Relating Environmental Attitudes and Contingent Values: A Comparison of Methods *

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Abstract

The New Ecological Paradigm (NEP) Scale is a set of 15 likert questions and is intended to indicate whether an individual holds pro-environmental or weak-environmental beliefs. This paper provide an overview and comparison of three methodologies that may be applied to NEP survey data to identify environmental attitudinal groups: summated score, latent class analysis, and cluster analysis methods. We find that while environmental attitudes do not significantly affect average willingness to pay measures, there are significant differences in willingness to pay across environmental attitude groups. The willingness to pay estimates for each attitudinal group are consistent across the different analystical measures. The robustness of these results across the different methods provides theoretical validation of the contingent valuation method.

Keywords: unobservable heterogeneity, contingent valuation, willingness to pay, latent class analysis, cluster analysis, NEP, CV validity

1 Introduction

Contingent valuation (CV) is one of the most common techniques for estimating the nonmarket benefits of environmental resources. The technique involves directly questioning people through surveys about the economic value they place on a change in the quantity and/or quality of a specified resource. The first application of CV dates back to the early 1960s (Davis, 1963), and the body of literature that applies the method has grown immense over the last four decades. Despite the popularity of CV, the technique is not without critics. Many argue that CV is not reliable because

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stated preferences in hypothetical markets are not good indicators of true economic intentions (e.g., Hausman (1993); Hausman and Diamond (1994)). Others defend CV on the grounds that careful survey design can minimize problems and that the method produces benefit estimates that are important for policy analysis (e.g., Smith (1993); Hanemann (1994)).

The controversy surrounding the validity of CV poses unique challenges when it comes to the estimation of nonuse values. Nonuse values are not revealed through observable economic transactions and are not measurable through market data. As a result, empirical estimation of nonuse values requires the use of hypothetical, or stated-preference, markets. Researchers are thus limited in the techniques available to assess the validity of nonuse value estimates. Whereas CV estimates of use values can be compared with the results of revealed-preference techniques—such as the hedonic price method and the travel cost method—such comparisons are not possible for CV estimates of nonuse values.

One of the available approaches for evaluating the validity of CV estimates of nonuse values is to assess the degree to which results are consistent with theoretical predictions. Mitchell and Carson (1989) refer to this approach as testing "theoretical validity," and it commonly means that researchers regress willingness to pay (WTP) responses on a set of independent variables that are believed to be determinants of people's WTP for the good being valued. The results are then used to help determine whether responses to the valuation question are either consistent or inconsistent with theory.

The importance of testing theoretical validity in CV studies was emphasized by a panel of prominent economists that were assembled by the National Oceanic and Atmospheric Administration (NOAA) to assess the reliability of CV for estimating nonuse values (Arrow et al., 1993). Among the specific guidelines that the panel recommended in order to produce credible studies was the following: "The survey should include a variety of other questions that help to interpret the responses to the primary valuation question. The final report should include summaries of willingness to pay broken down by these categories" (p. 4609).

One of the important categories that the panel advised considering was attitudes towards the environment. To date, however, relatively few studies have followed the NOAA panel recommendation to test theoretical validity of CV responses with indicators of environmental attitudes. While some studies do use membership in environmental organizations as a proxy for environmental attitudes, this approach can be problematic because of difficulty in interpretation (Spash, 1997) and because membership depends on confounding factors such as personal efficacy and resource availability (Mohai, 1985). Perhaps one reason why economists have tended not to move beyond using membership in an environmental organization is that the techniques for measuring environmental attitudes are unfamiliar.

We are aware of two studies in the literature that provide exceptions. The first, by Kotchen and Reiling (2000), conducts a CV study to estimate WTP for recovery efforts for two different endangered species, the peregrine falcon and the shortnose sturgeon. A key feature of their survey was the inclusion of attitudinal questions that comprise the New Ecological Paradigm (NEP) Scale. The NEP scale—originally proposed by Dunlap and Van Liere (1978) and later revised by Dunlap et al. (2000)—is commonly used by social scientists to measure environmental attitudes. The NEP scale is based on 15 Lickert-scale questions from which responses are typically combined into a summated scale, with higher scores indicating stronger pro-environmental attitudes. Drawing on the

literature in social-psychology that links attitudes and behavior, Kotchen and Reiling (2000) use the NEP scale to test theoretical validity of CV responses. Consistent with attitude-behavior theory, they find that respondents with stronger pro-environmental attitudes are more likely to respond yes to a referendum CV question about protecting an endangered species.

Cooper et al. (2004) conduct another CV study that focuses on the influence of environmental attitudes, and they too use the NEP scale. Their study was designed to estimate WTP for both use and nonuse values for water quality improvements in a lake. They include the NEP scale as an explanatory variable in regression models for an open-ended WTP question. They estimate two models: one on the entire sample, and one on a subset of the sample with stronger nonuse motives. For the entire sample model, they find a positive relationship between the NEP scale and WTP responses, but the relationship is not statistically significant. In contrast, the relationship is both positive and statistically significant in the model for the subset of the sample with stronger nonuse motives. They conclude that the NEP scale is a useful tool for testing theoretical validity of CV responses, and it is particularly suited to applications focusing on nonuse values.

