Using Attitudinal Data to Identify Latent Classes that Vary in Their Preference for Landscape Preservation

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Abstract

The likelihood of significant heterogeneity in preferences for landscape preservation should be accounted for when designing WTP questions, estimating WTP, and formulating resulting policy recommendations. Herein, heterogeneity in preferences for landscape preservation is investigated in the context of a latent-class model under the assumption of the existence of some finite number of preference classes/groups. The number of classes is estimated, so few restrictions are placed on the form of the heterogeneity. One estimates the probability that individual *i* belongs to class *c* where these probabilities are a function of observable characteristics of the individual (covariates); this is much more flexible than assuming, for example, that all farmers have the same preferences. This paper aims to identify preference classes for landscape preservation in the IBLEO, a rural and beautiful part of Sicily. Estimation of classes is performed using only attitudinal data consisting of answers to Likert-scale questions about the importance of preservation and why the respondent thinks preservation is, or is not, important. Summarizing the results, estimation indicates four distinct preference classes. The classes vary in the level of importance attached to preservation and the motivation for preservation (e.g. use vs. non-use motivations), and include one group that has little interest in preservation.

Key-words: landscape, latent class model, heterogeneity, preference

1 Introduction

The likelihood of encountering heterogeneity in individual preferences for landscape preservation necessitates a reevaluation of the methods used to develop willingness to pay (WTP) survey instruments, WTP estimation, and resulting policy recommendations. Preferences for landscape preservation are, by nature, heterogeneous. Some prefer rural and historic landscapes resulting in a WTP for preservation that is positive; others prefer progress and development to preservation (WTP < 0). In addition, a significant portion of the population will not care either way resulting in a WTP for preservations of zero. Prior knowledge of such heterogeneity informs how WTP questions should be formulated and directed at heterogeneous respondents. For instance, if it is known with high probability that an individual is indifferent to preservation versus development, or prefers development, a standard willingness to pay question for preservation will not be pertinent.

Preferences and preference heterogeneity for landscape preservation are investigated in the context of a latent-class model estimated with only attitudinal data: one assumes there are a finite number of preference classes/groups such that preferences are homogenous within each class but vary significantly across classes. The number of classes is estimated, along with the class-membership probabilities, so few restrictions are placed on the form of the heterogeneity.[1] We are not the first to investigate heterogeneity in the preference for preserving a landscape, but are the first to do it with only attitudinal data, and the first, we believe, to investigate it in the confines of a latent-class attitudinal model.[2]

Latent-class models are commonplace in the social sciences, less so in environmental economics. Standard references include Titterington et al. (1985), Bartholomew and Knott (1999), and Wedel and Kamakura (2000). Applications of latent–class models in environmental economics include Boxall and Adamowicz (2002), Provencher et al. (2002), Scarpa et al. (2003), Menzel and Scarpa (2005), Scarpa et al. (2005), Scarpa and Thiene (2005), Morey et al. (2006) and Breffle et al. (2008), For non-economic latent-class models estimated with only attitudinal data see Clogg and Goodman (1984), McCutcheon (1987), McCutcheon and Nawojcyzk (1995), De Menezes and Bartholomew (1996), Yamaguchi (2000), Eid et al. (2003), and Thacher et al. (2005). Our application here is the first to landscape valuation.

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[1] Note that a discrete distribution, with a sufficient number of supports, can approximate well most continuous distributions, including the normal.

[2] There is literature, not economic or valuation orientated, that uses attitudinal data to investigate what types of landscapes people find pleasing. See, for example Daniel (2001), Fanariotu and Skuras (2004), Arriaza et al. (2004), Manning and Freimund (2004), Kaplan (1995). No of these estimate a latent-class attitudinal model.

Historically, a common method for segmenting a sample is cluster analysis – individuals are statistically placed into clusters based on some measure or measures of similarity/dissimilarity. There are many different ways to cluster (measure similarity) and each measure can generate different clusters. Software makes it easy to cluster but good clustering is an art. The latent-class method has advantages, one being that it straightforward and the underlying assumptions are well specified. The method has a sound statistical and economic foundation. The latent-class model assumes the sample consists of random draws from a mixture of population density functions, one for each class (Magidson and Vermunt, 2002). The number of classes, class-membership probabilities, and the probability that an individual in a given class will express a specific attitude are all determined by maximum-likelihood estimation. The latent-class method provides rigorous methods for determining the number of groups. The latent-class method easily handles covariates, exogenous characteristics of the individual that influence the probability of class membership, and the covariates and their influence are determined by maximum-likelihood tests.

Cluster analysis deterministically places each individual into a specific group. In contrast, the latent-class model only probabilistically assigns an individual to a group. This is less restrictive and more appealing: there is no reason to assume that everyone who is the same in terms of observed characteristics belongs to the same group, but this is what cluster analysis assumes - there is an exception called fuzzy cluster analysis, but it is complex and its use is uncommon.

