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ANALYSIS

The effect of distance on willingness to pay values: a case study of wetlands and salmon in California

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Abstract

Most contingent valuation studies in the literature utilized a pre-determined geographic market area for their sample frame. In other words, they did not include variables that would measure the extent of the geographic areas over which to aggregate willingness to pay. These studies implicitly assumed that the effects of geographic distance were moot; an assumption that could have led to an understatement of the aggregate benefit values computed in these studies. The overall goal of this study was to determine if distance affects willingness to pay for public goods with large non-use values. The data used came from a contingent valuation study regarding the San Joaquin Valley, CA. Respondents were asked about their willingness to pay (WTP) for three proposed programs designed to reduce various environmental problems in the Valley. A logit model was used to examine the effects of geographic distance on respondents' willingness to pay for each of the three programs. Results indicate that distance affected WTP for two of the three programs (wetlands habitat and wildlife, and the wildlife contamination control programs). We calculate the underestimate in benefits if the geographic extent of the public good market is arbitrarily limited to one political jurisdiction.

Keywords: Willingness to pay; Contingent valuation; Dichotomous choice; Extent of the market

1. Introduction

As threats mount against the world's limited wildlife areas and natural resources, and environmental problems increase, the discipline of economics can play an important role (Mills and Graves, 1986). Economists have contributed through the use of non-market valuation techniques which have dramatically increased in use over the past 10 years. One technique, the contingent valuation method (CVM), has been tested extensively (Mitchell and Carson, 1989). Several CVM studies have been conducted that analyze and determine the value of recreation areas, wildlands, watersheds, etc., using the contingent valuation method (Lockwood et al., 1994; Olsen et al., 1991; Rubin et al., 1991; Boyle and Bishop, 1987; Sutherland and Walsh, 1985). Total value can be categorized into use and non-use values. Use

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value is defined as the willingness to pay (WTP) for use (consumptive or non-consumptive) of the resource or public good. Non-use value encompasses (1) existence value, which is defined as the WTP to know the public good exists, (2) option value, defined as the WTP for an insurance premium of sorts for retaining the option of using the good in the future, and (3) bequest value, defined as the WTP to ensure that future generations can enjoy the public good or resource (Sutherland and Walsh, 1985).

The contingent valuation method and its derived values are not without criticism. CVM derived values such as WTP reflect many of the assumptions of neoclassical economics, including an anthropocentric view of natural resources. Furthermore, CVM values are contingent upon the levels of information the respondent brings to the survey and the amount of information provided by the survey. Certainly WTP does not reflect all ecological values, since humans may not fully understand the functions of resources such as wetlands. In addition, moral and ethical considerations are important in setting natural resource policy. Researchers are, however, continually attempting to broaden the societal values reflected in CVM studies, as is this study.

The majority of the existing CVM studies utilized a pre-determined geographic boundary for their sample frame. They did not include variables that would measure the effects of geographic distance from the areas they were attempting to value. These studies implicitly assumed that the effects of geographic distance were moot; an assumption that could have led to an understatement of the aggregate benefit values computed in these studies. For example, by not including a distance factor, and if the sample was too limited geographically, there could have been positive values outside of the sample frame (Sutherland and Walsh, 1985).

Furthermore, if it is assumed geographic distance does play a role in a respondent's willingness to pay for an area, it would seem logical that this relationship would be a negative one. The further away the respondent resides from the area, the less likely he/she would be willing to pay for improvements or preservation of it. For further discussion on this general subject, the reader is referred to the study of Hannon (1994) which examines geographic discounting.

This research builds upon the one study that did examine the effect of geographic distance on CVM responses. Sutherland and Walsh (1985) evaluated the effect of distance on the non-use value of water quality in Flathead Lake, MT. Results indicated a negative relationship between distance and non-use values. Although encouraging, results from a single study cannot be conclusive. In fact, Sutherland and Walsh provided several recommendations for improvements of future studies which the present study incorporated, such as using alternative models and specifications, incorporating distance into the model as an independent variable, and using a larger sample size.

