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THE CASE FOR DIMINISHING MARGINAL EXISTENCE VALUES

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The Case for Diminishing Marginal Existence Values

Abstract

This study addresses the debate over sensitivity of existence values as measured by contingent valuation to the scope of the good. We reconcile much of the debate within one theoretical model. If marginal WTP for existence goods is diminishing, then a given study that tested for sensitivity to scope over a range for which marginal WTP is high would be more likely to detect sensitivity to scope than another similar study that focused on a range for which marginal WTP is much lower. An empirical model is developed to demonstrate this point. The study finds that the existence value of remote wilderness parks are sensitive to scope, but that differences in WTP for given proportionate changes in scope vary over the WTP curve in a way consistent with diminishing marginal WTP. These results have significant implications for future contingent valuation work.

The Case for Diminishing Marginal Existence Values

This paper contributes to the debate over the use of contingent valuation to measure existence values. In the debates over environmental damage assessment, there has been much disagreement over the extent to which non-users of a compromised resource suffer economic damages [11, 16, 2, 5]. The sensitivity of measured existence values to changes in the size of scope of the good has been called into question [1, 3, 6, 14]. A number of studies have investigated the issue of insensitivity to scope [13, 4, 17, 18, 15], conducting empirical tests and proposing theoretical explanations. Much of the empirical literature focuses on whether or not existence values as estimated by CV are sensitive to scope of the existence good in question [3, 4, 5, 18]. For example in a study of migratory waterfowl deaths, Boyle et al [3] found insensitivity to scope of migratory waterfowl deaths for 2% or less of waterfowl populations, and recommended further research to investigate the measurement of the value of small changes in the provision of environmental goods.

Much of the literature that interprets the implications of the debate do so in terms of the reliability of CV to measure existence values. Diamond and Hausman [7] review a number of CV studies that are not sensitive to scope and conclude that because individuals may not be able to distinguish between goods of different scope, reliability of CV estimates of existence values are suspect. In their study of the value of the 49th and 50th parks out of a system of 57 wilderness parks, McFadden and Leonard [14] conclude that CV estimates are not sensitive to scope in the case of unfamiliar and remote wilderness areas. Carson [4] reviews over 30 tests in which CV estimates are sensitive to scope and concludes that CV can produce reliable estimates in well constructed studies. Smith and Osborne [18] used a meta-analysis of past CV studies to conclude that estimates of the values of changes in visibility are sensitive to scope, and that similar analysis could be used to determine the reliability of existence values for other goods.

A number of papers have been concerned with how to devise various 'tests of scope' that any CV study must pass in order for the estimates to be regarded as reliable [1, 6]. Diamond [6] has proposed a simple test of scope in which the ratio of two WTP estimates for two different levels of scope should be

greater than the ratio of the differences in size of the existence good. Smith and Osborne [18] have questioned whether it is a reasonable task to develop an unambiguous test for scope, given the varying reasons for how changes in WTP may be associated with changes in the scope of a good.

Upon reviewing the above studies, it seems to us that seemingly conflicting results could all be reconciled within a simple theoretical framework, with implications for the design of contingent valuation studies to measure existence values. The theory is very straightforward, following the familiar Okum's razor principle of not using a more complicated theory when a simpler one will do. The empirical work was rather involved due to the number of internal consistency checks we built into the study.

We focus on the sensitivity of willingness to pay for successive quantities of preservation. Willingness to pay (WTP) was estimated for proposals to create four parks in Canada's Northwest Territories (NWT). Each park represents a unique Canadian ecosystem, and all were sufficiently remote that only 3 percent of the respondents who voted for park creation indicated they might some day visit them. We thus postulate that the primary component of value being measured is existence or passive use value.

The context of the empirical study, which was shared with the respondents via an information packet and map, was that out of a total of 39 distinct ecological regions of Canada, as defined by biologists, ten did not yet have representative protected areas with the level of protection associated with national park designation. One of the ten is in southern British Columbia, five are in Northern Quebec and Labrador and four are in the Northwest Territories (NWT). Canada's National Parks System plan calls for completion of the Parks System by creating 10 parks that would incorporate protected areas representative of each of the remaining 10 ecological regions in Canada. At the time the study was developed, Parks Canada had developed proposals for four specific remote wilderness parks to be created in each of the four ecological regions in the Northwest Territories. The empirical portion of this study is concerned with the values of creating the four NWT parks and of completion of the parks system as a whole. In order to test for scope effects, we split the sample to include tests for the value of individual parks, pairs of parks, four parks, or ten parks. For scope tests alone, there were 9 versions of the survey instrument.

In addition to the tests for embedding and scope effects, we had several split-sample experiments to test: the effects of question ordering, media effects (phone-mail-phone versus mail only), double-bounded versus single-bounded dichotomous choice question format, level of information provision, and donation to a foundation versus tax payment vehicle. Ultimately, not including a parallel discrete choice experiment study that was conducted concurrently, there were over 50 versions of the survey instrument. Every version was available in French and in English. Phone interviews conducted in French were conducted by native French-speaking interviewers. For a description of the phone-mail-phone part of the research refer to Gunning-Trant [10].