The goal of our paper is to explore additional techniques for investigating the relationship between environmental attitudes and CV estimates of nonuse values. Our contribution is primarily methodological. We continue to use the questions comprising the NEP scale in order to probe environmental attitudes, but we analyze the data in different ways. In particular, we employ two additional techniques—cluster analysis and latent class analysis—to identify different groups of respondents based on their environmental attitudes. These techniques have several advantages over the summated scale. Cluster and latent class analysis are more informative than the summated scale because they provide information on which factors are driving individuals' environmental attitudes; rather than looking at an aggregated score, these methods emphasize similarities in response patterns across individuals. In addition, analysts are often interested in identifying discrete groups and predicting the size of these groups in the population at large. While this cannot be done with the summated scale without imposing arbitrary decision rules, it is standard output from latent and cluster analysis.

Economists are beginning to use both cluster analysis and latent class analysis in order to account for heterogeneity in a variety of applications. For example, Morey et al. (2005) and Boxall and Adamowicz (2002) use latent cluster analysis to identify heterogeneity in a population of fishers and recreationlists respectively. Here we use the techniques to identify heterogeneity in environmental attitudes for the purpose of testing theoretical validity of nonuse value CV responses.

We conduct the analysis using the same data that are used in the Kotchen and Reiling (2000) study. These data have several advantages for the analysis that we conduct here. An obvious advantage is that the survey includes the questions comprising the NEP scale. Beyond this, the fact that the survey focuses on recovery of two endangered species ensures that WTP responses are based primarily on nonuse values. The survey also has a relatively large sample size that is split between the two species, and this provides an opportunity to consider the robustness of our results.

Our main findings in the paper are the following: Depending on the method used, strong environmentalists are willing to pay \$31 or \$36 to protect the peregrine falcon and \$27 or \$37 to protect the sturgeon. There is strong preference heterogeneity with regards to environmental attitudes, resulting in significant differences in WTP between strong and weak pro-environmental attitude groups. These results provide a degree of theoretical validation for the CV method with regard to estimating

non-use values. These results are fairly consistent across the analytic methods used.

The next section describes the data used for the analysis. Section 3 provides an overview and comparison of the different ways that we use the NEP data to identify heterogeneity in environmental attitudes. Section 4 compares the results across the different techniques. Section 5 investigates the relationship between environmental attitudes and CV estimates, with further comparisons across techniques. Section 6 provides a discussion of the main results and conclusions.

2 Data

As mentioned above, we use the same data that were used in the Kotchen and Reiling (2000) study. Questionnaires were mailed in the spring of 1997 to a random sample of 1200 residents in the state of Maine. Mailing procedures were conducted in accordance with the Dillman (1978) Total Design Method. After adjusting for undeliverable addresses, the survey response rate was 63 percent, which is relatively high for a general sample survey.

The survey was designed to measure environmental attitudes and estimate nonuse values for protection of peregrine falcons and shortnose sturgeons, both endangered species in Maine. The CV portion of the survey was designed following the NOAA panel guidelines (Arrow et al., 1993). In order to avoid potential bias resulting from asking respondents to value more the one species, the sample was stratified such that one-half received questions about peregrines and the other half received questions about sturgeons. The WTP questions were asked in the context of a voter referendum for the establishment of a state-wide fund designated for the purpose of protecting the specified species. The proposed fund was to be instituted through a one-time payment in the form of a tax increase. Follow-up questions were asked for the purpose of identifying protest responses.

While the survey included a variety of questions about socioeconomic characteristics, a key feature was the inclusion of the NEP questions to measure environmental attitudes. The NEP is based on 15 statements to which respondents indicate the extent that they agree or disagree with each one on a 5-point Lickert scale. We list the different statements in Table 1. The NEP is designed to elicit five facets of environmental attitudes. The different facets and corresponding statements are the following: reality of limits to growth (1,6,11), anti-anthropocentrism (2,7,12), the fragility of nature's balance (3,8,13), rejection of the idea that humans are exempt for the constraints of nature (4,9,14), and the possibility of an eco-crisis or ecological catastrophe (5,10,15).

Table 1 reports descriptive statistics for the responses to the NEP statements. The frequency percentages reflect substantial heterogeneity in the sample. While there appears to be a general opinion about some statements (e.g., 3,5,7,9,13) other statements elicit responses that are more balanced between the different categories. For instance, the majority of respondents strongly agree with the statement that "plants and animals have as much right as humans to exist," but the responses differ widely regarding the statement that "the so-called 'ecological crisis' facing human kind has been greatly exaggerated."