This paper examines the issue of geographical distance to determine if distance negatively affects willingness to pay values. The data used to explore this issue came from a contingent valuation study completed by Loomis et al. (1991) that examined California, Oregon, Washington and Nevada residents' willingness to pay for alternative programs to protect and expand wetlands and reduce wildlife contamination in the San Joaquin Valley, CA. The Valley provides a vital wildlife habitat that supports an estimated 2 million birds, and is therefore critical to the survival of many species (Loomis et al., 1991). In addition, the Valley supports about 90 000 acres of wetlands, both seasonal and permanent.

The San Joaquin Valley is troubled by several environmental problems. In fact, much of the remaining wetlands have only about 25 percent of the water required for optimum management. Furthermore, some of the Valley's water supply comes from agricultural drainage, which may contain high levels of selenium, boron, arsenic, and other trace elements that are hazardous. Because of federal regulations on this agricultural drainage, farmers have been increasing their use of on-farm evaporation ponds which attract many birds and cause reproduction problems and high levels of mortality. The San Joaquin River also has its problems. The river supported chinook salmon prior to the mid-1940s construction of the Friant Dam. Since that time, however, the river has seen a near elimination of the chinook salmon fishery (Loomis et al., 1991).

The three proposed programs in the San Joaquin Valley study represented potential responses and solutions to these problems, and they revolved around the areas of wetlands, contamination control, and salmon fisheries in the San Joaquin Valley. They were entitled the Wetlands Habitat and Wildlife program, the Wildlife Contamination Control program, and the San Joaquin River and Salmon Improvement program. Each program was described in the survey with regard to the current conditions of wetlands and contamination, as well as what was projected to occur if the program were implemented.

2. Methodology

Although methods vary widely among researchers, the ultimate goal of a contingent valuation survey is to obtain an accurate estimate of the benefits (or value) of a change in the level provided of the public good in question, so that this estimate can then be used in a cost–benefit analysis. Within the realm of CVM, the dichotomous choice or 'take-it-or-leave-it' approach is gaining in popularity among researchers (Mitchell and Carson, 1989) and is the one used in this study. This approach produces discrete responses of the yes/no variety (for examples, the reader is referred to Stevens et al., 1991; Whitehead and Bloomquist, 1991; Boyle and Bishop, 1987). Each respondent is asked if he/she is willing to pay a randomly assigned price for the good on an 'all-or-nothing' basis (Mitchell and Carson, 1989, p. 101). In this study respondents were asked, after being given a detailed description of each program, if they would be willing to pay $\$x$ per year in additional taxes to support the program. The $\$x$ values were randomly assigned and ranged from \$45 to \$225.

2.1. The survey, data collection and sample

The survey instrument was a 15-page, full-color booklet which began with introductory questions about wildlife, followed with the willingness to pay questions, and finished with the standard demographic questions. The data collection method used was a random digit dialing to identify households, then respondents were mailed a booklet and subsequently telephoned to conduct the interview. The households sampled included residents of the San Joaquin Valley, California residents outside of the Valley, Washington state, Oregon state, and Nevada state residents.

2.2. The model

The econometric model encompasses all variables that economic theory indicates should have an influence on WTP for each of the three programs: Wetlands, Wildlife Contamination, and River and Salmon Improvement. Because of the dichotomous structure of the dependent variable, a non-linear probability model is needed for estimation. The non-linear model most commonly used in contingent valuation studies is the logit model (for a complete discussion of this model, the reader is referred to Loomis, 1988; Aldrich and Nelson, 1984; Madalla, 1983). The logistic regression model developed to analyze the data follows in Eq. (1):

$$\log\{\text{prob(yes)}/1-\text{prob(yes)}\}$$
$$= C_0(\text{constant}) - C_1(D) - C_2(\text{bid}) + C_3(\text{know}) - C_4(\text{substitutes}) + C_5(\text{SpRec}) + C_6(\text{memb}) + C_7(\text{age}) + C_8(\text{sex}) + C_9(\text{angler}), \quad (1)$$

