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ANALYSIS

Comparison of contingent valuation and conjoint analysis in ecosystem management

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Abstract

Contingent valuation (CV) and conjoint analysis were used to estimate landowner's willingness to pay (WTP) for ecosystem management on non-industrial private forest land. The results suggest that even when conjoint and CV questions are the same, except for rating and pricing format, respectively, WTP estimates are quite different. Since most conjoint models essentially count 'maybe' responses to valuation questions as 'yes' responses, we conclude that conjoint model results often produce WTP estimates that are biased upwards. © 2000 Elsevier Science B.V. All rights reserved.

Keywords: Economic value; Contingent valuation; Ecosystem management; Conjoint analysis

1. Introduction

Contingent valuation (CV) is widely used for valuing environmental programs, but this approach is often viewed with scepticism. However, as noted by Boxall et al. (1996), there are alternatives; CV should be viewed as only one of several 'stated preference' elicitation methods. Other members of this class include conjoint analysis, contin-

gent choice, and polychotomous choice. Although very few comparisons of these techniques have been published, most empirical comparisons suggest substantial differences (Desvougues and Smith, 1983; Brown, 1984; Magat et al., 1988; Irwin, et al., 1993; Ready et al., 1995; Boxall et al., 1996). For example, Boxall et al. reported CV estimates of willingness to pay (WTP) for moose hunting 20 times higher than those derived from the contingent choice method. On the other hand, Magat et al. (1988) estimated contingent values for risk reduction that were 58% lower than those obtained from a paired comparison choice approach.

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Additional research comparing CV with other types of stated preference techniques is obviously needed. This paper compares CV and conjoint (CJ) techniques in a case study of WTP for ecosystem management of non-industrial private forest land in the Northeastern US.

2. Background and previous research

We are aware of very few studies comparing CV with other types of stated preference techniques. With the exception of Boxall et al. (1996), the empirical evidence suggests that WTP estimates derived from CJ (or choice) studies are significantly larger than those obtained from the CV method. For example, Barrett et al. (1996) concluded that CJ WTP estimates for two types of water purification programs were four to five times larger than the corresponding CV estimates. Desvousges and Smith (1983) compared CV and contingent rankings for water quality in the Monogahela River. Mean water use values derived from the direct CV question were three to four times less than the values estimated from the rankings approach.

Magat et al. (1988) used a paired comparison approach and an open-ended CV format to derive consumers' WTP for risk reduction associated with a set of market goods (bleach and drain openers) that differ only in terms of purchase price and risk of injury. In contrast to the one-step open ended CV procedure, the choice method asked each subject to make a series of comparisons between products in a manner which simulated actual choices in the marketplace. The CV approach produced monetary valuations that were 58% lower than the average choice valuation. Magat et al. (1988) argue that the CV approach creates incentives for respondents to understate their true value while the choice method eliminates this incentive thereby producing more accurate WTP estimates. However, Boxall et al. (1996) found that CV estimates of environmental quality changes affecting moose habitat were significantly larger than estimates derived from choice experiments.

Although there are many reasons why values derived from CV and other stated preference methods might differ, we focus here on factors specifically related to a comparison of CV and CJ analysis. First, substitutes are made explicit in the CJ format and this may encourage respondents to explore their preferences and tradeoffs in more detail. Indeed, as noted by Gan and Luzar (1993), conjoint analysis 'can be characterized as an extension of the referendum closed-end CV method in which large numbers of attributes and levels can be included in the analysis without overwhelming the respondents' (p. 37). As shown by Boxall et al. (1996), when compared to CJ, CV results may therefore be biased upward because respondents to the 'typical' CV survey are usually asked to consider fewer substitutes.

Another factor is that from a psychological perspective, the process of making choices in the CJ format may be quite different from that associated with making decisions about WTP (Irwin et al., 1993; McKenzie, 1993). That is, respondents may react differently when choosing among commodities that have an assigned price as compared to making dollar valuations of the same commodities. Moreover, Irwin et al. (1993) found that WTP questions lead to relatively greater preference for improved commodities, such as TVs and VCRs, while choice questions yielded relatively greater preference for environmental amenities like air quality. Similar results were reported by Brown (1984). Irwin et al. (1993) concluded that if monetary prices are an attribute, they carry more weight in determining a response measured in dollars (e.g. WTP) than they do in determining a rating or choice response. This arises from the fact that choices are driven from reason and arguments to a greater extent than are pricing responses.