In order to make comparisons between the statements, we also report mean responses (and standard deviations) for each item. The means are calculated based on coding such that higher values indicate stronger pro-environmental attitudes. Accordingly, odd-numbered statements are coded such that 'strongly agree' = 5, 'somewhat agree' = 4, 'undecided' = 3, 'somewhat disagree'

= 2, and 'strongly disagree' = 1. Even-number statements are coded in the reverse order. The strongest pro-environmental attitudes are associated with the statement that "despite our special abilities, humans are still subject to the laws of nature." The weakest pro-environmental attitudes are associated with the statement that "the earth has plenty of natural resources if we just learn how to develop them." The general pattern of results reported in Table 1 is similar that found in other studies using the NEP (e.g., Dunlap et al. (2000); Cooper et al. (2004)).

Of the 629 completed surveys, a useful sample size of 563 surveys (272 sturgeon and 291 falcon) remains after deleting underage respondents and observations with missing values for one or more NEP statements. Although a variety of views were expressed by survey respondents (respondents both strongly agreed and strongly disagreed with all NEP statements), the response frequencies and means indicate that in general the survey respondents agreed with the pro-environmental NEP statements and disagreed with the weak-environmental statements. The average respondent's attitudes fall between undecided and strong environmental.

Table 1: New Ecological Paradigm scale item response frequencies and descriptive statistics.[a,b]

	NEP Statement	SA	SWA	U	SWD	SD	Mean	StdDev
1.	We are approaching the limit of the number of people the earth can support.	26.5	32.0	23.1	11.0	7.5	3.6	1.2
2.	Humans have the right to modify the natural environment to suit their needs.	5.9	26.3	10.3	33.2	24.3	3.4	1.3
3.	When humans interfere with nature it often produces disastrous consequences.	42.3	38.9	8.2	7.6	3.0	4.1	1.0
4.	Human ingenuity will insure that we do not make the earth unlivable.	12.4	24.9	28.0	21.3	13.3	3.0	1.2
5.	Humans are severely abusing the environment.	41.9	39.6	6.6	8.9	3.0	4.1	1.1
6.	The earth has plenty of natural resources if we just learn how to develop them.	30.4	36.4	15.6	11.6	6.0	2.3	1.2
7.	Plants and animals have as much right as humans to exist.	55.6	29.1	4.1	6.4	4.8	4.2	1.1
8.	The balance of nature is strong enough to cope with the impacts of modern industrial nations.	1.4	10.3	20.4	32.9	35.0	3.9	1.0

Table 1: (continued)

	NEP Statement	SA	SWA	U	SWD	SD	Mean	Std Dev
9.	Despite our special abilities, humans are still subject to the laws of nature.	50.4	40.3	6.4	2.0	0.9	4.4	0.8
10.	The so-called 'ecological crisis' facing human kind has been greatly exaggerated.	6.8	17.9	25.6	25.4	24.3	3.4	1.2
11.	The earth is like a spaceship with very limited room and resources.	25.2	32.9	15.6	19.0	7.3	3.5	1.3
12.	Humans were meant to rule over the rest of nature.	9.4	15.8	12.4	27.4	35.0	3.6	1.3
13.	The balance of nature is very delicate and easily upset.	38.7	39.3	9.6	9.8	2.7	4.0	1.1
14.	Humans will eventually learn enough about how nature works to be able to control it.	5.5	18.7	27.4	28.4	20.1	3.4	1.2
15.	If things continue on their present course, we will soon experience a major ecological catastrophe.	22.7	31.1	26.6	13.5	6.0	3.5	1.2

[a] SA=strongly agree, SWA=somewhat agree, U=unsure, SWD=somewhat disagree, SD=strongly disagree. Frequencies may not sum to 100 due to rounding.

3 Measuring environmental attitudes

In this section we briefly describe three methods that can be applied to the NEP in order to measure environmental attitudes. We begin with the summated scale and then turn to the methods of cluster analysis and latent class analysis.

3.1 Summated Scale

The most common method for using the NEP to measure environmental attitudes is to combine the responses into a summated scale. This involves coding the responses 1 through 5 such that higher values indicate stronger pro- environmental attitudes (as described above). Then for each respondent the codes for each statement are simply summed to create a scale that can range from a 15 to 75, with higher scores reflecting stronger pro-environmental attitudes. Before creating the scale, researchers typically verify internal consistency among the items; this usually involves a determination of whether

item-total correlations and/or Cronbach's coefficient are reasonable.

Creating a summated scale from the NEP statements has advantages and disadvantages. The primary advantages are that the method is straightforward to implement, the scale is easy to interpret, and the scale provides a continuous measure of attitude strength. A disadvantage relates to the researchers ability to categorize respondents into dierent groups depending on their environmental attitudes. This may be important in several contexts. With respect to CV, for example, researchers may wish to compare estimates of WTP between different groups. Accomplishing this with the summated scale would require the analyst to choose arbitrary thresholds on the scale to distinguish between groups.[1] With this approach, groupings are not based on similarities in responses to particular NEP statements, and it is unclear how results may be sensitive to differently chosen thresholds. The next two methods that we describe- cluster analysis and latent class analysis- enable researchers to categorize respondents into different groups based on similarities in responses and without requiring ad hoc decisions on the part of analysts.