The paper is organized as follows. Section 2 develops the theoretical model of diminishing marginal existence values. Section 3 describes the Northern Parks study and data. Section 4 presents empirical results that show diminishing marginal WTP. Section 5 describes the quality of the survey design, several tests for internal consistency of the contingent valuation application, and their results. Implications are discussed in Section 6.

II. THEORY OF DIMINISHING MARGINAL EXISTENCE VALUES

In this section we first review the context in which we expect to find diminishing marginal values for preserving additional wilderness areas. We note the circumstances in which recent work has contended that, conversely, WTP may be expected to be convex and we explain where our study differs. We suggest a framework which is consistent with the seemingly disparate results of various empirical scope tests in the literature.

In the following theoretical development, we refer to parks to preserve wilderness areas. One could substitute some other amenity, such as preservation of additional species. We develop the theory for the case when several aspects of the context are held constant. Regardless of whether we are discussing preservation of wilderness areas, species, or some other amenity, the respondent is informed of the maximum number to be preserved by the proposed program for wilderness valuation, the respondent also is told the context of how many areas are already preserved.

For example, our empirical work was conducted in the context of a proposed public policy that would preserve representative examples of distinct ecological regions by establishing parks with high levels of protection. Respondents were told the context, which is that biologists have identified 39 distinct ecological regions in Canada, that 29 of these regions contained at least one national park, and that 10 did not. We investigated the value of representing more regions (1, 2, 4 and 10) with parks.

If people value knowing that representative examples of each ecological region are represented within a system of protected areas, then utility can be represented by $U(x,y)$ where y = the number of parks created out of 10 potential parks remaining to complete the system and x = all other goods. Holding the prices of all other goods constant, we can write utility as $U(I,y)$ where I is income:

$$U(I,y) \tag{1}$$

From strict convexity of preferences, $U(\bullet)$ is locally quasiconcave, implying diminishing marginal rates of substitution. This is demonstrated mathematically below for the case of zero income effects and the case when income effects may be present. Diamond [6] has a more complex derivation which would simplify to the case below if 1) the maximum size of the environmental amenity (total possible number of birds, total number of parks to be created) were held constant, and 2) it were clearly the case that without payment the proposed good would not be provided. The survey design controlled for both these items and thus the more complex models are not necessary. Instead, we focus on whether the data from our study are consistent with the standard economic assumption that $U(\bullet)$ be locally quasiconcave.

Suppose there are zero income effects. Utility can be written as $I + U(Y)$, and then

$$WTP(y) = \frac{U(y) - 0}{\lambda} = \frac{1}{\lambda} U(y) \tag{2}$$

where λ is the marginal utility of income, $\lambda > 0$.

Differentiating Eq. (2) twice with respect to y, it is clear that if U is concave in y then WTP would also be concave in y. Thus we would see diminishing marginal willingness to pay for each additional park created.

Permitting income effects, WTP(y) satisfies Eq. (3):

$$U(I - WTP(y), y) = U(I, 0) \tag{3}$$

The right hand side of Eq. (3) sets $y = 0$ because the information provided prior to the contingent valuation question states that the parks would not be created if enough people voted against the proposal. Differentiating Eq. (3) once with respect to y, and using subscripts to denote partial derivatives, gives

$$-U_I(I - WTP(y), y)WTP_y + U_y(I - WTP(y), y) = 0 \tag{4}$$

or,

$$U_I(I - WTP(y), y)WTP_y = U_y(I - WTP(y), y) \tag{5}$$

From Eq. (4), willingness to pay should be increasing in the number of parks. Differentiating a second time gives:

$$WTP_{yy}U_I(I - WTP(y), y) = U_{yy}(I - WTP(y), y) + \left(WTP_y(y)\right)^2 U_{II}(I - WTP(y), y) \tag{6}$$

Investigating the signs of the terms in Eq. (6):

$$U_I > 0,$$

that is, utility is increasing in income;

$$U_{yy} < 0,$$

that is, utility is locally quasiconcave in number of parks; and

$$U_{II} < 0,$$

that is, utility is locally quasiconcave in income. Thus,

$$WTP_{yy} < 0. \tag{7}$$

From Eq. (7), as the number of parks to be created increases, the marginal willingness to pay for an additional park should diminish.

Suppose a study, Study I, was designed to estimate WTP for subunits of differing scope for a good in the lower region of the WTP curve shown in Figure 1, while another study, Study II, was designed to estimate WTP for different scoped units of the same good in the upper region of the same WTP curve. Study I might determine WTP for a program to create 2 parks, 3 parks and 4 parks, for

example; while Study II might determine WTP for 8 parks, 9 parks and all 10 parks. We can further imagine that, except for the scope of the good, all other elements of the studies are identical (payment vehicles, information, CVM elicitation format, sample design).

It is feasible that Study II results might indicate no measurable difference in WTP between subunits of different scope. Meanwhile Study I, which uses subunits of the same difference in scope as those in Study II, but along a different section of the WTP curve, would theoretically result in a much greater difference in WTP.

As stand alone studies, results of these two hypothetical studies might appear to support conflicting interpretations as to whether respondents are able to respond to valuation questions regarding the good. One might conclude from Study II that respondents do not have an ability to express economic values for existence goods, that respondents cannot distinguish between goods of different scope, and that contingent valuation is not useful, because existence values would appear to be too fickle to be measurable. In direct contrast, one might conclude from Study I that people can respond to valuation questions about existence goods and that the measured values appear to be consistent with economic theory.