Aldrich et al. (2007) compare the cluster analysis and a latent-class model using the data from an endangered-species valuation study. With their data, the two methods generate similar groups and group assignments. They recommend the latent-class method when the researcher desires detailed output on predicted behaviour and the ability to test the validity of results using a host of commonly used statistical tests. Cluster analysis and latent-class analysis are also compared in Thacher, Morey and Craighead (2005). They find similar segmentations with the two methods, but conclude *"there are a number of arguments to be made for using latent class analysis rather than defaulting to cluster analysis."* In addition to the above mentioned advantages they list other advantages, including *"A third argument to be made on behalf of latent class analysis is the type of output produced. Cluster analysis essentially produces mean responses that allow you to characterize the groups and identify the individuals that belong to each group. Latent class analysis can produce this; it also produces response probabilities and conditional probabilities. The response probabilities enhance the ability to characterize the groups and can provide guidance for clinicians about how treatment preferences vary among demographic groups. Because they are probabilities, researchers can generate estimates of the size of these classes for different patient populations."*

2 The literature on valuing landscapes

Most of the economic studies to estimate preferences for preserving landscape do it by estimating WTP for the preservation of landscape. These studies estimate WTP typically with stated-preference data (the contingent valuation method, CVM, data or the answers to stated-preference, SP, choice questions).[3] Hanley et al. (1998), for example, use choice experiments to estimate how WTP for preservation varies as a function of the characteristics of the respondent and the landscape. Other choice-experiment examples include Sayadi et al. (2000), Alvarez-Farizo and Hanley (2002), Gonzalez and Leon (2003), McVittie et al. (2004), Campbell et al. (2006), Campbell (2007) and Scarpa et al., (2007). The latter found taste heterogeneity but decided that is was better explained by a mixture model than by a latent-class model. Landscape WTP studies based on CVM data include Pruckner (1995), Willis et al. (1995), Bonnieux and Le Goffe (1997) and Tyrvainen (2001).

Many of these studies have investigated and found heterogeneity in the WTP (preferences) for landscape preservation, finding WTP depends on income category, whether the respondent is urban or rural, a user or nonuser of the landscape, and whether or not the respondent is a local, a visitor to the region, or other. Such covariate findings are consistent with ours.

In these studies, preference heterogeneity is typically modelled by interacting preference parameters with covariates of the individual. Incorporating preference heterogeneity by making preference parameters deterministic functions of characteristics of the individual is quite restrictive: individuals are deterministically placed in categories as a function of their covariates – e.g., all land owners have this preference parameter and all non-landowners have that preference parameter.[4] The latent-class model relaxes this assumption: presence of a covariate only affects the probability that one belongs to a particular class.[5]

The primary goal of these studies has not been to utilize attitudinal data to learn about preference heterogeneity. That said, some of these studies have utilized the answers to attitudinal question in the pursuit of explaining heterogeneity in WTP. For example, Willis et al. (1995) allow the probability of accepting a bid amount to be a function of answers to attitudinal questions, including

[3] SP choice questions consist of a small number of hypothetical alternatives and the respondent is asked to identify his or her most preferred alternative; e.g. "which of the following landscape alternatives do you prefer," where each alternative is described in terms of the levels of a small number of site characteristics and cost. A referendum CVM question, the most common type of CVM question, is a SP choice question with two alternatives, one being the status quo. For examples of hedonic landscape valuation studies, see Geoghegan et al. (1997) and Bastian et al. (2002). Fleischer and Tsur (2000) is a travel-cost landscape valuation study.

[4] For example, Willis et al. (1995) do this by estimating separate WTP functions for locals, visitors, and the general population of the U.K.

[5] Heterogeneity can also be modelled with a random-parameters model (preference parameters are assumed to have some assumed distribution, usually normal) or a finite-mixture model (a random parameters model where the distribution parameter as assumed functions of the characteristics of the individual). For a random-parameters model applied to landscape valuation see Campbell et al. (2006).

questions such as whether "respondent would like to see more heather moorland (or wildlife) in the countryside". See also Alvarez-Farizo and Hanley (2002). Including responses to attitudinal questions as determinants of WTP is very different than what we are doing here. Here, we assume individuals have stable but latent preferences, and that answers to WTP questions, observed choices, and answers to attitudinal questions are all manifestations of those preferences; that is, answers to CVM questions, choice questions and answers to attitudinal questions about what one likes or would like to see happen are jointly determined by unobserved/latent preferences - one type of preference manifestation does not determine another type.

3 Attitudinal questions and the application

We begin by assuming that there is small and finite number of preference classes for landscape preservation: the latent-class model is based on the assumption that class membership is latent/unobserved: one estimates the probability that individual *i* belongs to class *c* as a function of the observable characteristics of the individual (covariates). This approach to modelling heterogeneity is more flexible and reasonable: the number of classes is estimated so the approach can approximate most types of preference heterogeneity, and individuals are only probabilistically assigned to classes. The application is preferences for landscape preservation in the Altopiano Ibleo, a rural and beautiful part of Sicily. The Altopiano Ibleo is an extensive high plateau in the Southeast of Sicily. The plateau covers 3190 square km and varies in elevation between 200 m and 600 m; it is etched by several deep river valleys. The distinctive features of the Ibleo landscape are carob trees, both cultivated groves and isolated trees, and a network of thousands of km. of hand-built dry-stone walls. There are olive trees, cereal crops, and local cattle breeds.