3.2 Cluster Analysis

Cluster analysis segments individuals into groups with homogeneous intra-group characteristics and heterogeneous inter-group characteristics. Although a variety of clustering methods exist and the details of the various methods differ, each method entails the same principal steps (Romesburg, 1984):

1. standardize the data (if appropriate),
2. compute the proximity coefficients (if appropriate),
3. apply the chosen clustering method, and
4. determine the number of clusters.

Because responses to the NEP statement are measured using a likert scale, and are thus measured in dimensionless units and contribute equally to the calculation of proximity coefficients, standardization is an unnecessary step for the present analysis. Proximity coefficients, which measure the degree of either similarity or dissimilarity between two individuals, are calculated for the i^{th} and j^{th} individuals for all $i = 1, \ldots, n$ and $j = 1, \ldots, n$, and are arranged in an $n \times n$ matrix referred to as a resemblance matrix. In this analysis we use the Euclidean distance measure (a measure of dissimilarity), one of the most commonly used of several proximity coefficients appropriate for use with ordinal data (Romesburg, 1984; Aldenderfer and Blashfield, 1984).[2]

Survey respondents are segmented into different environmental ethics groups by applying Ward's minimum variance clustering algorithm to the resemblance matrix. Ward's method is one of numerous

[1] This is the approach used by Kotchen and Reiling (2000) and subsequently by Cooper et al. (2004). Both studies choose thresholds on the NEP scale to establish three groups differing in the strength of their pro-environmental attitudes. While the different groups are used to investigate protest responses to CV questions, neither study investigates the question that we focus on here, which is relationship between the groups and estimates of WTP.

[2] The Euclidean distance measure is $d_{ij} = \sqrt{\sum_{k=1}^{n} (x_{ik} - x_{jk})^2}$.

hierarchical agglomerative methods, which iteratively merge n observations into a single cluster in a process of $n-1$ steps. Hierarchical agglomerative methods differ in the rules used to determine which clusters should be merged at each of the $n-1$ steps. Ward's method uses an error sum of squares criterion to determine which observations to merge at each stage in the clustering procedure. The objective is to minimize the increase in the total within-cluster error sum of squares:

$$\min \sum_{m=1}^{g} ESS_m = \sum_{m=1}^{g} \sum_{i=1}^{n_m} \sum_{k=1}^{p} \left(x_{mi,k} - \frac{1}{n_m} \sum_{i=1}^{n_m} x_{mi,k} \right), \tag{1}$$

where ESS_m denotes the error sum of squares within the m^{th} cluster, $x_{mi,k}$ is the value of the k^{th} NEP variable for the i^{th} individual in the m^{th} cluster, and n_m is the number of individuals in the m^{th} cluster (Aldenderfer and Blashfield (1984), Everitt et al. (2001)). We determine the appropriate number of clusters using the pseudo t^2 and pseudo F statistics.

3.3 Latent Class Analysis

A latent class model assumes that there are a number of distinct environmental attitudinal groups and that membership in these groups is latent or unobserved. The basic intuition of a latent class model is that the NEP response patterns of individuals who share similar environmental attitudes will be highly correlated; these response patterns will be very different from those who have opposing environmental attitudes.

Latent class models are widely used in psychology and education. Standard references to latent-class models include Titterington et al. (1985), Bartholomew and Knott (1999), and Wedel and Kamakura (2000). A few researchers have applied latent-class models to attitudinal data (Clogg and Goodman, 1984; McCutcheon, 1987; McCutcheon and Nawojcyzk, 1995; De Menezes and Bartholomew, 1996; Yamaguchi, 2000; Eid et al., 2003). References in economics include Boxall and Adamowicz (2002), Provencher et al. (2002), Morey et al. (2005), and Scarpa and Thiene (2005).

The estimation goal of latent class analysis is to find the most likely response probabilities and unconditional class probabilities, given the response pattern of all respondents. A response probability, $\pi_{qs|c}$, is the probability that an individual in environmental attitude group c gives answer s to attitudinal question q; for example, it is the probability that someone in group c answers "Strongly agree" to the statement that humans have the right to modify the natural environment. An unconditional class probability, $\Pr(c)$, is the probability that any individual in the sample will belong to environmental group c; this probability does not depend on an individual's specific answers to the NEP.

The ln likelihood function for a C-class model for the data in this sample is:

$$\ln L = \sum_{i=1}^{N} \ln \left[\sum_{c=1}^{C} \Pr(c) \prod_{q=1}^{Q} \prod_{s=1}^{S} (\pi_{qs|c})^{x_{iqs}} \right], \tag{2}$$

where x_{iqs} is a dummy variable that reflects whether individual i chose s on question q.

One can estimate both the unconditional and response probabilities that maximize the ln likelihood function. Furthermore, one can also estimate the conditional membership probabilities, or the

probability that individual i belongs to group c, given the set of her answers to the NEP. A more detailed explanation of the derivation of this model and how one can be estimated can be found in Morey et al. (2005) and Thacher et al. (2005). A number of software packages now exist that allow estimation of latent class models, including Latent GOLD (Vermunt and Magidson, 2000) and Mplus (Muthen and Muthen, 2004). The results for this study were estimated using LEM (Vermunt, 1997).