A third difference between traditional CV and CJ analysis is that CJ respondents can express ambivalence or indifference directly. As a result, CJ surveys may result in relatively less non-response and protest behavior. Moreover, allowing for respondent uncertainty may have a significant effect on the WTP of those who do respond. For example, Ready et al. (1995) compared a dichotomous choice CV format to a polychotomous

choice format. Their CV question asked respondents to determine whether or not they preferred a given program while the polychotomous choice format gave six options (i.e. definitely prefer, probably prefer, maybe prefer, maybe not prefer, probably not prefer, definitely not prefer). This format was motivated by the belief that respondents might be more comfortable answering valuation questions when given the opportunity to express strength of conviction; since the polychotomous method allows for a range of answers, it might produce a more accurate description of respondents' preferences. In two empirical studies, preservation of wetlands and horse farms, the polychotomous format yielded a higher rate of usable responses and much higher WTP estimates.

More recently, Champ et al. (1997) found that although contingent values were greater than actual donations for an environmental good, when the contingent values were restricted to respondents who said they were very certain to contribute, mean CV and actual donations were not statistically different. Elkstrand and Loomis (1997), Alberini et al. (1997) and Wang (1997) also found that contingent value estimates vary widely depending on how respondent uncertainty is incorporated in the analysis.

3. Theoretical considerations

From the perspective of neo-classical economic theory, the CV and CJ techniques should produce similar results, provided that the CV and CJ formats are properly specified. Suppose that individual utility associated with environmental quality, EQ, can be expressed as a function of income, Y , and EQ attributes such as water quality, wildlife habitat preserved, and cost. In dichotomous choice CV, individuals are asked to undertake activities on their own property to improve EQ that cost them a predetermined amount, $\$N$. The value of utility, observed by the researcher, when amount N is paid is:

$$U_1 = U(\mathbf{D}_1, Y - N) + e_1 \quad (1)$$

where \mathbf{D}_1 is a vector of EQ attributes and e is a random variable. Utility when $\$N$ is not paid is:

$$U_0 = U(\mathbf{D}_0, Y) + e_0 \quad (2)$$

where \mathbf{D}_0 represents EQ attributes for the status quo situation. The individual is assumed to pay if, and only if:

$$U_1 \geq U_0 \quad (3)$$

Utility difference, dV , can be expressed as:

$$dV = U_1 - U_0 \quad (4)$$

If utility is assumed to be linear, additive, and separable with respect to income and EQ attributes, dV is given by:

$$dV = U(\mathbf{D}_1, Y - N) - U(\mathbf{D}_0, Y) + e_1 - e_0 \quad (5)$$

The WTP probability can then be written as:

$$P_r = G(dV) \quad (6)$$

where G is the probability function for the random component of utility ($e_1 - e_0$). Assuming a logit probability function for G , the WTP probability is:

$$P_r = (1 + e^{-dV})^{-1} \quad (7)$$

Median WTP for the EQ improvement, $\mathbf{D}_1 - \mathbf{D}_0$, can then be estimated by calculating the value of N , N^* , for which $dV=0$, i.e. at the point of indifference there is a 50% chance that the individual would pay amount N^* .

Following Roe et al. (1996) a CJ format which is conceptually consistent with the dichotomous choice CV format (Eq. (7)) can be derived by asking individuals to rate the current situation without the EQ program as given by (Eq. (2)) and a set of EQ programs, (Eq. (1)). It is implicitly assumed that:

$$R_1 = h(U_1), \text{ and } R_0 = h(U_0) \quad (8)$$

where R_1 , and R_0 are individual ratings and h is a transformation function. Utility difference, dV , is then approximated by the ratings difference $R_1 - R_0$:

$$dV = R_1 - R_0 = U(\mathbf{D}_1, Y - N) - U(\mathbf{D}_0, Y) + e_1 - e_0 \quad (9)$$

where Eq. (9) is the same as Eq. (5) and the WTP probability can therefore be represented by Eq. (7).

In other words, setting aside the issue of substitutes and respondent uncertainty for the moment, if individuals are asked, for example, to rate the status-quo, and programs which cost \$ N on a scale of 1 to 10 (10 indicating programs they would definitely undertake), a binary response CJ model is obtained which is identical to the dichotomous choice CV model (Eq. (7)) given the approximation in Eq. (9).