One may interpret results as not passing a reliability test when in fact the issue is that one does not know where the subunits of differing scope are positioned on the curve. By using the same CV instrument and varying the scope of the good sufficiently, one can easily obtain results that would support the notion that both sets of results, from Studies I and II, are fully consistent with one another and with economic theory. Thus, any CVM study that attempts to elicit existence values should provide a minimum level of information that includes finite beginning and ending points to the WTP curve in order to allow respondents to determine the appropriate level of scope. We demonstrate this empirically by comparing WTP for adding additional parks to a national parks system, with the goal of having 39 ecologically distinct regions represented within the system, when 29 are currently represented.

III. AN EMPIRICAL EXAMPLE USING SUB-SETS OF THE LARGEST SCOPED GOOD

The contingent valuation (CV) study consisted of two surveys: a 'mixed-mode' phone-mail-phone survey and a mail-only survey. The mixed-mode survey relied on random digit dialing (RDD) to make first

contact with a random sample of Canadians. The Angus Reid Group, Canada's foremost survey research firm, conducted all interviews. The first interview asked a variety of attitudinal questions and questions designed to force respondents to make choices between a variety of alternative policy options with different economic implications. These questions were of a general nature, to prepare respondents for the CV task; however, a specific focus on protected areas was not revealed during the first interview to reduce response bias. The first interview gathered demographic data and the names and addresses of participants, so they could be mailed the informational materials. Participants were phoned for a second interview during which the CV questionnaire was implemented. Mixed-mode participants did not receive a written copy of the questionnaire.

Mixed-mode participants were each asked two double-bounded dichotomous choice referendum format valuation questions. One question was to vote on the creation of four specific parks in the NWT. These parks have been proposed by Parks Canada, and were individually described to respondents in mailed information packets. The other question was to vote on a proposal to create all ten parks as necessary to establish protected areas to represent each of the 39 ecological regions in Canada. The question order was rotated so that 50% of the sample received the 4-park proposal first and 50% received the 10-park proposal first, so that ordering effects could be tested. In addition, 50% of the sample was asked whether they would vote for each proposal if it were to cost their household nothing, before the double bounded bid questions, in order to test for 'yea-saying'.

From an initial 558 RDD phone connections, 201 declined to be interviewed, leaving an initial response rate of 64%. Of the 357 contacts who agreed to participate, 304 (85%) completed the second phone interview (due to budget constraints, the period for the second contact was limited to 1 week). The item non-response rates for the phone CV questions were: 9.5% for the 4-park proposal and 8.2% for the 10-park proposal.

As much as was possible, the survey was designed to conform to the NOAA recommendations on survey design. Survey instruments and informational materials were developed over a period of two years, with numerous focus groups using verbal protocol, pretests and a pilot for each survey instrument. These extensive development efforts paid off in terms of respondent understanding of the task, credibility

of the scenario, response rates on general population surveys dealing with a remote and unfamiliar good, item response rates to the CV questions, assurance that votes made full reference to program costs, and reasonable sensitivity to scope.

The mail-only survey packet consisted of the information pages and a questionnaire. These were mailed to a random sample of named Canadians over age 18, resulting in an overall response rate of just over 50%. The average item non-response rate for the mail-only survey instrument was 5.9%. The mail-only instrument was divided into a number of versions according to an experimental design plan that allowed for internal consistency tests. Versions used for the scope tests, and response rates are listed in Table 1. All versions reported on in this paper used double bounded dichotomous choice referendum questions with a one-time surtax as a payment vehicle.

Both the mixed-mode and the mail-only survey instruments included a section that prompted respondents to be cognizant of their budget constraints, asked them to indicate from what category of discretionary funds they would make their payment, and to be aware of how the payment might affect their options for other uses of the same funds. Both instruments allowed respondents to change their answers in light of budget considerations.

The survey instrument stressed that few visitors would ever visit these remote northern parks, that recreation opportunities for those who went would be limited, and the purpose of these parks would be to preserve representative examples of Canada's 39 Natural Regions. Repeated checks in the survey instrument indicate that the vast majority of WTP responses are indicative of existence, not use, values.

Both CV instruments used the same set of informational materials. Information packets included 2 pages common to all versions, and combinations of up to four additional park-specific pages for park-specific versions. The common pages included maps and text describing the goal to complete the National Parks System by creating parks that would each represent the 10 different Canadian ecological regions which are not yet represented in the current Parks system. A map of Canada outlined all 39 ecological regions, indicated the 29 already represented in the Parks System, and the 10 which remain to be represented. The text explained that the remaining regions are in very remote northern areas. The mail-only sample included splits that were designed to test for information effects, as explained below.

Northern tundra ecosystems were described as being especially fragile and slow to recover from disturbance. For these reasons, the parks would not be developed as tourist destinations, but instead as natural preserves. The information discussed substitute uses, characterized in terms of the economic trade-offs. If parks were created, all exploration for mineral deposits would cease and the areas could never be used for mineral extraction, which could provide jobs and revenue for poor northern communities. Mining is an important source of NWT economic development. The information packet included four individual pages with detailed maps and descriptions of each of four specific proposed parks for the NWT.