Five hundred residents of the Altopiano Ibleo completed a survey to determine preferences for preserving the region's rural landscape. In addition to the aforementioned attitudinal and covariate questions, most respondents were asked a double-bounded CVM question[6]. The survey was carried out in October 1998-March 1999.

Estimation here is with only attitudinal data: answers to Likert-scale questions about the importance of preservation and why the respondent thinks preservation is, or is not, important. Examples include the following preference questions from our survey.

1) When you plan a tourist trip, how much importance do you give to the beauty of the landscape?
a lot *some* *a little* *no importance*

2) How much importance do you give to the maintenance and conservation of the Altopiano Ibleo landscape?

[6] If the individual answered yes to paying x lire, they were asked whether they would pay a higher amount; if they answered no to paying x lire, they were asked whether they would pay a lower amount.

a lot *some* *a little* *no importance*

3) Do you believe it is important to act as soon as possible to avoid further deterioration of the Altopiano Ibleo landscape?
yes no don't know

and

3(1) Check here □ if you are not interested in the problem

And, questions directly asking about one's motivations for preservation such as

4) How much do you agree or disagree with the following statements about why the rural landscape of the Altopiano Ibleo should be preserved?

4.a The landscape should be preserved because it is great for outdoor recreational activities
totally disagree somewhat disagree neither agree or disagree somewhat agree totally agree

4.b The landscape should be preserved because of its historical value
totally disagree somewhat disagree neither agree or disagree somewhat agree totally agree

4.c The landscape should be preserved for future generations
totally disagree somewhat disagree neither agree or disagree somewhat agree totally agree

4.d The landscape should be preserved because its structural components preserve soil from erosion
totally disagree somewhat disagree neither agree or disagree somewhat agree totally agree

4.e The landscape should be preserved because of its potential to create new jobs and foster economic development
totally disagree somewhat disagree neither agree or disagree somewhat agree totally agree

Sixteen such attitudinal questions were used to estimate the latent-class model. Attitudinal questions are asked in many landscape valuation surveys.[7] Our application should be considered an illustration of how standard attitudinal questions can be used to better estimate preferences for landscape preservation.

Looking ahead, estimation suggests four distinct preference classes varying in the importance associated with preservation and the motivations for preservation (e.g. use vs. non-use motivations). There is the Care Little if at All Class (hereafter the *If at All Class*), Strong Preservationists with Non-use Motivations (hereafter the *Strong Non-use Preserv. Class*), the *Ibleo Preserv. Class* and the *Moderate Use-value Preserv. Class*.

We did not find a group that preferred development, but this is not surprising. This survey, and many landscape valuation surveys, is predicated on the assumption that preserving landscape is a good, so surveys are not written to identify those who think it bad. The only option for those who prefer development is to say they "don't value preservation". This is unfortunate and discussed in more detail in the concluding section.

[7] See, for example, Willis et al. (1995) and Bonnieux and Le Goffe (1997), Alvarez-Farizo and Hanley (2002), Fleischer and Tsur (2000), Ek (2002), and Tyrvainen (2001).

The class membership probabilities are found to be a function of a number of covariates: age, whether the respondent resides in the center of the region's main town, education level, whether there is or was a farmer in the extended family, whether the family owns land, whether the respondent is a stay-at-home female, family income level (poor or not), and whether the individual belongs to any environmental organizations.

The survey also asked a CVM question. This allows us to assess how responses to the CVM questions vary by class membership, even though the classes and the class-membership probabilities were estimated with only the attitudinal data. Variation in WTP for preservation by class aligns, to a reasonable degree, with the characterizations of the four classes. For example, the class that shows the least interest in preservation, based on the attitudinal data, has the lowest probability of accepting each bid amount, but the class with the strongest general preference for preservation does not have the highest WTP for preservation of the Altopiano Ibleo. Reasons for why attitudinal responses and WTP responses should or should not align are discussed.

The rest of the paper is organized as follows: Section 4 develops a latent-class attitudinal model of preferences for landscape preservation. Section 5 reports the results for preserving the Altopiano Ibleo, finding four distinct preference classes. Section 5.1 investigates how covariate levels vary by class. Section 5.2 looks at the WTP data by class, asking whether the attitudinal data and WTP data align. Section 6 concludes and suggests extensions.

4. A latent-class attitudinal model of preferences for landscape preservation

The model assumes that the population consists of a number of different preference classes with respect to landscape preservation. An individual's preference class is unobserved/latent. The researcher observes an individual's set of answers to the attitudinal questions (the individual's response pattern) and characteristics of the individual. The response patterns of individuals from the same preference class are more correlated with each other than with individuals in other classes; individuals of the same type answer similarly. Latent-class models assume that once you have controlled for class membership, attitudinal responses are independent.