It is important to note that the CJ model set forth in Eqs. (8) and (9) differs from the traditional CJ format in that the dependent variable in Eq. (9) is the ratings difference from the status quo and independent variables are changes in program attributes from the status quo.¹ As shown by Roe et al. (1996), this specification provides estimates of Hicksian surplus which can then be directly compared with CV estimates (also see McKenzie, 1990; Johnson et al., 1995).²

However, in empirical applications CV respondents are typically presented with far fewer substitutes than are CJ respondents. Boxall et al. (1996)

¹The traditional conjoint model involves estimating the following relationship between ratings and program attributes:

$$U_i = R_i = V(\mathbf{Z}^K) + P_z = b_0P_z + b_1Z_1^1 + \dots + b_nZ_n^1 + e_i \quad (a)$$

where U_i is individual i 's utility for an attribute bundle; R_i is the individual's rating, $V(\cdot)$ is the non-stochastic component of the utility function, \mathbf{Z}^K is a vector of attribute levels, P_z is the price for the attribute bundle Z , and b is the marginal utility or weight associated with each attribute (Johnson et al., 1995).

Setting the total differential of Eq. (a) to the point of indifference and solving:

$$dU_i = b_0dP_z + b_1dZ_1^1 + \dots = 0 \quad (b)$$

yields marginal rates of substitution for the attributes Z_1^1 . Since a price attribute, P_z , is included, the marginal utilities of all attributes can be rescaled into dollars, and marginal willingness to pay for each attribute may be derived:

$$dP_z = -b_1dZ_1^1/b_0 \text{ or} \quad (c)$$

$$dP_z/dZ_1^1 = -b_1/b_0$$

²Another important aspect of the ratings difference CJ model specification is that in the traditional specification different respondents tend to center on different ranges of the ratings scale. Roe et al. (1996) argue that this problem is avoided by using the status quo rating as a common anchoring point.

found that CV respondents therefore tend to ignore substitutes, and if this difference is not taken into account, choice and CV estimates are very dissimilar. Consequently, comparisons of the CV and CJ techniques requires that: (a) both formats convey the same information about substitutes; (b) the CJ model is specified as outlined in Eqs. (8) and (9); and (c) respondent uncertainty is accounted for.

3.1. Case study

Our comparison of the CV and CJ methods is based on a case study of the willingness of non-industrial private forest landowners to pay for activities that are compatible with ecosystem management (EM). EM is often defined as ecologically based, sustainable management that blends environmental, social, and economic values (Stanley, 1995). Effective EM requires planning on broad spatial and temporal scales, often by definition beyond the bounds of individual private ownership. And, instead of focusing on commodity outputs, the EM approach seeks to achieve desired future conditions, with outputs such as timber harvests, wildlife, and recreational opportunities occurring throughout the process (Stanley, 1995).

The EM paradigm seeks to manage land in greater synchronicity with the natural patterns and effects of disturbance, habitat, and nutrient and hydrologic cycling. Consequently, adoption of this approach or paradigm by landowners requires consideration of their individual property at broader spatial and temporal scales. Approximately 58% of forest land in the United States is owned by non-industrial, private individuals or families. However, as noted by Brunson et al. (1996), very little is known about landowner attitudes and preferences related to EM alternatives. Since by definition EM is a broad approach or paradigm, in order to test landowners' attitudes, it was necessary to create a particular, reasonable situation or case study typical of adopting this approach.

Information about WTP for EM was obtained through a mail survey of all 1116 Massachusetts landowners enrolled in the Forest Stewardship

Program. This program is a voluntary, federally funded program that entitles participants to share the cost of improving their forest land with the federal government. Consequently, survey participants were generally knowledgeable about forest land management activities, and all had 10-year management plans for their properties, prepared by professional foresters.

Landowners were partitioned into two groups. One group received a CV format containing EM management alternatives based on our specific scenario; the second group was given a CJ format. In contrast to the study by Boxall et al. (1996), the CV and CJ questions were virtually identical so that any differences related to substitutes would be eliminated. An example of each format is presented in the Appendix.

All respondents were asked to value (rate) the status quo (do nothing) and three EM alternatives which involved setting aside a portion of their land to create a buffer zone that would provide a wildlife corridor connecting two larger wildlife habitats; a state forest and town conservation land. Respondents were told that the buffer zone would also improve water quality downstream to maintain a wood turtle population located on the town conservation land (see Appendix). The wood turtle, *Clemmys insculpta*, is listed as a species of special concern in Massachusetts.