IV. EMPIRICAL RESULTS

The data from this study conform both to Eq. (3) which implies WTP is increasing in the number of parks, and to Eq (7) which implies diminishing marginal WTP. Using the mail survey, the value estimated for 1 park was $114.66, the value estimated for 2 parks was $147.17, the value estimated for 4 parks was $211.33 and the value for 10 parks was $212.45. Table 2 shows the coefficients and confidence intervals in addition to these point estimates. Figure 2 illustrates WTP versus number of parks; the 'curve' is clearly increasing and concave, except that the difference between WTP for 4 parks and WTP for 10 parks is insignificant. One explanation for this would be that after 4 parks have already been created the consumer is nearing satiation and marginal WTP is low.

Marginal WTP was computed from the total WTP estimates where possible. Figure 3 shows the way marginal WTP diminished. The marginal value of the first park is equivalent to the value for one park, estimated at $114.66. Subtracting WTP for 1 park from WTP for 2 parks, a point estimate for the marginal WTP for a second park is $32.51. Marginal WTP equal to $64.16 for two more parks (the third and fourth) is found by subtracting WTP for 2 parks from WTP for 4 parks. For mail survey estimates, adding 6 more parks after four have been created is worth only $1.12. For graphing purposes in Figure 3, the marginal WTP when it was computed over more than 1 park was split evenly between the number of additional parks used in the estimate; that is why these regions look flat.

Table 3 shows the results of computing marginal WTP for the mail and phone surveys. In Table 3, estimated standard errors and t-statistics for the marginal WTP are also shown. For the first increments to the park system, the t-statistics are high. The values are clearly sensitive to changes in scope. As the

value of an additional park diminishes toward zero, we lose the power to distinguish between goods of different scope. A larger sample size would be required to decrease the standard error, which otherwise is large with respect to the marginal value.

The standard errors in Table 3 are estimates assuming zero covariance between values estimated from independent samples and assuming symmetry of the error distribution in a very small neighborhood around the point estimates. Recall that var(A-B) = var(A) + var(B) if cov(A,B)=0, and that the t-value for a 99% confidence interval (c.i.) is 2.576. Since the 99% c.i. were actually computed by the Krinsky & Robb method, the standard errors were estimated as follows:

Let U = upper bound of the 99% c.i.,

WTP = point estimate, and

L = lower bound of the 99% c.i.

Then $s_+ = \frac{U - WTP}{2.576}$

$$s_- = \frac{WTP - L}{2.576}$$

where s_+ is the estimated standard error of WTP as parks are added, and s_- is the estimated standard error of WTP as parks are taken away.

Based on the fact that different levels of information were provided for the four parks than for the remaining 6 parks, one might posit an information provision effect instead of diminishing marginal WTP to explain why there was little difference between WTP for 4 parks versus 10 parks. This possibility was tested and rejected. The information effect could potentially have arisen because the 4 park proposal respondents were given specific information sheets about each of the four parks (there were only 4 specific park proposals, the other 6 were "generic" in the sense that respondents only knew that they would be representative of natural regions that were as yet not represented in the Parks system). Therefore respondents to the 10 park proposals who had already received a 1 park proposal would have only seen a specific information sheet pertaining to one out of the 10 parks. The respondents to the 10 parks proposals who had also received a 4 park proposal would have seen all 4 specific information sheets.

Therefore if there had been information effects, we would anticipate that the 10 park values for those receiving the 4 information sheets would be different from the 10 park valued from those receiving only 1 sheet.

In order to more fully explore this possibility, the sample that included 10 park questions was split in order to determine the effect of information. A subsample that was asked only one CVM question, which was for 10 parks, received only the two common pages in their information packet. Thus they received the general description of the goal to preserve examples of all 39 natural regions by creating 10 parks for regions still unrepresented within the National Parks system, and a map showing where these natural regions were located; but were not given specific information about the parks proposed for the Northwest Territories. The WTP for 10 parks for this sample was $218. The sample split that received both the 4 and the 10 park questions received the most complete information packets, which included separate sheets describing particular details and boundaries of each of the four proposed parks in the Northwest Territories. The WTP for all ten parks for this sample was $215.95. There is no statistical evidence that including descriptions of specific parks influenced values for the 10 park proposal.

V. INTERNAL CONSISTENCY AND VALIDITY TESTS

The surveys and informational materials for this study were developed to incorporate three different survey formats (the third was a discrete choice experiment, which will be reported elsewhere) and to conform to a complex experimental design allowing numerous tests for internal consistency and validity of estimates. Results from tests on question ordering, yea-saying, method of survey administration, information effects and contrasting individual parks are briefly discussed here.