4 Consistency Across Methods

We have applied the three different methods for measuring environmental attitudes with the NEP data. There is precedence with the literature for considering three groups, and the results of our cluster analysis and latent class analysis indicate that a three-class model fits the data reasonably well. We thus consider heterogeneity of environmental attitudes based on three groups that capture whether respondents have "strong," "moderate," or "weak" pro-environmental attitudes. In this section, we compare the different methods in terms of their consistency in group assignment and the attitudes reflected within groups.

The previous section describes how the grouping of respondents is an output of cluster analysis and latent class analysis, but not of a summated scale. If, however, the analyst is willing to set arbitrary thresholds, the summated scale can also be used to establish different groups. This was the procedure used by Kotchen and Reiling (2000), and for purposes of comparison, we use their thresholds here. With the summated scale, the moderate group is defined as those respondents with summated responses between 50 and 59, while the weak and strong groups have lower and higher scores, respectively.[3]

To assess the consistency with which the different methods assign individuals to attitudinal groups, we consider the percent of respondents assigned to the same group by each of the methods.[4] Comparing the group assignments of cluster analysis and the summated scale indicates that nearly three-fourths of the respondents (74 percent) were assigned to the same group. Furthermore, no individuals were assigned to the weak (strong) group by one method and the strong (weak) group by the other method. Comparisons of latent class group assignments with those of both cluster analysis and the summated scale indicate that in each case sixty-five percent of the respondents were assigned to the same group. Although the remaining thirty-five percent were assigned to different groups, only three individuals were assigned to strong by latent class analysis and weak by the summated scale, and only one individual was assigned to strong by latent class analysis and weak by cluster analysis.

A three-way comparison of results indicates no instances of an individual assigned to the strong (weak) group by two methodologies but weak (strong) by the third methodology. Additionally, fifty-two percent of the respondents were assigned to the same group by all three methodologies. As a point of comparison, it is worth noting that if group assignments had been random, only eleven percent of the respondents would have been assigned to the same group by all three methods.

Table 2 reports the mean responses to each of the NEP statements for each attitudinal group

[3]Kotchen and Reiling (2000) justify these thresholds on the basis that each of the groups contain roughly one-third of the sample.

[4]In order to compare the latent class results with those of the other two methods, individuals were assigned to the group for which they had the highest conditional probability.

for all three methods. We list the statements within the five facets that the NEP is designed to measure. These results are useful to see how the specific responses differ between the strong, moderate, and weak pro-environmental attitude groups. In general, the mean responses between the different groups are statistically different.[5] The exceptions occur between the strong and moderate pro-environmental groups derived from latent class analysis; for these groups the statements within the rejection of exemptionalism facet and the *interfere* statement are not statistically different.

There is a fair amount of consistency in the results derived using the three methodologies. The strong pro-environmental groups have relatively strong pro-environmental attitudes on all facets, although they consistently demonstrate weaker attitudes regarding the sufficiency of the earth's resources (*suffresources*). Across the methods, the moderate groups are somewhat environmental on all facets, yet there are some statements for which they are either undecided or appear to not hold a pro-environmental attitude (e.g., *suffresources*, *ingenuity*). The weak group consistently holds seemingly anti-environmental attitudes for the statements within the two facets that probe an eco-crisis and anti-anthropocentrism; however, responses within other facets are more mixed. For example, results for the facet probing the fragility of nature's balance show somewhat pro-environmental attitudes or uncertainty.

One notable difference between the different methods pertains to the size of the different groups. Although the moderate pro-environmental group is consistently the largest, there are substantial differences in group sizes across the three techniques. In particular, latent class analysis yields a much smaller weak group. Consequently, the latent class weak group has weaker pro-environmental attitudes. This difference in most pronounced for the *ecolcrisis* statement and the variables associated with the anti-anthropocentrism facet.

5 Relationship between WTP and attitudes

The evidence above suggests strong consistency in how the different methods use the NEP data to identify environmental attitude groups. We further examine this issue by testing whether WTP varies across the different methods. This also allows us to examine the theoretical validity of CV by including environmental attitudes in estimation of WTP.

We estimate logit models of willingness to pay. Following Kotchen and Reiling (2000), the covariates examined include previous knowledge about the good, household income, and environmental attitudes, as measured by the different methods.[6] Table 3 provides the definition and descriptive statistics for each of the variables used in the logit models.[7]

[5] We conducted t-tests for all pairwise comparisons of the mean response for statements between groups and within methods.

[6] Including income as a separate linear term is not utility theoretic, as it implies a different marginal utility of income based on the bid and income variables. However, it is a common practice; the typical reasoning is that income is a proxy variable for a number of other socio-economic attributes. We follow Kotchen and Reiling (2000) and include income.

[7] Observations with missing values for any of the variables included in the regression were deleted. In addition, following the approach taken by Kotchen and Reiling (2000) with this dataset, we exclude any individuals exhibiting protest behavior. Estimation was performed using proc logistic in SAS (SAS Institute Inc, 1987).