Each EM option consisted of three attributes; acreage set aside for the buffer zone, increase in wood turtle population, and annual improvement and maintenance costs associated with the buffer zone. There were three possible values for buffer zone acreage, 5, 10, or 20 acres, three levels of increase in the wood turtle population, 0%, 10%, and 25%, and three annual cost levels, \$50, \$100, and \$200. All possible combinations of these were generated and three EM programs, plus the status quo, were randomly assigned to each respondent. It is important to note that all possible combinations of EQ program attributes must be considered in order to evaluate interactions between attributes. However, this means that some programs are either redundant or seem inconsistent (McKenzie, 1990). For example, program D in Appendix A has less acreage in buffers than

alternatives A and B, yet it has a greater increase in wood turtle population. Consequently, we would expect that program D would receive a higher rating than either A or B, all else held constant.

CJ respondents were asked to rate the three EM options and the status quo on a scale of 1 to 10, with 10 indicating EM programs, if any, the respondent would *definitely* undertake and 1 indicating that the respondent would *definitely not* undertake the program. If respondents were not sure, they were asked to use a scale of 2 through 9 to indicate how likely they would be to undertake each EM program. A dichotomous choice CV format was used wherein each respondent was asked whether they would *definitely* undertake each program (see Appendix B). The 1116 landowners were randomly divided into two groups — 558 CV surveys and 558 CJ surveys were mailed.³

4. Results

The CV response rate was 67% and 42% of the CV surveys returned were fully completed. The CJ response rate was 56%, but 67% were completed giving the CJ format a higher completed return rate. It is interesting to note that only 7% of those who returned a CV survey would not pay some amount for an EM program and only 8% of the CJ respondents rated EM programs below the mean status quo rating.

Empirical comparison of the CV and CJ formats involved estimating dV (see Eq. (9)). The following approximation of utility difference, dV , was used:

$$dV = a + b(\mathbf{D}) + c(N) + d(F) + e \quad (10)$$

where \mathbf{D} is a vector of EM attributes (acres, turtles), N is the predetermined program cost, F is a set of taste and preference variables which

³ Land trusts and businesses were removed from the analysis. Therefore a total of 850 usable surveys were delivered — 419 CV surveys and 431 CJ surveys.

Table 1
Independent variables ($n = 692$)

Variable	Expected sign	Mean	Standard deviation	Range	
				Low	High
Acres set aside	–	11.83	6.24	5	20
WTINC (% turtle increase)	+	11.85	10	0	25
Costs (\$)	–	\$117.96	\$61.64	\$50	\$200
Income (thousand \$)	+	\$57.24	\$31.75	\$7.50	\$102.50
Age	+/-	57	14	25	99
Environment	+	0.1299	0.34	0	1

differ among individuals, and a , b , c , and d are estimated coefficients.⁴

Four different econometric models were estimated; a dichotomous choice CV logit model (Eq. (7)), two CJ logit models, (Eq. (7)), and a ‘ratings difference’ CJ model (Eq. (9)). The dependent variable in the first CJ model, CJ1, equals 1 if the respondent would definitely undertake an EM program (rating equal to 10), and 0 otherwise. Sensitivity to respondent uncertainty was examined in the second and third CJ models. The dependent variable in the second CJ model, CJ2, equals 1 if the respondent rated an EM program greater than the status quo and 0 otherwise. The third CJ model, CJ3, is a more traditional specification wherein Eq. (10) is estimated using the Tobit procedure. As shown by Roe et al. (1996), WTP is derived from CJ3 by increasing the value of N until the point of indifference is reached ($dV = 0$).

Independent variables are presented in Table 1. The first variable, acres, is the amount of land respondents were asked to set aside for the purpose of EM. We expect a negative relationship between acres and probability of EM program acceptance, all else held constant. The second variable, WTINC, is the percentage increase in the wood turtle population as a result of EM. A positive relationship between WTINC, WTP and program rating is expected. The cost variable is

the monetary commitment incurred by respondents undertaking EM programs. Three annual cost levels were used: \$50, \$100, and \$200. These amounts were determined by analyzing cost information provided by the Massachusetts Forestry Stewardship Council. Clearly, an increase in cost should decrease WTP and program ratings. Three variables, age, income and environment were used to represent socio-economic characteristics of respondents. The environment variable is a binary variable which takes a value of 1 if a respondent agreed with the statement, ‘the environment should be given priority even if it hurts the economy’, and 0 otherwise.⁵

Estimated CV and CJ model coefficients are presented in Table 2. With the exception of acres, estimated CV coefficients were of the expected sign. However, only two variables, increase in wood turtle population and costs, were statistically significant in all four models. The CJ model results were much more robust; all coefficients had the expected sign and relative to the CV model, more variables were statistically significant.