In the mixed-mode survey, we tested whether the WTP estimates for ten parks (or four parks) was influenced by the order in which the respondent voted: the smaller-scope project first or the larger scope project first (see table 4). Question order tests confirmed that question order did not significantly affect WTP estimates. The mail-only WTP for the 10 park proposal was estimated to be $218.82 when no other proposal was asked (version 8), $185.01 when the 1 park proposal was also asked (versions 2 and 3), $231.17 when the 2 park proposal was also asked (version 4), and $215.95 when the 4 park proposal was asked (versions 6 and 7). Not only do the directions of values show no consistent pattern based on the

scope of the first question, but the 99% confidence intervals for every sub-sample includes the WTP using the combined all 10 park results (see Table 2). These data do not indicate a problem arises from having included an initial question about a good of smaller scope. There is also no evidence of a directional bias in the estimates from asking one question as opposed to two questions.

Mail-only versions 1 through 4 included different combinations of parks in the one and two park proposals. Statistical tests did not determine any difference in WTP estimates between parks in different ecological regions.

This study provides a controlled comparison between elicitation by mail versus phone. The phone survey WTP for the 4 park proposal was $244.35, while that for the mail survey was $211.33 (Tables 2 and 3), indicating that the two formats provided similar results. Demographic data of the 357 mixed-mode participants conformed well to census data for the national population, while demographic data from the mail-backs conform less well. The mail-only respondents were typically more highly educated with higher average and median income levels than the census and the mixed-mode sample. That the phone instrument resulted in a more representative sample than the mail-only instrument is not surprising and has been noted elsewhere [12, 1]. Differences in WTP results between the instruments were not striking. Tables 2 and 3 show that income and education were not significant predictors of WTP.

Some researchers have suggested that WTP estimates can be biased upwards if respondents feel compelled to answer in a way that they think may be pleasing to the interviewer/survey researcher, but that is not indicative of their true WTP. In order to test for "yea-saying" a random sample of 50% of the mixed-mode respondents and a split of the mail-only respondents were asked an additional question, whether they would vote for the proposal if it effectively would cost their household nothing to do so. There was no evidence of "yea-saying", that is, there was no statistical difference in WTP between those respondents who had the zero-bid questions and those who did not.

VI. IMPLICATIONS

In the light of the present study, seemingly disparate results from previously published scope tests can be reconciled in a single framework. Consider studies where contingent valuation was insufficiently

sensitive to scope. Boyle et al [3] found that values for preventing migratory waterfowl deaths were not sensitive to scope. The 3 levels of insult considered were from less than 1 percent of the waterfowl population to about 2 percent. Perceptually this range may have all been at the upper end of the WTP curve as in our hypothetical Study II, where large sample sizes would be required to detect significant responsiveness to scope. Similarly, values for wilderness areas in the Diamond et al [7] study did not pass a scope test. In this case, the range considered was for protecting the 49th, 50th, or 49th and 50th out of 57 wilderness areas. This may have also been a range such as that in our hypothetical Study II.

Meanwhile, the Carson et al study [5], Loomis and Larson [13], and others have found that contingent valuation results are sensitive to scope. In the Carson et al [5] Southern California study, for example, the two goods considered were restoring 4 species in 15 years versus restoring 2 species in 50 years. The difference in scope between these two scenarios may have fallen in the range of our hypothetical Study I. One of the strengths of the Carson et al [5] study was its conformity with the NOAA guidelines. We do not believe that this alone is sufficient to assure values will pass a scope test. Unless a range of scope changes is considered, CV estimates are vulnerable to being replicated except with a different specification in a change in scope that is close to the upper end of the range, and reaching the opposite conclusion about the CV method's responsiveness to changes in scope.

Many researchers have voiced concern over the issue of scope in measures of existence values, and some have suggested that results such as our hypothetical Study I and Study II above may indicate theoretical inconsistencies [1, 3, 6, 7, 14]. In our study, the difference between the two largest goods was much smaller than the difference between three smaller goods. This is consistent with diminishing marginal existence values for the parks system. However, if a researcher had not known the shape of the marginal value curve, and had concentrated on the larger scope goods, for which the successive increments were so small as to be indistinguishable by empirical methods, it might have erroneously been concluded that people do not distinguish by the scope of the good. This study indicates that people do distinguish between existence goods of different scope, but due to diminishing marginal valuations for larger scope goods, the differences between the values of larger scope goods may be negligible unless sample sizes are adjusted accordingly.

In measuring existence values using contingent valuation, it is necessary to do so in a policy-relevant framework in which the good is anchored within a context that clearly defines the relevant range of scope: how much of the good already exists, what would remain if the policy action is not carried out, and an upper limit describing how much of the good is "sufficient" in terms of a policy-relevant context.

Our work makes three contributions to the debate over whether CV existence estimates are sensitive to scope, what an adequate test for sensitivity to scope must involve and theoretical reasons for why some studies do and others do not result in estimates that are sensitive to scope. The first point involves the importance of a well-defined CV good. We are not the first to make this point [8], yet it is worth reiterating how important it is to 'peg' the end-points of the existence good in order to understand what the WTP curve may look like and where on the WTP curve a good of a given scope would lie. The second point involves the interpretation of scope tests. Our work indicates that it is necessary to recognize the danger of false rejection because the scope test was carried out within a range of the WTP curve too close to the upper end-point for the sample size to detect differences in scope. A good idea for future CV work is to use at least two ranges, as this study did. The added expense of splitting the sample to do so is not great relative to the initial investment in survey design and implementation. The third point involves sample sizes for scope tests. It should be recognized that the upper ends of ranges will require larger samples, and an experimental design plan should reflect this.