Table 2: Mean NEP scores for ethics groups.

	NEP Score			Cluster Analysis			Latent Class Analysis		
	Strong	Moderate	Weak	Strong	Moderate	Weak	Strong	Moderate	Weak
Limits to Growth									
earthcap	4.285	3.602	2.862	4.071	3.785	2.819	4.130	3.398	2.553
suffresources	2.828	2.138	1.823	2.635	2.198	2.006	2.574	2.177	1.553
spaceship	4.269	3.464	2.740	4.051	3.595	2.806	4.041	3.289	2.534
Anti-Anthropocentrism									
modifyenv	4.210	3.490	2.591	4.410	3.372	2.594	4.104	3.250	1.914
righttoexist	4.758	4.439	3.503	4.846	4.482	3.288	4.763	4.156	2.737
humanrule	4.452	3.725	2.674	4.404	3.676	2.794	4.303	3.465	1.925
Fragility of Nature's Balance									
interfere	4.672	4.082	3.525	4.756	3.972	3.650	4.627	3.797	3.671
strongbalance	4.699	3.949	3.017	4.756	3.842	3.144	4.599	3.574	2.933
delicatebalance	4.661	4.041	3.326	4.840	4.036	3.181	4.608	3.776	3.038
Rejection of Exemptionalism									
ingenuity	3.661	2.852	2.425	3.558	2.846	2.631	3.459	2.749	2.398
lawsofnature	4.704	4.327	4.088	4.679	4.421	4.006	4.686	4.192	4.151
controlnature	3.962	3.357	2.834	3.929	3.198	3.156	3.822	3.146	3.023
Possibility of an Eco-Crisis									
ecolcrisis	4.393	3.378	2.486	4.455	3.413	2.444	4.279	3.130	1.757
abusingenv	4.737	4.087	3.414	4.776	4.024	3.506	4.706	3.819	3.133
ecolcatastrophe	4.312	3.546	2.646	4.410	3.547	2.575	4.280	3.198	2.229
n	186	196	181	156	247	160	211	298	54

Table 3: Descriptive Statistics

		Falcon		Sturgeon	
Variable	Definition	Mean	Std Dev	Mean	Std Dev
CA Moderate	Belongs to cluster analysis moderate group (1=yes, 0=no)	0.454	0.499	0.432	0.497
CA Strong	Belongs to cluster analysis strong group (1=yes, 0=no)	0.293	0.456	0.312	0.464
LC Moderate	Belongs to latent class analysis moderate group (1=yes, 0=no)	0.517	0.501	0.513	0.501
LC Strong	Belongs to latent class analysis strong group (1=yes, 0=no)	0.420	0.495	0.397	0.491
Bid	Presented bid	24.410	11.891	11.819	7.941
Mean Income	Mean of household income range	41,500	24,494	38,731	24,401
Knowledge	Prior knowledge of species in Maine (1=yes, 0=no)	0.459	0.499	0.266	0.443
NEP summation	Total NEP summation	55.317	8.997	55.171	9.304

Tables 4 and 5 report the parameter estimates and significance levels for the falcon and sturgeon surveys respectively. In all three attitudinal models, the bid, socio-economic, and attitudinal variables are significant and of the expected sign. As expected, individuals are less likely to say yes to the given price as the bid amount increases; the probability of saying yes increases with income. Each table also contrasts these results with a model that does not include any attitudinal measures.

Consider first the falcon dataset. Coefficients on attitudinal measures are strong across most of the three methods and of the expected sign. For example, coefficients associated with attitudinal groups identified by both the latent class and cluster analysis methods show that the strong environmental groups are significantly more likely to agree to the referendum than the weak environmental group; in each case, strong environmentalists are approximately four to five times more likely than weak environmentalists to accept the bid. Cluster analysis also finds that moderate environmentalists are about two times more likely to accept the bid; there is not a significant difference between moderate and weak environmentalists in the latent class model. Individuals with a higher NEP score are significantly more likely to accept the bid.

In the model without attitudes, knowlege about the good increases the probability of acceptance. Knowledge is not significant once attitudes have been controlled for; knowledge appears to be proxying for environmental attitudes.

The Hosmer Lemshow goodness of fit test shows that for all but the latent class model we fail to reject the null hypothesis that there is a difference between the expected and predicted response; thus, these models fit the data well.