where D = natural log of distance between Valley and respondent's home. The distances ranged from 0 to 1134 miles from the San Joaquin Valley. Bid = the initial bid amount offered to the respondent for each program. Know = knowledge index. This was a value between 0 and 6, with 0 representing no knowledge and 6 representing the most knowledge of fish and wildlife issues in the San Joaquin Valley. Substitutes = substitute variables. The substitute variable for the wetlands and contamination control programs was an estimate for acreage of wetlands in California, Oregon, Nevada and Washington. For Oregon, Washington, and Nevada, the Congressional Hearings on Wetlands Conservation (United States Congress, 1991) was used to determine total acreage for each state. For California, however, more data were available to segregate the state into smaller regions (Dennis and Marcus, 1984). For the salmon improvement program, the substitute variable was an estimate of the population of salmon in California, Washington, and Oregon. In this case, the Pacific Fishery Management Council (1994) was used to

Table 1
Results of the three programs

Variable	San Joaquin Valley program		
	Wetlands Improvement Coefficient (t-stat)	Contamination Control Improvement coefficient (t-stat)	River/Salmon Improvement coefficient (t-stat)
Constant	2.87 (4.61) [d]	2.47 (4.10) [d]	1.33 (1.78) [a]
WimBid	−0.006 (−4.47) [d]	—	—
CCimBid	—	−0.004 (−3.90) [d]	—
RSimBid	—	—	−0.005 (−2.02) [b]
Log D	−0.196 (−1.89) [a]	−0.198 (−1.97) [b]	−0.039 (−0.35)
Acrwet	−4.6E−07 (−2.24) [b]	−3.7E−07 (−1.86) [a]	—
Salmon	—	—	−2.554E−08 (−0.10)
Memb	0.51 (2.59) [c]	0.593 (3.26) [c]	0.388 (1.70) [a]
Age	−0.02 (−3.78) [d]	−0.01 (−3.04) [c]	−0.02 (−3.86) [d]
SpRec	0.0001 (2.47) [b]	9.25E−05 (2.31) [b]	—
Sex	—	—	0.397 (2.51) [b]
Angler	—	—	0.79 (4.65) [d]
χ^2	64.58 [d]	53.44 [d]	59.06 [d]
Correct predictions	67%	65%	74%

Dependent variable: WTP (probability of yes response to bid amount).
[a] $P < 0.10$; [b] $P < 0.05$; [c] $P < 0.01$; [d] $P < 0.001$.

segregate each state into regions. [1] SpRec = respondent's spending on fish and wildlife recreation. This variable was intended to be an indication of how important wildlife/recreation was to the respondent. Memb = dummy variable representing whether the respondent was a member of any environmental, conservation, or outdoor sporting organizations. Age = respondent's age. Sex = respondent's gender. Angler = dummy variable representing whether the respondent fished.

The model states that willingness to pay (more specifically, the probability of being willing to pay the bid amount) for the Wetlands, Wildlife Contamination Control or River and Salmon Improvement programs is a function of the above independent variables. Each coefficient is interpreted as the change in the log odds associated with a one-unit change in the independent variable.

[1] An alternative specification of substitutes that may be more consistent with demand theory would be to include the distance to substitute natural resources in the model rather than the quantity of substitutes. We believe, however, that the quantity may be more relevant for measuring non-use values of public goods than the distance, which might be more relevant for a recreation study.

2.3. Hypothesis

The hypotheses are stated in terms of the expected signs on the regression coefficients (C). The variables hypothesized to *decrease* the likelihood of the respondent answering yes are: distance, bid amount, and substitutes. The variables hypothesized to *increase* the likelihood of the respondent answering yes are: knowledge, spending on recreation, and environmental organization membership.

3. Results

There were 1003 complete responses, of which 577 were California residents outside of the San Joaquin Valley, 228 were San Joaquin Valley residents, 112 were Washington state residents, 65 were Oregon state residents and 21 were Nevada state residents. The overall response rate was 51%.

The results of the model are shown in Table 1.

3.1. Contamination control and wetland improvement programs

The individual variables in each model were examined first. The coefficient on distance was signifi-

Table 2
Regression coefficients after transformation

Variable	Wetlands Improvement transformed coefficient	Contamination Control Improvement transformed coefficient
Constant	480.75	452.5
Log D	−32.71	−45.62
Acrwet	−0.0001	−0.0001
Memb	85.99	136.34
Age	−2.64	−2.97
SpRec	0.018	0.021

cantly negative for both the wetlands improvement model and the contamination control model, as hypothesized.