Figure 1: Diminishing Marginal Existence Value

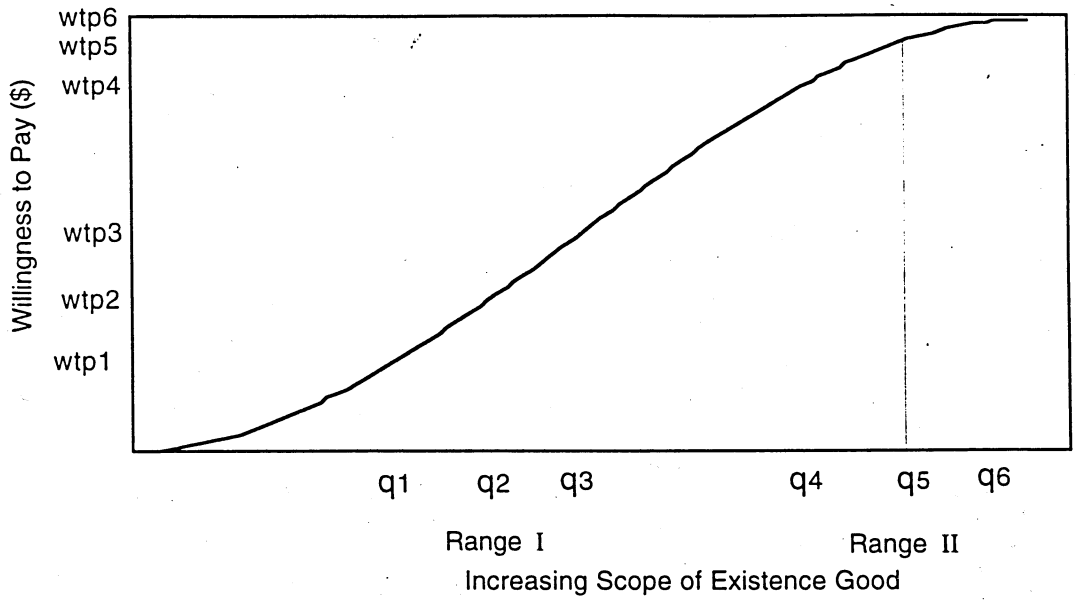


Figure 2

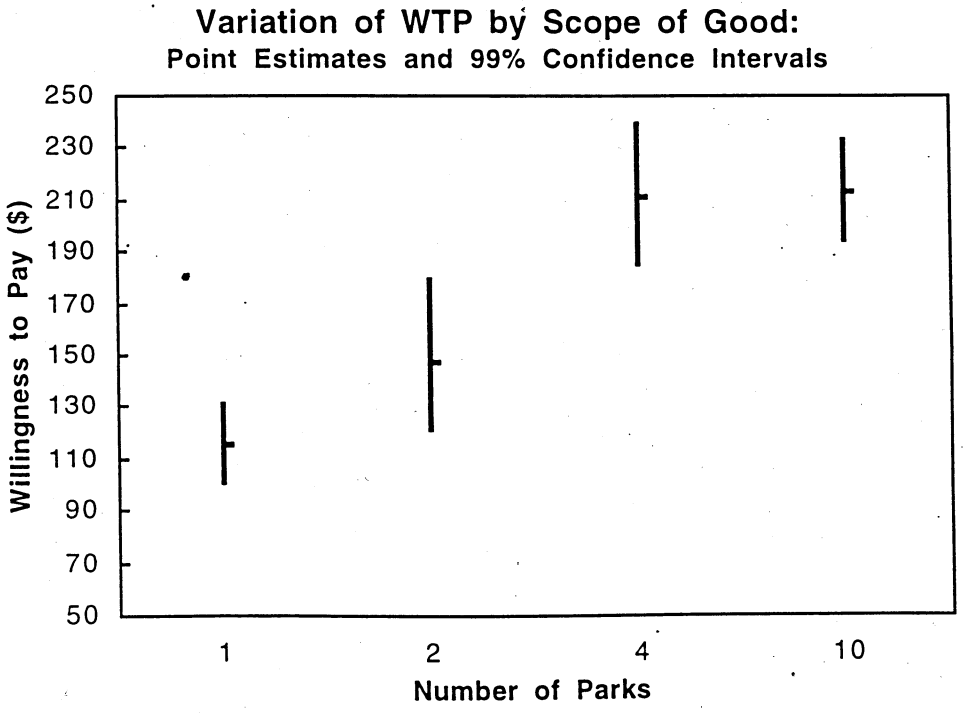


Table 1 CVM Mail Responses - Response Rates by Survey Version and Item Non-response Rates for CVM Questions