The estimation goal is to find the response probabilities (the probability that an individual in a certain preference class gives a particular answer to an attitudinal question) and unconditional class-membership probabilities (the probability that an individual belongs to a particular preference class given her observable characteristics) that are most likely, given the response patterns to the attitudinal questions. For example, one unconditional class probability is the probability that an individual with farmers in the family belongs to a particular landscape preference class; this

probability does not depend on the individual's specific answers to the attitudinal questions. All individuals with the same observed characteristics have the same unconditional probability of belonging to a particular preference class. The unconditional probabilities are estimated; they are not known a priori. Once the unconditional class probabilities are estimated, conditional class-membership probabilities can also be calculated; these are the probability that an individual belongs to a particular class given her observable characteristics and her specific answers to the attitudinal questions.

The ln likelihood function for a *C*-class model is:

$$\ln L = \sum_{i=1}^{500} \ln \left[\sum_{c=1}^{C} \Pr(c : z_i) \prod_{q=1}^{16} \prod_{s=1}^{S} \left(\pi_{qs|c} \right)^{x_{iqs}} \right] \qquad (1)$$

where $\pi_{qs|c}$ is the probability that individual *i* answers level *s* on question *q*, conditional on being a member of class *c* – note that once one conditions on class it is not a function of the individual's covariates. Pr(c: $\mathbf{z}_i$) is the unconditional probability that individual *i* belongs to class *c* as a function of his or her observable covariates, $\mathbf{z}_i$, and $x_{iqs} = 1$ if individual *i*'s answer to attitudinal question *q* is level *s* and 0 otherwise. Maximum likelihood estimation is with Latent Gold, Vermunt and Magidson (2005).

The ln likelihood function, Equation 1, is maximized assuming one class, then two classes, then three classes, etc. Each time a class is added, one assesses whether adding an additional class substantively increases the explanatory power of the model.

In addition to the Pr(c: $\mathbf{z}_i$) and the $\pi_{qs|c}$, after estimation one can derive estimated Pr(c: $\mathbf{z}_i$| $\mathbf{x}_i$) and Pr($\mathbf{x}_i$: $\mathbf{z}_i$): the former is the probability that individual *i* belongs to class c given his covariates and conditional upon his answers to the attitudinal questions - these membership probabilities can typically be used to assign individuals to a specific class with a high probability. The latter, Pr($\mathbf{x}_i$: $\mathbf{z}_i$), is the probability of observing the response pattern **x** given the vector of covariates **z**.

5. Estimated preferences for preserving the rural landscape of the Altopiano Ibleo

We concluded the population of the Ibleo Altopiano is best characterized in terms of four preference classes. Following previous research, the BIC, AIC, AIC3 and the CAIC information criteria were used as indicators for the number of classes (Akaike 1974; Bozdogan 1987; Hurvich and Tsai 1989). These criteria are essentially log-likelihood scores with a correction factor for sample size and number of parameters. The estimated number of classes is the number that minimizes the information criteria. Two of information criteria suggest three classes; two suggest

five classes. We then examined the composition and sizes of the classes in the three, four, and five class models. Going from the three to four class model adds a unique new class (those who care little, or not at all, for preservation), while expanding the model from four to five classes does not. This finding, along with the results from the different information criteria, leads us to conclude that a four-class model adequately accounts for the preference heterogeneity in our population.

The estimated unconditional class-membership probability for Class 1, the *Ibleo Preserv. Class*, is forty-two point seven percent (s.e. .02); that is, 42.7% of the sample are estimated to be in this class. Twenty-seven percent (s.e. .02) are estimated to be in Class 2, the *Strong Non-use Preserv. Class*. Twenty-five percent (s.e. .02) are estimated to be in Class 3, the Moderate, and Use-value Preserv. Class. And, five point six percent (s.e. .01) are estimated to be in Class 4, the *If at All Class*.

One can more accurately predict each individual's class membership by conditioning their membership probabilities on their specific responses to the attitudinal questions and on the levels of their covariates. For each individual one of the estimated conditional-membership probabilities are typically close to one (respondents are placed in a class with high certainty) and this is true of the four-class model: it has a high entropy statistic, 0.8 (Wedel and Kamakura 2000). Seventy-seven percent of the respondents are put in one of the classes with at least ninety-five percent certainty, and ninety-six percent of the respondents are put in one of the classes with at least seventy-percent certainty.

Table 1 reports the estimated response probabilities for many of the questions. For example, only 8% of Class 4 attach "a lot of importance" to "the preservation of the Altopiano Ibleo"; in contrast, 89% of Class 2 attach "a lot of importance." Class 2 cares much more about preservation, both in general and for the Altopiano Ibleo, than those in the other classes. Figure 1 reports the estimated average response level for each question for each class; for example, the estimated average response for those in Class 2 to the "importance of conservation in general" is 2.9 on a scale of 0 to 3, whereas for those in Class 4 it is 1.8. The response levels to each of these sixteen questions are significant determinants of the classes and their estimated sizes.

Classes 1 and 2 are much more likely to express non-use motivations for preservation (historic values and future generations) than are members of Class 3; those in Class 4 are unmotivated. The non-use motivations are stronger for Class 1 than Class 2, even though Class 2 cares more about preservation than does Class 1. Also note that Class 2's historic and future generations motivations for preservation are stronger than its recreational motivation.