The logit coefficients were then transformed into WTP coefficients using the method of Cameron (1988). Cameron shows how the variation in dollar bid amounts allows the researcher to rescale the logit equation into the more familiar WTP function. This is accomplished by dividing the constant term and all of the slope coefficients in the model (other than the bid amount) by the absolute value of the coefficient on the bid amount variable. This transforms the coefficients in the equation into coefficients with ordinary least squares interpretation, insofar as the estimation of the impact on WTP. Table 2 shows the transformed coefficients.

The coefficient on the natural log of distance in the wetlands improvement model became −32.71 and in the contamination control model it became −45.62. As distance increased, willingness to pay decreased more dramatically for the contamination control program than it did for the wetlands improvement program. This may have to do with the fact that the contamination control program included only resident waterbird, not migratory bird populations. Thus, the residents living further away from the Valley may have felt more disassociated than they did with the wetlands improvement program since this program also affected migratory birds.

The importance of local conditions is strengthened when the effect of substitutes is examined. After the coefficients were transformed, we see that the effect of substitutes was identical for both programs. This indicates acres of wetlands in the individual's locale had an equivalent effect on willingness to pay for both wetland improvement and contamination control programs.

Age and environmental organization membership also played a role in willingness to pay decisions for both programs. Older individuals were less likely to pay, while those belonging to environmental organizations were more likely to pay. The χ^2 values for overall significance of the logit equations were significant, and the percent of correct predictions reasonable.

3.2. River and salmon improvement program

The results of the salmon program model were different from the wetlands and contamination control programs – neither distance nor substitutes played a role in the determination of an individual's willingness to pay for this program (this finding will be discussed in further detail in the discussion section below). Environmental organization membership and age remained significant in this model, however, it is interesting that gender and angling participation were uniquely significant in this model. It is also interesting that those who fish found the river and salmon program more valuable than the other two programs. The χ^2 was also significant, and the percent of correct predictions was a little higher for this program compared to the other two programs.

3.3. Average and aggregate willingness to pay

Using the two equations for wetland improvement and contamination control, average and aggregate willingness to pay was computed. First, average willingness to pay was calculated by multiplying each transformed coefficient (except for log of distance) by its respective variable mean, and summed to form a 'grand constant'.

$$\mathrm{WTP} = \sum\{(\text{mean } X_i) * (C_i/C_2(\text{bid}))\} + C_1(\log D)/C_2(\text{bid}) \qquad (2)$$

The resulting expressions for both models are

$$\mathrm{WTP}\ (\text{Wetland Improvement}) = 371.67 - 32.71 * \log \text{distance}, \qquad (3)$$

$$\mathrm{WTP}\ (\text{Contamination Control}) = 451.21 - 45.62 * \log \text{distance}, \qquad (4)$$

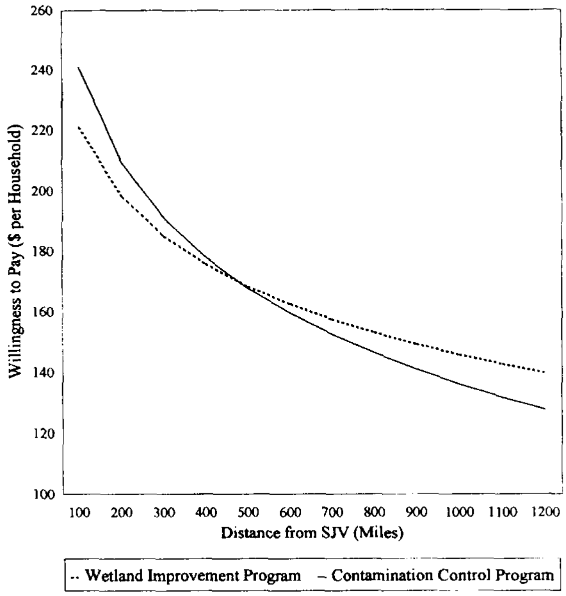

Fig. 1. Average willingness to pay per household.

and are graphed in Fig. 1 by substituting in several values for the log of distance. Willingness to pay fell off at a more dramatic rate for the contamination control improvement program.