		Response Rates by Survey Version			Item Response Rates for CVM Questions[2]			
Version	Type[1]	# sent out	# undeliverable	# returned surveys	# of responses to 1 park questions	# of responses to 2 park questions	# of responses to 4 park questions	# of responses to 10 park questions
1	BC 1	148	13 (8.8%)	72 (53.3%)	67 66	---	---	---
2	ABC 1-10	296	23 (7.8%)	136 (49.8%)	134 127	---	---	133 129
3	BC 1-10	170	12 (7.1%)	83 (52.5%)	78 79	---	---	79 80
4	BC 2-10	374	19 (5.1%)	184 (51.8%)	---	177 175	---	175 175
5	BC 4	146	9 (6.2%)	56 (40.9%)	---	---	53 54	---
6	BC 4 -10	146	17 (11.6%)	70 (54.3%)	---	---	66 66	67 67
7	ABC 4-10	295	17 (5.8%)	143 (51.4%)	---	---	141 136	140 134
8	BC 10	338	13 (3.5%)	158 (48.6%)	---	---	---	152 150
Totals for all versions		1913	123 (6.4%)	902 (50.4%)				

[1] Coding for "type":
- A = includes a question asking whether the respondent would vote yes, to create the proposed park(s), if doing so would cost the respondent's household nothing.
- BC = Double bounded dichotomous choice format.
- Each questionnaire version included either one or two separate proposals. Versions that included only one proposal list only one number for "type"; versions with two proposals list two numbers for "type". Type numbers are coded as follows: 1 = single park proposal, 2 = two park proposal, 4 = 4 park proposal, and 10 = completion of the park system.

[2] Coding for item response rates:
- Two numbers are given for double bounded versions. The first refers to the lower bid amount and the second to the higher bid amount.

Table 2 CVM Mail Results

	All 1-park responses combined	All 2-park responses combined	All 4-park responses combined	All 10-park responses combined
Constant (t-value)	2.24 (1.88)	3.50 (2.40)	5.20 (3.53)	2.56 (3.46)
Bid amount ($)	-0.02 (-8.58)	-0.02 (-6.84)	-0.01 (-8.34)	-0.01 (-14.32)
French language				
education (years)	0.01 (0.22)	0.04 (0.51)	-0.07 (-1.35)	0.05 (1.59)
Age (years)	0.05 (3.55)	0.03 (1.80)	-0.01 (-0.51)	0.02 (2.01)
Per Capita household income (1000's)	-0.00 (-0.09)	0.00 (0.44)	0.00 (0.06)	0.00 (1.17)
awareness of park locations (1=yes; 0=no)	-0.44 (-1.32)	-0.60 (-1.42)	0.01 (0.03)	-0.14 (0.68)
Disagree with goal (1=yes; 0=no)	-1.19 (-4.92)	-0.87 (-2.97)	-0.36 (-1.53)	-1.16 (-7.17)
Past donations ($)	-0.00 (-0.01)	0.00 (1.35)	0.00 (0.32)	0.00 (1.02)
Money from Charitable giving (1=yes; 0=no)	-0.01 (-0.03)	0.54 (1.19)	0.30 (0.83)	-0.29 (-1.39)
Female (1=yes; 0=no)	0.91 (2.30)	0.07 (0.12)	0.58 (1.23)	0.75 (2.70)
N	187	116	175	490
loglikelihood	-152.69	-109.59	-145.34	-411.37
WTP estimate	$114.66	$147.17	$211.33	$212.45
99% c.i. for WTP	$100.41 - $130.46	$120.91 - $178.87	$185.41 - $239.02	$194.18 - $232.19