Estimated WTP was derived from the CV, CJ1, and CJ2 models for the ‘average’ EM program by using Eqs. (7) and (10). The estimated value of dV from Eq. (10) was substituted for dV in Eq. (7) and the probability of program acceptance was

⁴ It is important to note that empirical formulations which approximate utility difference, such as Eq. (10), often outperform models employing explicit utility difference specifications (Bowker and Stoll, 1988).

⁵ A t -test was used to test for differences in socio-economic characteristics of CV and CJ respondents. The null hypothesis that the two groups are the same was not rejected for age, but was rejected for income. The mean income of CJ respondents (\$59 844) was statistically different than the mean income of CV respondents (\$55 151).

Table 2
Estimated CV and CJ models^a

	CV	CJ		
	CV DC Logit	CJ 1 ^b Logit	CJ 2 ^c Logit	CJ 3 ^d Tobit
Intercept	-0.7382 (0.1254)	-2.1796** (0.0001)	-1.3038** (0.0209)	2.4867** (0.0437)
Acres	0.0093 (0.5068) [1.009]	-0.0133 (0.3961) [0.987]	-0.0385** (0.0122) [0.962]	-0.0797** (0.0180)
WTINC	0.073147** (0.0001) [1.08]	0.060634** (0.0001) [1.06]	0.042823** (0.0001) [1.04]	0.1133** (0.0001)
Costs	-0.0044** (0.0036) [0.996]	-0.0040** (0.0168) [0.996]	-0.0061** (0.0001) [0.994]	-0.0154** (0.001)
Age	-0.0022 (0.7421) [0.998]	0.0011 (0.8844) [1.001]	-0.0089 (0.2125) [0.991]	0.0104 (0.5044)
Income	0.00421 (0.1384) [1.000]	0.00649* (0.0563) [1.316]	0.00706** (0.0301) [1.305]	0.01362* (0.0557)
Environment	0.1929 (0.4547) [1.213]	0.2745 (0.3300) [1.000]	0.2665 (0.3443) [1.000]	0.9791 (0.1076)
Observations	581	692	692	504

^a The values reported in the [] represent $\exp(\beta_j)$, the odds ratio statistic.

^b Dependent variable is 1 if individual would definitely undertake the program (i.e. rating = 10); 0 otherwise.

^c Dependent variable is 1 if individual rated program greater than the status-quo; 0 otherwise.

^d Dependent variable is rating difference from status-quo.

* The values reported in the () are $\chi^2 P$ values significant at the 0.10 level.

** Significant at the 0.05 level.

obtained by multiplying the mean value of all independent variables, except cost, by the appropriate estimated coefficients (Table 2). Median WTP was then derived by calculating the cost that yields a 0.5 payment probability (see Eq. (7)). Mean WTP values were calculated by integrating over the \$0 to \$200 cost range. The CJ3 WTP estimate was derived by finding the value for N which sets dV in Eq. (10) equal to zero.

Results of these calculations are presented in Table 3. As shown in Table 3, the CV and CJ 1

model WTP point estimates are very different.⁶ It is important to emphasize that from the perspective of economic theory and econometric technique, these models are virtually identical. The only difference is that while CV respondents were asked if they would definitely pay a predetermined

⁶ Confidence intervals were estimated using a bootstrapping method wherein 300 random observations, selected with replacement, were used to generate 1000 estimates of median WTP for each model. The difference between the CV and CJ1 value estimates is statistically significant at the 90% level.

Table 3
Estimated WTP values

	CV		CJ	
	CV DC Logit	CJ 1 ^a Logit	CJ 2 ^b Logit	CJ3 ^c Tobit
Estimated median values	\$86	\$-287	\$211	\$285
Estimated mean values ^d	\$86	\$31	\$116	-

^a Dependent variable is 1 if rating is 10; 0 otherwise.

^b Dependent variable is 1 if program rated above status-quo; 0 otherwise.

^c Dependent variable is ratings difference from status-quo.