Class 3 values preservation, although less than Classes 1 and 2, and values use motivations (viewing it, travelling through it) more than non-use motivations. Sixty percent of Class 3 attaches great importance to landscape on a tourist trip. Interestingly though, recreation is not their primary

motivation even though this is the class with the most recreators (49%). In Class 1 only 10% are predicted to recreate, but 64% are predicted to strongly agreed with the recreation motivation for preservation. Class 1 values recreation use, not by themselves but by others.

Summarizing, across the questions, Class 4 is the *If at All Class*: those in this class care little if at all about preserving the Ibleo Altopiano: 32% of the *If at All Class* responded that they are "not interested in the problem", compared to 4% or less for the other classes. Class 2 is the *Strong Non-use Preserv. Class*. Those in Class 1, the largest class, are the Ibleo Altopiano Preservationists, the *Ibleo Preserv. Class*: they care more about preserving the Altopiano Ibleo than they do about preservation in general. Class 3 is the *Moderate Use-value Preserv. Class*: almost half recreate; they are much less likely to express non-use motivations for preservation than are those in Classes 1 and 2, and they care more about the landscape while travelling and at their destinations than those in Class 1.

One would predict at this point that those in the *If at All Class* (4) would have the lowest WTP for preservation of the Altopiano Ibleo, and the answers to the WTP questions support this. One also might be tempted to predict that those in the *Strong Non-use Preserv. Class* will have the highest or close to the highest WTP for preservation of the Altopiano Ibleo, but this is not what we find. Consider why preference and WTP can differ. The responses to attitudinal questions inform about preferences, but not about ability to pay (income). WTP depends on preferences, ability to pay, and perceptions as to whether it is possible to stop or slow development. For example, I might strongly favour preservation but have little WTP for it because I am poor or because I don't think a preservation program can be successfully implemented, or both. There is also the issue of a preference for preservation in general versus preference for preservation of the Altopiano Ibleo. The *Strong Non-use Preserv. Class* care strongly about preservations of the Altopiano Ibleo, but care even more strongly about preservation in general, so might have a lower WTP for preserving the Altopiano Ibleo than others who preservation interests are more focused on the Altopiano Ibleo. Expressions of attitudes about preservation and expressions of what one would pay for preservation might not be consistent, even after one adjusts for ability to pay and differing perceptions - they are different sorts of questions.

5.1 Covariate levels by class

Covariates that significantly influence the probability of group membership are age by category[8], urban, education level[9], farmer in family, immediate family owns land, whether one belongs to an environmental organization, stay-at-home female, and whether one is poor.[10]

To estimate the proportion of a class at each level of each covariate, respondents were assigned to the class for which they had the largest conditional class-membership probability. As noted above, this placed most individuals in one class with high certainty. Table 2 reports the proportion at each covariate level by class after each respondent was assigned to one of the four classes. Older individuals are more likely to be in the *Ibleo Preserv. Class* or *If at All Class*; for example 20% of the *If at All Class* are 60 or over. In contrast, only 3% of the *Moderate Use-value Preserv. Class* are 60 or over.

The *If at All Class* is the only class with no one with a university degree, and 9% of them did not make it past primary school. In contrast, 25% of the *Strong Non-use Preserv. Class* have university degrees; the *Moderate Use-value Preserv. Class* is also educated. Being uneducated makes it more likely you are in the *If at All Class*.

Having no farmer in one's extended family also makes it more likely that you belong to the *If at All Class*. Stay-at-home females are also more likely to be in the *If at All Class*. In contrast, belonging to an environmental organization makes it less likely that one is in the *If at All Class*.

Most of the population is urban and urban makes it more likely one belongs to the *Moderate Use-value Preserv. Class* or the *If at All Class*. Interestingly, those in *Ibleo Preserv. Class* have the lowest proportion of individuals who own land. This is surprising and might result because the survey did not distinguish between ownership of urban and rural land.

Being poor makes it more likely that you belong to the *Strong Non-use Preserv. Class*. Recall that being poor is one reason a strong preservationist might not have a high WTP for landscape preservation - the difference between "desiring" preservation and WTP for preservation.

5.2 How does WTP for preservation vary by preference classes that are identified solely using responses to attitudinal questions?

Respondents were asked WTP questions in two steps: first they were asked whether they would be willing to pay anything to preserve the Ibleo Altopiano; 11% said no. Figure 2 shows how the no's are allocated across the 4 classes. For example, of the 29 individuals assigned to the *If at All Class*, 11 said they would pay nothing (38%), but only 3% of those predicted to be in the *Ibleo Preserv.*

[8] 1<=30, 2 = 31 − 40, 3 = 41 − 50, 4 = 51 − 60, 5 = 61 − 70, 6 > 70

[9] 1 =primary school, 2 =secondary school, 3 =high-school degree, and 4 =college degree.

[10] 1=poor

Class said they would pay nothing. Note that 20% of those estimated to be in the *Strong Non-use Preserv. Class* said they would pay nothing.

Those who said they were willing to pay something were then asked a double-bounded WTP question for preservation. The responses at this second stage also often indicated no WTP (answers of "no" to each bid amount). For example, 66 individuals in the *If at All Class* were asked a double-bounded question and 54 of them said no to both bid amounts. In contrast, 404 of the individuals in the *Ibleo Preserv. Class* were asked a double-bounded question and only 162 said no to both bid amounts.