The aggregate WTP was then examined within the subsamples. For this analysis, the mean values for *each subsample* were substituted into the respective models, and aggregate willingness to pay calculated (Tables 3 and 4). Admittedly, the average willingness to pay values per household seem fairly high. While Adamowicz et al. (1994) note that CVM may overstate WTP relative to revealed preference methods, our emphasis in this paper is on how public good values change with distance, not on the absolute values themselves.

Interpretation of how WTP varies with distance is less direct than the other results. For both models, the average resident of the San Joaquin Valley is willing to pay more than residents in other states. Just looking at distance, one would expect the rest of California or Nevada to be willing to pay the next to highest amount, and this is the case in both models. However, Washington is willing to pay more for both programs than Oregon, which at first glance seems counter to the distance concept. The reason for this is that Oregon has a large acreage of substitute wetlands compared to the other states, which rapidly decreases the willingness to pay for that state because of the negative effect of substitutes in the model.

4. Discussion

Why then did distance and substitutes have an effect on willingness to pay for wetlands and contamination control, but not the river and salmon program? This question cannot be answered with a high degree of certainty using the results of this study, but some speculation can be made. There may be something unique about the salmon program, for the results indicate that it did not matter how far

Table 3
Aggregate willingness to pay for wetland improvement by subsample

	SJV	Rest of CA	OR	WA	NV
Average WTP	$215.55	$210.77	$67.80	$99.75	$196.01
No. of households [a]	810989	11182882	1193567	2032378	518858
Aggregate (millions)	$175	$2357	$81	$203	$102

[a] See Census of Population and Housing (1990).

Table 4
Aggregate willingness to pay for contamination control by subsample

	SJV	Rest of CA	OR	WA	NV
Average WTP	$233.86	$222.69	$51.92	$86.35	$203.08
No. of households [a]	810989	11182882	1193567	2032378	518858
Aggregate (millions)	$190	$2490	$62	$175	$105

[a] See Census of Population and Housing (1990).

away the respondent lived, or how many substitutes were close by; this did not affect his/her willingness to pay for the program.

Perhaps it is species driven. It is possible that a significant proportion of the people in North America can relate to a salmon in some way or another (consume, fish for, etc.).

Another related possibility is that WTP for salmon is mostly *use value* driven. This study looked at total value only, it did not distinguish between use and non-use (existence, option, and bequest) values. The study of Sutherland and Walsh (1985) did separate out existence, option, and bequest WTP values, and found that WTP fell off at a less dramatic rate with distance under the option value category compared to the other two categories of value. While recognizing that use and option value are obviously not equivalent, of the three non-use values option value is probably closest to use value. If it is true that the value of salmon consists primarily of use value (consume, fish for, etc.), then these results are consistent with what they found.

Another interesting issue arose with regards to the knowledge variable. There was a high level of multicolinearity between distance and knowledge, which led to unstable results. As distance from the San Joaquin Valley increased, knowledge about the Valley decreased, which makes intuitive sense.

Multicolinearity is difficult to treat, particularly with cross-sectional data. It is not traditional to simply remove one of the variables to alleviate multicolinearity, but in this case it made theoretical and procedural sense to remove it and allow distance to be used as a proxy for knowledge. Theoretically, distance can be used as a proxy for constructs such as price and knowledge of the good in question. Travel cost studies are based on using distance as a proxy for cost. The same case can be made for knowledge; the farther away from the good in question, the less likely knowledge/information about the good is available. This was reflected in the level of correlation between knowledge and distance. Letting distance represent a proxy for knowledge made procedural sense as well. Distance is something observable and concrete, and knowledge is not. Using distance allows the researcher to extrapolate out to the entire population, whereas knowledge is on an individual level and does not. In other words, obtaining a value for knowledge, unlike distance, requires the use of a survey to extrapolate out to the population, thus making it difficult to assess the extent of the market.