Table 4: Linear Utility Logit Regression ($n = 205$): Falcon Estimates, Odds Ratio, and Significance Level
[a]

	NEP			LC			CA			No Att		
Variable	**Est**	**OR**	**Sig**	**Est**	**OR**	**Sig**	**Est**	**OR**	**Sig**	**Est**	**OR**	**Sig**
Intercept	−3.28	.	***	−1.09	.	−1.10	.	**	−0.32	.		
Bid	−0.05	0.95	***	−0.05	0.96	***	−0.05	0.96	***	−0.04	0.96	***
IncomeMean	0.00	1.00	***	0.00	1.00	***	0.00	1.00	***	0.00	1.00	***
Knowledge	0.44	1.55	0.44	1.55	0.47	1.60	0.59	1.80	**			
CAModerate	.	.	.	.	0.80	2.23	**	.	.			
CAStrong	.	.	.	.	1.60	4.95	***	.	.			
LCModerateDiscrete	.	.	0.58	1.78	.	.	.	.				
LCStrongDiscrete	.	.	1.44	4.21	*	.	.	.	.			
NEPscore	0.06	1.06	***	.	.	.	.	.	.			
LogL	−123.11			−123.53			−121.00			−128.20		
Hosmer-Lemshow (χ^3_8)	5.09			16.03			5.87			6.14		
Mean WTP [b]	$18.32			$18.07			$18.11			$18.15		
Confidence Interval [c]	$9.96 − $23.63			$8.75 − $23.39			$8.35 − $23.56			$7.85 − $23.48		

[a] $* = 10\%, ** = 5\%, *** = 1\%$

[b] Calculated for a representative individual in the sample.

[c] Based on 500 draws. $\alpha = 0.05$

Table 5: Linear Utility Logit Regression ($n = 207$): Sturgeon Estimates, Odds Ratio, and Significance Level
[a]

	NEP			LC			CA			No Att		
Variable	**Est**	**OR**	**Sig**	**Est**	**OR**	**Sig**	**Est**	**OR**	**Sig**	**Est**	**OR**	**Sig**
Intercept	−4.66	.	***	−0.96	.	−0.75	.	0.38	.			
Bid	−0.05	0.95	**	−0.05	0.95	***	−0.05	0.95	***	−0.05	0.95	***
IncomeMean	0.00	1.00	**	0.00	1.00	**	0.00	1.00	**	0.00	1.00	*
Knowledge	0.74	2.10	*	0.80	2.23	**	0.79	2.20	**	0.75	2.12	**
CAModerate	.	.	.	.	0.96	2.62	**	.	.			
CAStrong	.	.	.	.	1.88	6.56	***	.	.			
LCModerateDiscrete	.	.	1.21	3.37	**	.	.	.	.			
LCStrongDiscrete	.	.	1.69	5.42	***	.	.	.	.			
Knowledge	0.74	2.10	*	0.80	2.23	**	0.79	2.20	**	0.75	2.12	**
NEPscore	0.09	1.09	***	.	.	.	.	.	.			
LogL	−112.70			−120.69			−115.72			−125.27		
Hosmer-Lemshow (χ^3_8)	4.75			9.02			14.78			13.62		
Mean WTP [b]	$21.38			$20.65			$21.25			$20.51		
Confidence Interval [c]	$15.49 − $35.58			$15.26 − $38.91			$15.37 − $46.08			$14.79 − $36.32		

[a] $* = 10\%, ** = 5\%, *** = 1\%$

[b] Calculated for a representative individual in the sample.

[c] Based on 500 draws. $\alpha = 0.05$

The results shown in Table 5 are for the sturgeon and are generally similar to those of the falcon dataset (Table 4). More variables are significant in explaining acceptance of the bid than with the falcon dataset. For example, knowledge is now a significant explanatory factor in all of the models. All of the attitudinal variables are now significant and are of a slightly stronger magnitude than before. The Hosmer Lemshow goodness of fit test shows that all the models fit the data well.

We use the model estimates from Tables 4 and 5 to estimate willingness to pay for each endangered species under each of the attitudinal measurement methods. The estimated mean WTP and corresponding confidence intervals for an average person in the sample for each method and dataset are reported at the bottom of Tables 4 and 5 for an average person in each sample. [8] For both the falcon and sturgeon datasets, there is no significant difference among the WTP estimates derived using the various methods of identifying environmental attitudes; these estimates are remarkably close. In other words, the average willingness to pay for an individual is the same across all of the methods. [9]

This result suggests that the attitudes captured through the various methods of analyzing the NEP are robust. However, these WTP estimates are also not significantly different from the WTP estimates derived from a model that does not include attitudes. The likely explanation of the equivalence of estimated WTP in both the attitudinal and non-attitudinal models is the presence of very strong preference heterogeneity; the different attitudinal groups are canceling each other out.

The significance of the attitudinal variables suggests that CV has theoretical validity; individuals with stronger environmental attitudes are more likely to accept the bid and thus have a higher WTP. Kotchen and Reiling (2000) showed this previously using a summated NEP score. A stronger test of theoretical validity, however, is to examine whether WTP varies significantly between environmental attitudinal groups. Because of the linear and continuous nature of the summated measure Kotchen and Reiling (2000) could not doing this without imposing an exogenous and arbitary decision rule as to what score is a cutoff between weak, moderate, and strong environmental attitude groups. As noted earlier, one of the advantages of latent and cluster analysis is that they can identify group membership. Using the output from these methods, we can thus perform this stronger test of theoretical validity.