Now investigate the percentage of individuals that were offered a bid amount and said yes to that bid amount: for example, the percentage of those assigned to class c, c = 1, 2, 3, 4, that were offered and accepted a bid amount of 50,000 lire ($32.67). These percentages are presented in Figure 3. In explanation, 75 of the 404 individuals assigned to the *Ibleo Preserv. Class* were offered a bid of 50, 000 lire, and 91% (68 individuals) said that they would pay that amount.[11] In contrast, 7 of the 66 individuals in the *If at All Class* were offered a bid amount of 20,000 lire, and only 43% of them said they would pay it. Note that at a number of bid levels sometimes no one in a class accepted that bid level; for example, no one accepted a bid amount of 5,000 lire.

That there are no "yes" votes at 5,000 lire ($3.26) is due to two factors: most of these are the individuals who said no to the WTP anything question. The rest are due to the fact that everyone who was presented with a bid of 10,000 lire and said no to 10,000 lire then said no to 5000 lire.

Figure 4 reports the estimated logit probabilities for each bid amount, by class. The intercept is the estimated probability that an individual in Class c would vote for the preservation at zero cost; few in the *If at All Class* would - maybe some of them would prefer development.

As expected, most in the *If at All Class* would not even pay 5,000 lire for the preservation of the Altopiano Ibleo. At every bid amount those in the *If at All Class* have the lowest probability of saying they would pay that amount - this is as expected given the attitudinal latent-class results.

The other three bid functions cross, making it more difficult to determine which class has the highest WTP. Those in the *Ibleo Preserv. Class*, have the highest probability of accepting bids of 150,000 lire ($98.03) or less, but the Moderate Use-value Preserv. have the highest probabilities of acceptance once the bid amounts are greater than 200,000 lire ($130.72). Based on the areas under the bid functions, The *Ibleo Preserv. Class* has the largest per-household WTP.

[11] There are votes on two bid amounts for each respondent who was asked the double-bounded question. Individuals who said no to the WTP anything question were recorded as voting no to the lowest amount offered in the bounded questions (5, 000 lire, that is $3.26) Further complicating things, a few respondents were asked an open-ended CVM question instead of a double-bounded question. If an individual indicated they would pay *x*, then their response was coded as a yes on the first lower bid amount and a no to the first higher bid amount.

At no bid amounts did those in the *Strong Non-use Preserv. Class* have the highest probability of accepting the bid, even though this class has the highest expressed preference for preservation. This is at first surprising, but maybe it shouldn't be: (1) the *Strong Non-use Preserv. Class* has the highest proportion of poor (15%) - the *Ibleo Preserv. Class* the lowest (2%), and (2) members of the *Strong Non-use Preserv. Class* care more about preservation in general than they do about preservation of the Altopiano Ibleo, so lire allocated to preservation needs to be divided between the Altopiano and other regions. That said, based on the attitudinal data, we did not expect the *Strong Non-use Preserv. Class* to be ranked third in terms of WTP. Maybe they have more doubts about whether a preservation program would achieve its objective. If we were to survey again, we would ask how confident a respondent was that a preservation program would be successful.

6. Conclusions and extensions

In this paper, preferences and preference heterogeneity for landscape are estimated using only attitudinal data. Many existing valuation surveys ask attitudinal questions. A latent-class model is assumed: there are a finite number of preference classes and class membership is latent. Statistically, four classes were found that varied in terms of how much the individual cared about preservation and in terms of their motivations for preservation (e.g. for recreational use, historic reasons, save for future generations). One class cared little for preservation.

Numerous characteristics of the respondent affect their class-membership probabilities. Investigating which characteristics help explain preference heterogeneity with a latent-class model is much more appealing than deterministically assigning individuals to preference groups as a function of their characteristics, as is done in cluster analysis.

Once our classes were identified with attitudinal data, we investigated how WTP for preservation differed across the four classes and whether those differences were, or were not, consistent with how the answers to the attitudinal questions differed across the four classes. The class that expressed the least interest in preservation in terms of their attitudinal responses also had the lowest WTP for preservation of the Ibleo Altopiano, but the class that expressed the highest general interest in preservation did not express the highest WTP for preservation, possibility because it is the poorest class and possibly because its members are interested in preservation in general, not just preservation of the Ibleo Altopiano.

Our attitudinal questions were not designed with a latent-class attitudinal model in mind, and the attitudinal data and CVM data were collected in the same survey. In future research, one might want to survey in two stages. The first stage would ask only attitudinal questions and estimate a latent-

class attitudinal model. This would generate estimates of the extent to which preferences vary, the number of classes, class sizes, and identify covariates. Then, in the second survey, WTP questions designed to accommodate the types of heterogeneity found at the first stage would be asked, along with the same attitudinal questions. Different individuals could be surveyed at each stage.