In addition, further investigation revealed that the knowledge variable ended up as a simple dummy variable for knowledge of the San Joaquin Valley. The survey question was intended to get at more of a 'level' of knowledge by asking the respondent to check off various sources of information. However, it ended up that each respondent either marked none (0 response) or only one category (1 response). This is a surprising result given the large sample size.

Yet another interesting issue arose with regards to the functional form of distance, which was a logarithmic form. This seemed to make theoretical sense in that it captured the possible diminishing marginal effects concept. More specifically, distance changes which are relatively close to the public good in question should have a more dramatic impact on WTP than distance changes which are farther away. To illustrate, consider the present study which looks at WTP for improvement programs in the San Joaquin Valley. The (assumed) decrease in WTP between Chicago and Indianapolis should be less than the decrease in WTP from San Francisco to Portland. The distance between Chicago and Indianapolis may be the same as the distance between San Francisco and Portland, but Chicago is already several hundred miles away from the San Joaquin Valley, and San Francisco very close.

5. Conclusion

This paper provides several conclusions regarding the issue of the effects of distance on willingness to pay.

(1) Foremost, though the results are not entirely conclusive, there is an indication that willingness to pay does decline as distance increases. The results showed that for certain goods distance did play a role in the determination of willingness to pay, and for others it did not. More specifically, WTP for the contamination control and wetland improvement programs did show a statistically significant negative relationship, whereas the salmon improvement program did not. Future research should focus on this

interesting phenomena, and examine why and which public goods are possibly immune to distance effects.

(2) Another interesting issue this study uncovered is knowledge of the good in question and its role in willingness to pay research. This study highlighted the issue of the difficulty of using knowledge in the same model as distance, as the level of correlation between the two should be extremely high. In this case, it was found that the knowledge variable ended up being a simple dummy variable, thus not a measure of the extent of knowledge, and perhaps this influenced the results. Therefore, it seemed logical to use distance as a proxy for knowledge, thus eliminating the multicolinearity problem. Future research should examine this issue, as well as the possibility of using distance as a proxy for other difficult to measure concepts (which may also correlate highly with distance), such as importance and salience of the public good in question to the respondent.

(3) Yet another issue is that of substitutes. This study uncovered an effect of substitutes on respondents' willingness to pay. It seems to indicate that substitutes did play a negative role in determining an individual's willingness to pay – the more substitutes in close proximity to the respondent, the less they should be willing to pay for those farther away. Again, this result did not occur with the salmon improvement program.

(4) Extent of the market. This study was not intended to actually define the extent of the market for each program, but to determine if there was even a basis for attempting to define the market, i.e., determine if distance affects willingness to pay.

Of the many factors that could enter into the decision regarding the extent of the market, one possible factor might be the total cost (direct, indirect, opportunity, etc.) of the program of interest, and what relevant constituency will bear these costs. It may prove beneficial to determine the governmental level of the public program of interest, i.e., county level, state level, federal level. This issue becomes explicit in the benefit–cost analysis because the focus turns to who benefits from and who bears the costs of the program of interest. For instance, Van-Vuuren and Roy (1993) derived and compared the net benefits from wetland preservation with those obtained from converting wetlands into agricultural use in Lake St. Clair, Ont. Therefore, it seems critical that future research focus more specifically on relating the extent of benefits relative to the distribution of costs.

(5) Finally, this study shows that restricting benefits to just the political jurisdiction in which the site is located would understate the benefits by at least $300 million. It is important to empirically determine the extent of the public goods market, not pre-determine it unless all costs of the program will be borne solely in that political jurisdiction.

Recall that this study attempted to, in part, build upon the suggestions of Sutherland and Walsh (1985), the only other substantive study in the literature that focused on this issue. They also found a negative distance-preservation value for water quality at a recreation site. Suggestions that were incorporated and seemed to be successful included the alternative model and specifications, the larger sample size (both in the study area and farther from the study area), and the addition of substitutes. However, the knowledge issue still seems somewhat unresolved. This study helped to expand the body of knowledge in the literature on this issue, and the combination of these two studies add yet another dimension to the research area of contingent valuation.

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