^d Mean values were calculated over the \$0 to \$200 cost range.

amount, CJ1 respondents were asked to rank each EM option on a scale of 1 to 10 with 10 indicating that they would definitely undertake EM.

When comparing WTP estimates from the CJ2 and CJ3 model and the CV model, it is important to remember that CJ2 respondents are assumed to undertake all EM programs that were rated above the status quo, and the CJ3 specification assumes that rating difference is a cardinal measure of respondent preferences (Roe et al., 1996).

As expected, the CJ2 point estimate is greater than the CV estimate and this difference is statistically different at the 95% level. The CJ2 WTP estimate is biased upward because it is implicitly assumed that all respondents who ‘might’ pay will, in fact, do so. The CJ3 model results should also be interpreted as an upper bound because this specification does not clearly distinguish between those who are or are not actually in the market for the commodity being valued.

Table 4
Calculated probability of EM program adoption

Program ^a	Probability of adoption		
	CV	CJ1	CJ2
\$100 cost; 11.83 acre buffer zone; 11.85% increase in wood turtle population	0.48	0.18	0.66
\$200 cost; 11.83 acre buffer zone; 11.85% increase in wood turtle population	0.38	0.13	0.52
\$100 cost; 11.83 acre buffer zone; 25% increase in wood turtle population	0.71	0.32	0.78
\$200 cost; 20 acre buffer zone; no increase in wood turtle population	0.22	0.06	0.32

^a All independent variables not indicated are set at their mean value (see Table 1).

Estimated probabilities that respondents would undertake several different types of EM programs are presented in Table 4. These probabilities were derived by substituting the estimated value of dV from Eq. (10) into Eq. (7). As expected, probabilities based on the CJ1 model are much lower than those based on the CV or CJ2 model.

Despite sensitivity to model specification, it is important to note that the results reported in Table 4 suggest that many non-industrial forest landowners would be willing to undertake EM programs even though the benefits accrue downstream and off the landowner’s property. For example, the probability that the average respondent would pay \$100 per year for EM to increase the wood turtle population by 25% ranged from 0.32 to 0.78, depending on model specification (see Table 4).

Moreover, the probability of EM adoption ranged between 0.13 and 0.52 for a program which sets aside about a 12-acre buffer zone, results in $\approx 12\%$ increase in the wood turtle population, and costs each landowner \$200 per year. However, in interpreting these results it is important to remember that since all survey respondents were already enrolled in a forest stewardship management program, the likelihood of EM program adoption is undoubtedly higher for this group than for the forest landowner population in general.

5. Conclusions

Many economists have argued that the CJ technique has several advantages compared to the CV method. Although few comparisons have been published, previous empirical evidence suggests

that WTP estimates often differ dramatically. Several explanations for this have been offered. For example, Magat et al. (1988) argue that CV creates incentives for respondents to understate their true WTP. On the other hand, Boxall et al. (1996) conclude that CV results may be biased upward because of 'yea-saying' and because respondents to the 'typical' CV survey consider fewer substitutes.

Our results suggest that when CV and CJ questions are the same, except for rating and pricing format, WTP estimates are different. In particular, since most previous CJ studies have essentially counted 'maybe' responses as 'yes' responses, we believe that CJ WTP estimates have often been biased upwards.

While no comprehensive conclusions can be drawn about landowner attitudes towards the ecosystem management approach, several points about EM can be drawn from this analysis. For example, many respondents would pay some amount for wood turtle habitat protection downstream and off their own property. Also, for the three CJ models, the coefficient of landowner income was significantly positive, suggesting that landowner affluence and likelihood of participation in EM are related.

This is only one case study and much more research about EM and comparing the CV and CJ techniques is needed. Although the CJ approach seems to offer several conceptual advantages relative to CV, CJ is very sensitive to model specification. Although we agree with Boxall et al. (1996) that the CJ technique offers 'considerable enhancements' compared to CV and should therefore be more widely used in the valuation of environmental programs, CJ results should certainly be interpreted with caution.

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Appendix A. Conjoint survey

Please consider the situation shown below. Suppose that you own and reside on property number 2 which is adjacent to two other privately owned forested parcels. Each forested parcel contains about 50 acres. Two-hundred acres of state forest land is adjacent to one end of the forested parcels. Adjacent to the opposite end of the forest parcels is 600 acres of town wildlife conservation land. A stream runs through all five parcels of land. All land next to this stream is forested but is not suitable for any other land use, such as housing development. Wood turtles exist downstream on the town wildlife conservation land. It is important to view the five separate parcels as one regional ecosystem, where the environmental functions of each parcel are interconnected. That is, land management decisions on one parcel of land impact environmental functions on the surrounding parcels.