Consider the potential for improvement in the estimates of the WTP for preservation of the Ibleo Altopiano. If there was a first survey with only the attitudinal questions, CVM questions asked in a second survey would likely have been quite different from the ones that were asked. After the first stage, the developer of the CVM questions would approach the task knowing there are four distinct preferences classes, one of which has little or no willingness to pay for preservation of the landscape. The survey developer would also be able to probabilistically assign new respondents to a class based on the levels of the respondent's covariate levels and their answers to the attitudinal questions, both asked in the second survey. With survey branching, individuals could be directed to different WTP questions and follow-up questions based on there estimated conditional class-membership probabilities, all calculated in real time. For example, those with a high probability of being in the *If at All Class*, individuals likely to have little or no WTP for preservation, could be asked questions to determine whether they find preservation a bad, and, if so could be asked a WTP question about development. If they do not indicate that preservation is a bad, they would be presented with small bid amounts. In contrast, likely members of classes that express strong preservation attitudes would be presented with larger bid amounts. Members of classes whose express use motivations for preservation would be probed with more questions about their use; those likely to be in a class with non-use motivations would be probed about the nature of their non-use motivations.

When we do valuation surveys in the future, we will design our attitudinal questions specifically to determine whether the respondent feels the environmental policy, at a zero cost, will increase their utility, decrease their utility (this is now rarely asked), or have no effect on them, and to determine why in terms of use-values (by the respondent or others, now or in the future) and non-use values. Past experiences suggest that at least one *don't care class* will be identified. One might also ask attitudinal questions about trust in government and the respondent's assessment of whether a temporary tax to pay for a policy will be temporary; these sorts of questions could identify a class of scenario rejecters. For example, there might be three classes of individuals with no WTP for preservation: a class that is indifferent to preservation, a class that that prefers development, and a class that prefers preservation but rejects the ability of the government to achieve preservation.

While the emphasis here is on what information about preferences and preference heterogeneity can be extracted from only attitudinal data, the latent-class model presented can be generalized to

include both attitudinal and choice data. One simultaneously finds the maximum likelihood estimates for the class-membership probabilities, the probability of choosing answer s to attitudinal question q, and the class-specific parameters in the WTP function, See Breffle et al. (2008). For example, if the surveying was done in two steps, a model could be estimated using the attitudinal data from both surveys and the WTP data from the second survey.

A long-term goal is a latent-class meta-analysis using the answers to attitudinal questions from many different landscape surveys. Many surveys ask similar questions, and a project could be initiated to develop a common set of attitudinal questions for all landscape valuation surveys. The goal would be to see if there is consistency of preference classes across populations and preservation policies. If so, and the significant covariates were common across samples, likely, one could predict classes and their sizes in a new population based on covariate levels in that population.

In closing, it is our experience that identifying classes that vary in their preferences and for preservation makes explaining WTP estimates to policy makers and legal authorities much easier. The mean WTP for preservation in the population might be $50, but often few individuals will have a WTP near the mean; rather, some individuals will have substantively higher values and other individuals will have no interest in preservation, different values for different, but understandable, reasons. A latent-class attitudinal model is a way to quickly and easily identify how preferences for preservation vary in a population.

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Table1 Percentage response probabilities by class

	Ibleo Preserv. Class		*Strong Non-use Preserv. Class*		*Moderate, Use-value Preserv. Class*		*If At All Class*	
	Class 1	*s.e*	*Class 2*	*s.e*	*Class 3*	*s.e*	*Class 4*	*s.e*
Recreator Q5								
Yes	10%	0.02	25%	0.04	49%	0.05	7%	0.05
No	90%	0.02	75%	0.04	51%	0.05	93%	0.05
Importance of conservation general Q7								
Not at all important	0%	0.00	0%	0.00	0%	0.00	0%	0.00
A little important	1%	0.01	0%	0.00	2%	0.02	21%	0.08
Rather important	66%	0.04	5%	0.03	49%	0.05	71%	0.09
Very important	33%	0.04	95%	0.03	49%	0.05	8%	0.05
Importance landscape destination - Q8								
Not at all important	0%	0.00	0%	0.00	0%	0.00	4%	0.03
A little important	0%	0.00	1%	0.01	1%	0.01	43%	0.09
Rather important	84%	0.03	6%	0.02	40%	0.05	47%	0.10
Very important	15%	0.03	92%	0.03	60%	0.05	7%	0.05
Importance Ibleo conservation - Q13								
Not at all important	0%	0.00	0%	0.00	0%	0.00	0%	0.00
A little important	1%	0.01	4%	0.02	11%	0.03	32%	0.09
Rather important	48%	0.04	7%	0.03	49%	0.05	61%	0.10
Very important	50%	0.04	89%	0.03	40%	0.05	8%	0.07
Historical motivation - Q16b								
Totally disagree	0%	0.00	0%	0.00	0%	0.00	4%	0.04
Somewhat disagree	0%	0.00	0%	0.00	2%	0.01	11%	0.05
Neither agree or disagree	0%	0.00	1%	0.01	12%	0.03	39%	0.11
Somewhat agree	1%	0.01	2%	0.01	48%	0.05	36%	0.10
Totally agree	99%	0.01	97%	0.02	38%	0.05	1%	0.06
Recreation motivation - Q16a								
Totally disagree	0%	0.00	2%	0.01	3%	0.01	14%	0.12
Somewhat disagree	0%	0.04	5%	0.02	12%	0.03	18%	0.08
Neither agree or disagree	2%	0.01	10%	0.04	35%	0.04	36%	0.10
Somewhat agree	33%	0.04	4%	0.02	30%	0.04	18%	0.07
Totally agree	64%	0.04	79%	0.05	21%	0.04	15%	0.09
Future generation motivation - Q16c								
Totally disagree	0%	0.00	0%	0.00	1%	0.01	4%	0.03
Somewhat disagree	0%	0.00	2%	0.02	4%	0.02	0%	0.00
Neither agree or disagree	0%	0.00	6%	0.04	17%	0.04	32%	0.10
Somewhat agree	2%	0.02	3%	0.02	42%	0.05	32%	0.08
Totally agree	98%	0.02	89%	0.05	35%	0.05	33%	0.10
Interest in problem - Q21(1)								
Yes	100%	0.01	100%	0.00	96%	0.02	68%	0.10
No	0%	0.01	0%	0.00	4%	0.02	32%	0.10