Table 3 CVM results: Phone survey

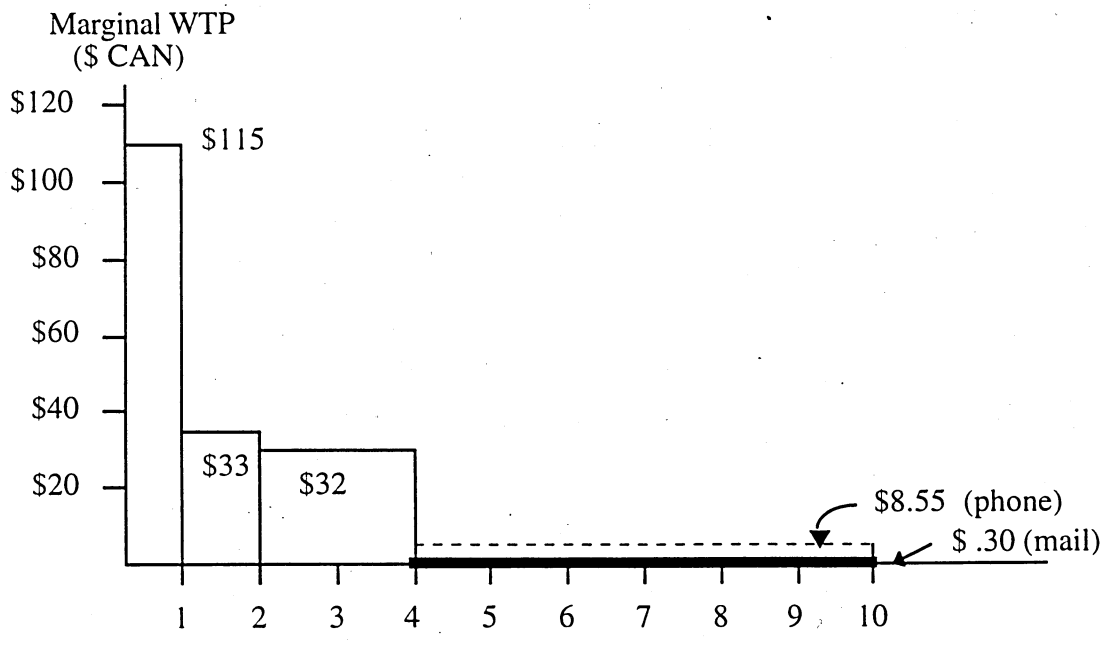
	4 - park first	4 - park second	All 4-parks	10-park first	10 - park second	All 10 -parks
Constant (t-value)	3.058 (2.190)	2.657 (1.899)	2.849 (2.942)	1.978 (1.460)	4.100 (2.741)	3.506 (3.621)
Bid amount ($)	-0.009 (-7.300)	-0.007 (-6.508)	-0.008 (-9.758)	-0.009 (-6.961)	-0.007 (-6.067)	-0.007 (-9.436)
French language (1=yes; 0=no)	-0.517 (-0.998)	-1.124 (-2.218)	-0.801 (-2.261)	-0.303 (0.602)	-1.137 (-2.210)	-0.567 (-1.629)
education (years)	-0.051 (-0.669)	-0.049 (-0.650)	-0.049 (-0.937)	0.042 (0.572)	-0.055 (-0.746)	-0.027 (-0.517)
Age (years)	0.008 (.573)	0.007 (0.547)	-0.008 (-0.851)	0.000 (0.031)	-0.016 (-1.183)	-0.008 (-0.821)
Per Capita household income ($1000's)	0.029 (2.657)	0.007 (0.772)	0.016 (2.325)	0.023 (2.154)	-0.003 (-0.317)	0.014 (1.951)
Awareness of park locations (1=yes; 0=no)	-0.820 (-0.209)	-0.034 (-0.089)	-0.048 (-0.180)	-0.026 (-0.069)	0.155 (0.397)	0.174 (0.663)
Disagree with goal (1=yes; 0=no)	-0.994 (-3.066)	-0.734 (-2.172)	-0.892 (-3.989)	-0.807 (-2.659)	-1.122 (-3.098)	-0.975 (-4.339)
Past donations ($1000's)	-0.000 (-0.296)	0.000 (0.210)	0.000 (-0.001)	-0.033 (-0.035)	1.000 (1.187)	1.000 (1.609)
Money from Charitable giving (1=yes; 0=no)	0.989 (2.439)	0.882 (2.246)	0.938 (3.381)	0.939 (2.399)	1.166 (2.888)	0.319 (1.117)
Female						
N	134	125	259	139	121	260
loglikelihood	-161.22	-109.59	-327.57	-169.12	-145.71	-327.57
WTP estimate	$249.30	$240.74	$244.35	$271.59	$288.72	$278.54
99% c.i. for WTP	$202.95 - $302.80	$184.55 - $321.99	$207.11 - $285.00	$223.26 - $338.73	$231.14 - $367.42	$242.03 - $326.23

Table 3
Finding Significant Sensitivity to Scope When Marginal Willingness to Pay is Diminishing

	Mail			Phone		
Description	WTP'	Estimated Standard Error	t-value	WTP'	Estimated Standard Error	t-value
WTP'(1..4)	211.33	10.06	18.01	244.35	14.46	16.90
WTP'(1)	114.66	6.13	18.70			
WTP'(2)	32.51	11.89	2.73			
WTP'(3..4)	64.16	15.90	4.03			
WTP'(5..10)	1.12	12.88	0.09	34.19	21.21	1.61

Notation: WTP'(n) = marginal WTP for the nth through the nth park.
WTP'(n...n+k) = marginal WTP for the nth through the (n+k)th parks.

Figure 3
Diminishing Marginal WTP



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APPENDIX: Derivation of the second derivative of Eq. (4)

The first derivative:

$$U_I(I - WTP(y), y)WTP_y = U_y(I - WTP(y), y) \tag{5}$$

$$WTP_{yy}U_I(I - WTP(y), y) + WTP_y\left(U_{II}(I - WTP(y), y)\left(-WTP_y(y)\right)\right) + WTP_yU_{Iy}(I - WTP(y))$$

$$= U_{yy}\left(I - WTP(y), y\right) + U_{yI}\left(I - WTP(y), y\right)\left(-WTP_y(y)\right)$$

so:

$$WTP_{yy}U_I(I - WTP(y), y) - \left(WTP_y\right)^2 U_{II}(I - WTP(y), y) + WTP_yU_{Iy}(I - WTP(y))$$

$$= U_{yy}\left(I - WTP(y), y\right) - WTP_y(y)\,U_{yI}\left(I - WTP(y), y\right)$$

so:

$$WTP_{yy}U_I\left(I - WTP(y), y\right) + 2WTP_yU_{Iy}\left(I - WTP(y), y\right)$$

$$= U_{yy}\left(I - WTP(y), y\right) + \left(WTP_y\right)^2 U_{II}\left(I - WTP(y), y\right)$$

and $U_{Iy} = 0 \quad \Rightarrow$

$$WTP_{yy}U_I\left(I - WTP(y), y\right) = U_{yy}\left(I - WTP(y), y\right) + \left(WTP_y(y)\right)^2 U_{II}\left(I - WTP(y), y\right) \tag{6}$$