Table 6 reports the estimated WTP by method, group, and dataset. As would be expected from the results in Tables 4 and 5, the average willingness to pay for each group is quite different in magnitude and not significantly different from zero for those in the weak environmental group. There are two important points to focus on in Table 6: the significant differences in estimated WTP between groups within a method and the insignificant differences for a group between methods. In all cases, individuals with strong environmental attitudes have a significantly greater willingness to pay than those with weak environmental attitudes. Generally, while individuals in the moderal environmental group have a willingness to pay in between those of the weak and strong groups, these differences are not statistically significant. Table 6 therefore finds evidence of theoretical validity of the CV method: individuals with stronger environmental attitudes are willing to pay more to preserve an endangered species.

Table 6 also reports that there are not significant differences across methods for the same group.

[8] Confidence intervals were calculated using the Krinsky-Robb approach (Krinsky and A., 1986; Park et al., 1991) and were based on 500 random draws. All calculations were performed in Python.

[9] Similar results were obtained for the left truncated mean WTP but are not reported.

Table 6: WTP by group by method

[a]

Method	Mean	Confidence Interval	Mean	Confidence Interval
		Falcon		
	Latent Class Analysis		**Cluster Analysis**	
Strong	\$31.54	\$22.96 – \$43.68	\$35.98	\$25.27 – \$52.43
Moderate	\$10.23	-\$6.51 – \$18.33	\$17.41	\$4.42 – \$25.50
Weak	-\$5.04	-\$14.14 – \$21.13	-\$1.73	-\$28.56 – \$11.59
		Sturgeon		
	Latent Class Analysis		**Cluster Analysis**	
Strong	\$27.22	\$18.47 – \$51.65	\$36.55	\$24.02 – \$75.29
Moderate	\$19.47	\$12.56 – \$31.76	\$19.76	\$12.57 – \$37.80
Weak	-\$2.84	-\$36.68 – \$14.44	\$4.41	-\$10.83 – \$13.07

[a]Calculated for a representative individual in the sample. Based on 500 draws. $\alpha = 0.05$

For example, there is not a significant difference in estimated WTP across the methods for the strong environmental group. This suggests that the results obtained from the attitude measures are robust; the theoretical validity of the CV measure is not just a function of the method used to identify attitudinal groups.

6 Discussion

There are a number of important points that can be drawn from the previous analysis. First, we find evidence of strong preference heterogeneity with regards to environmental attitudes. Second, we find that environmental attitudes are strong and significant predictors of CV responses, regardless of the method used to identify these attitudes. Our results show that accounting for this heterogeneity does not significantly affect estimates of average WTP. However, we do find significant differences in WTP between strong and weak pro-environmental attitude groups. These results provide a degree of theoretical validation for the CV method with regard to estimating nonuse values.

We used three assessment techniques based on the NEP data—a summated scale, cluster analysis, and latent class analysis—and found fairly consistent results. In particular, the classification into different attitude groups was similar between the methods. Moreover, all three methods show that willingness to pay increases with the strength of pro-environmental attitudes. The output of both cluster analysis and latent class analysis allows us to determine whether there are significant differences in WTP across environmental groups, without imposing arbitrary decision rules about thresholds between strong, moderate, or weak pro-environmental attitudes.

Given the consistency across the three classification techniques, an important question is following: Which method is most appropriate for incorporating environmental attitudes into CV studies? The obvious strength of the summated scale is its simplicity, but a weakness of the summated scale is that it is designed to be a continuous measure rather than a segmenting approach. Therefore, any

decision rules on how to divide individuals into groups is arbitrary. In contrast, both cluster analysis and latent class analysis have methods for determining the appropriate number of groups and who should belong to which group. This may be a important consideration if, for example, a policy-maker is interested in the size of different groups that support or oppose a policy change. In such cases, the summated scale is less useful than either cluster analysis or latent class analysis.

The primary limitation of the latent class approach is that, depending on the data, the number of parameters that must be estimated increases very quickly. This is the case with the NEP data, which has many questions with five response categories for each question. While techniques are available for reducing the number of variables to be estimated, these techniques require more assumptions and expertise on the part of researchers. Nevertheless, latent class analysis has the advantage of being model-based, and the outputs of predicted response probabilities, conditional probabilities, and unconditional probabilities can be useful for economic analysis. Morey et al. (2005) suggest a further use for this type of output.

Cluster analysis has the advantage that it can be applied more generally because it is not a cpu-intensive process. Cluster analysis programs are also available in numerous software packages. A disadvantage of cluster analysis is the need to make somewhat arbitrary decisions at various stages of the clustering process. Although guidelines and considerations for the various decision points exist, there are no definitive rules. Thus, compared to the summated scale, researchers may be trading off one set of arbitrary decisions for another.

In conclusion, this paper finds that environmental attitudes can be useful for testing theoretical validity of nonuse contingent values. While the NEP appears to be a reasonable source of data, there are several available methods for using the data to measure environmental attitudes. We have considered and compared three of these methods and find the results are generally robust. The desired method may depend on particular research goals and/or data availability. Future research should examine whether similar results are obtained from different data sets. If so, it would be a strong argument for economists to include the NEP as a standard measure of environmental attitudes in their survey instruments. This would allow greater comparability across studies and would allow researchers to capture environmental attitudes in a way that is not currently done using demographic variables.

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