie Irwin, and David Schenk, 1990, "Sources of Error in Contingent Valuation," unpublished mimeo.
12. Mitchell, Robert C. and Richard T. Carson, 1981, "An Experiment in Determining Willingness to Pay for National Water Quality Improvements," draft report to the U.S. Environmental Protection Agency, Washington, D.C.
13. Mitchell, Robert C. and Richard T. Carson, 1984, *A Contingent Valuation Estimate of National Freshwater Benefits: Technical Report to the U.S. Environmental Protection Agency*, Washington, DC: Resources for the Future.
14. Mitchell, Robert C. and Richard T. Carson, 1985, "Comment on Option Value: Empirical Evidence from a Case Study of Recreation and Water Quality," *Quarterly Journal of Economics* vol. 100, no. 1, pp. 291-294.
15. Mitchell, Robert C. and Richard T. Carson, 1989, *Using Surveys to Value Public Goods: The Contingent Valuation Method*, Washington, DC: Resources for the Future.
16. Roberts, Kenneth J., Mark E. Thompson, and Perry W. Pawlyk, 1985, "Contingent Valuation of Recreational Diving at Petroleum Rigs, Gulf of Mexico," *Transactions of the American Fisheries Society* vol. 114, no. 2, pp. 214-219.
17. Slovic, Paul, Baruch Fischhoff, and Sarah Lichtenstein, 1980, "Response Mode, Framing, and Information-Processing Effects in Risk Assessment," in Robin M. Hogarth, ed., *Question Framing and Response Consistency*, San Francisco: Jossey-Bass.
18. Smith, V. Kerry and William H. Desvousges, 1986, *Measuring Water Quality Benefits*, Boston: Kluwer-Nijhoff.
19. Tversky, Amos, and Daniel Kahneman, 1982, "The Framing of Decisions and the Psychology of Choice," in Robin M. Hogarth, ed., *Question Framing and Response Consistency*, San Francisco: Jossey-Bass.

## VITA

Sara P. Hudson was born in Portsmouth, Virginia on June 5, 1965. She attended the College of William and Mary from 1983 to 1986, graduating with a Bachelors of Arts degree in Economics.

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A handwritten signature in cursive script that reads "Sara P. Hudson". The signature is written in black ink and is positioned above a solid horizontal line.

Sara P. Hudson

# USING CONTINGENT VALUATION DATA TO SIMULATE REFERENDUMS

by

Sara P. Hudson  
(Abstract)

Does the way a question is asked affect the answer given? This thesis looks at this question from two perspectives.

First, using contingent valuation data for water quality in the Monongahela River in Western Pennsylvania, an analysis is performed to test for differences in responses across four different formats of the willingness-to-pay question. This analysis shows that the question format has some systematic relationship with the valuation responses given. Specifically, iterative bidding games with high starting points lead to higher willingness-to-pay values than other formats. This result appears to arise from information relayed to the respondent from the question format. That is, since the bidding begins at a high value the respondent interprets that information as a cue to what the value of the commodity should be.

The four different question formats are then re-interpreted in a referendum context. Referendum campaigns can be characterized by the amount of information provided to the voters and the degree of focus of that information. For example, some referendum campaigns give the voters a great deal of data, and that data all

gives a consistent message. Other campaigns provide very little information for the voters to use in their decision. By transforming the willingness-to-pay data into a discrete-choice format, referendum models are simulated. Then, an analysis shows how the characteristics of the information content affect the vote. Also, the value of the median voter is calculated. This median shows the value at which the referendum just passes. This analysis shows that the campaign associated with the high starting point bidding game yields that highest percentage of yes votes and the highest median-voter value.

Finally, the referendum data are used to analyze differences in non-voting behavior. Those respondents who protest the valuation mechanism are analogous to nonvoters in a referendum. The analysis shows that the voters faced with a campaign where there is very little, if any, information given are less likely to vote.

This thesis explores the similarities between the contingent valuation task and the voting task for respondents. The behavior exhibited by respondents is affected by the information available to them in predictable and sensible ways.