Suppose that you are asked to co-operate with your neighbors for the purpose of managing your land as part of a larger unit. Specifically, you are asked to agree to set aside, improve, and maintain a buffer zone on each side of the stream. Improvements include planting of shrubs along the stream bank to reduce damage from runoff and sediment to downstream areas. Final decisions about improvements and the cost of all improvements will be shared equally with your neighbors. This buffer zone creates a natural wildlife corridor; it connects the two larger parcels of wildlife habitat, the state forest and town wildlife conservation land. The buffer zone also improves water quality downstream which is important for maintaining the wood turtle population located on the town wildlife conservation land.

Please consider the following alternatives, each of which consists of several attributes. Please consider and compare all the alternatives presented and then indicate how you would rate each on a scale of 1 to 10. Use 10 for alternatives, if any, that you **WOULD DEFINITELY** undertake. Use 1 for alternatives, if any, that you **WOULD DEFINITELY NOT** undertake. If you are not sure use 2 through 9 to indicate how likely you would be to enter into each alternative arrangement.

A.1. Alternative A

You agree to set aside 10 acres of your property for the buffer zone. Limited timber management, including harvest, could continue in this zone, but please assume that this land is not suitable for other uses, such as housing development. Population of the wood turtle will increase by 0%. Your share of improvement and maintenance costs associated with the buffer zone will be \$50 per year. This cost will also be incurred by your neighbors.

Your rating for alternative A is (scale 1 to 10).

A.2. Alternative B

You agree to set aside 20 acres of your property for the buffer zone. Limited timber management, including harvest, could continue in this zone, but please assume that this land is not suitable for other uses, such as housing development. Population of the wood turtle will increase by 10%. Your share of improvement and maintenance costs associated with the buffer zone will be \$200 per year. This cost will also be incurred by your neighbors.

Your rating for alternative B is (scale 1 to 10).

A.3. Alternative C

Do nothing.

No buffer zone.
No increase in wood turtle population.
No additional improvement or maintenance costs.

Your rating for alternative C is (scale 1 to 10).

A.4. Alternative D

You agree to set aside 5 acres of your property for the buffer zone. Limited timber management, including harvest, could continue in this zone, but please assume that this land is not suitable for other uses, such as housing development. Population of the wood turtle will increase by 10%. Your share of improvement and maintenance costs associated with the buffer zone will be \$200 per year. This cost will also be incurred by your neighbors.

Your rating for alternative D is (scale 1 to 10).

Appendix B. CV survey

Introduction and instructions to respondents; same as CJ survey (Appendix A).

Please consider and compare all the alternatives presented and then indicate which alternatives, if any, you would definitely undertake.

B.1. Alternative A

You agree to set aside 10 acres of your property for the buffer zone. Limited timber management, including harvest, could continue in this zone, but please assume that this land is not suitable for other uses, such as housing development. Population of the wood turtle will increase by 0%. Your share of improvement and maintenance costs associated with the buffer zone will be \$50 per year. This cost will also be incurred by your neighbors.

Would you definitely undertake alternative A?
.....Yes
.....No

B.2. Alternative B

You agree to set aside 20 acres of your property for the buffer zone. Limited timber management, including harvest, could continue in this zone, but please assume that this land is not suitable for other uses, such as housing development. Population of the wood turtle will increase by 10%. Your share of improvement and maintenance costs associated with the buffer zone will be \$200 per year. This cost will also be incurred by your neighbors.

Would you definitely undertake alternative B?

.....Yes

.....No

B.3. Alternative C

Do nothing.

No buffer zone.
No increase in wood turtle population.
No additional improvement or maintenance costs.

Would you definitely undertake alternative C?

.....Yes

.....No

B.4. Alternative D

You agree to set aside 5 acres of your property for the buffer zone. Limited timber management, including harvest, could continue in this zone, but please assume that this land is not suitable for other uses, such as housing development. Population of the wood turtle will increase by 10%.

Would you definitely undertake alternative D?

.....Yes

.....No

Your share of improvement and maintenance costs associated with the buffer zone will be \$200 per year. This cost will also be incurred by your neighbors.

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