(Due to rounding the probabilities do not always sum to 100)

Table 2 Percentage at each covariate level, by class (rows, by covariate, sum to 100%)

		Ibleo Preserv. Class Class 1	*Strong Non-use Preserv. Class Class 2*	*Moderate, Use-value Preserv. Class Class 3*	*If At All Class Class 4*
Age	30 or less	13%	34%	38%	23%
	31-40	22%	25%	28%	25%
	41-50	34%	19%	15%	18%
	51-60	21%	14%	16%	14%
	61-70	6%	4%	3%	16%
	more than 70	3%	3%	0%	4%
Urban	Yes	59%	67%	81%	70%
	No	41%	33%	19%	30%
Education level	Primary school	15%	3%	2%	9%
	Secondary school	26%	19%	18%	23%
	High-school degree	50%	52%	61%	68%
	College degree	10%	25%	19%	0%
Farmer in one's family	Yes	39%	25%	32%	9%
	No	61%	75%	68%	91%
Land owner	Yes	17%	30%	31%	24%
	No	83%	70%	69%	76%
Environmental organization	Yes	15%	37%	26%	0%
	No	85%	63%	74%	100%
Stay-at-home female	Yes	12%	3%	5%	21%
	No	88%	97%	95%	79%
Poor	Yes	2%	15%	11%	5%
	No	98%	85%	89%	95%

Figure 1 Average estimated response levels by question and class

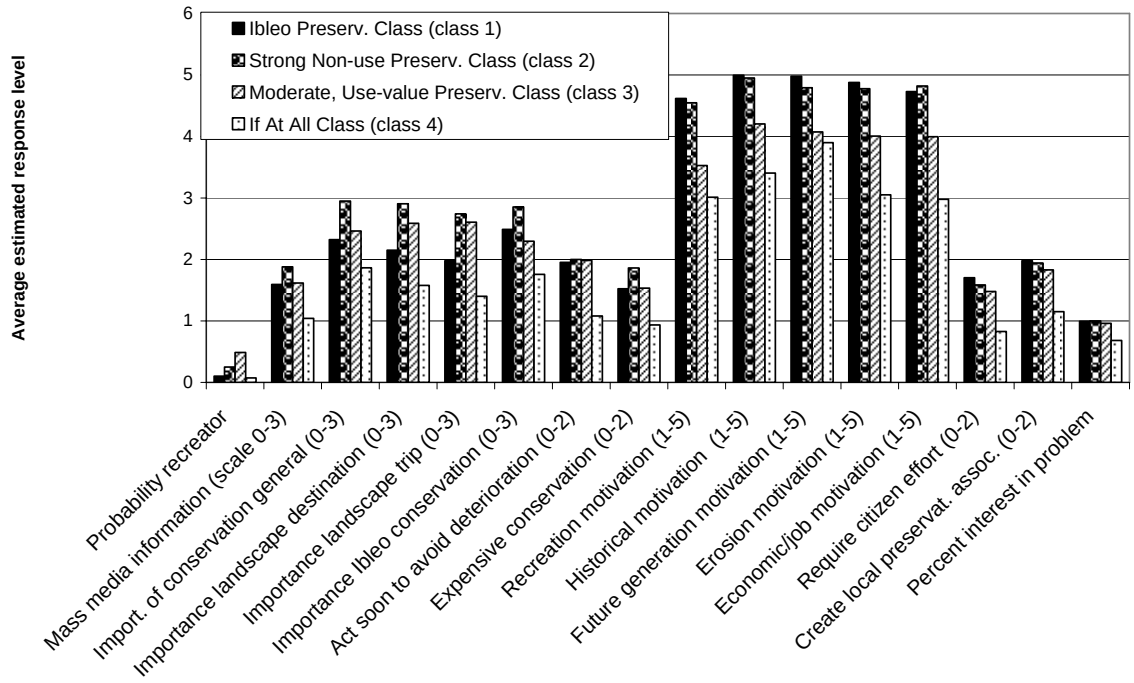


Figure 2: Percent of each class that said they would pay nothing, on the "would you pay anything question"

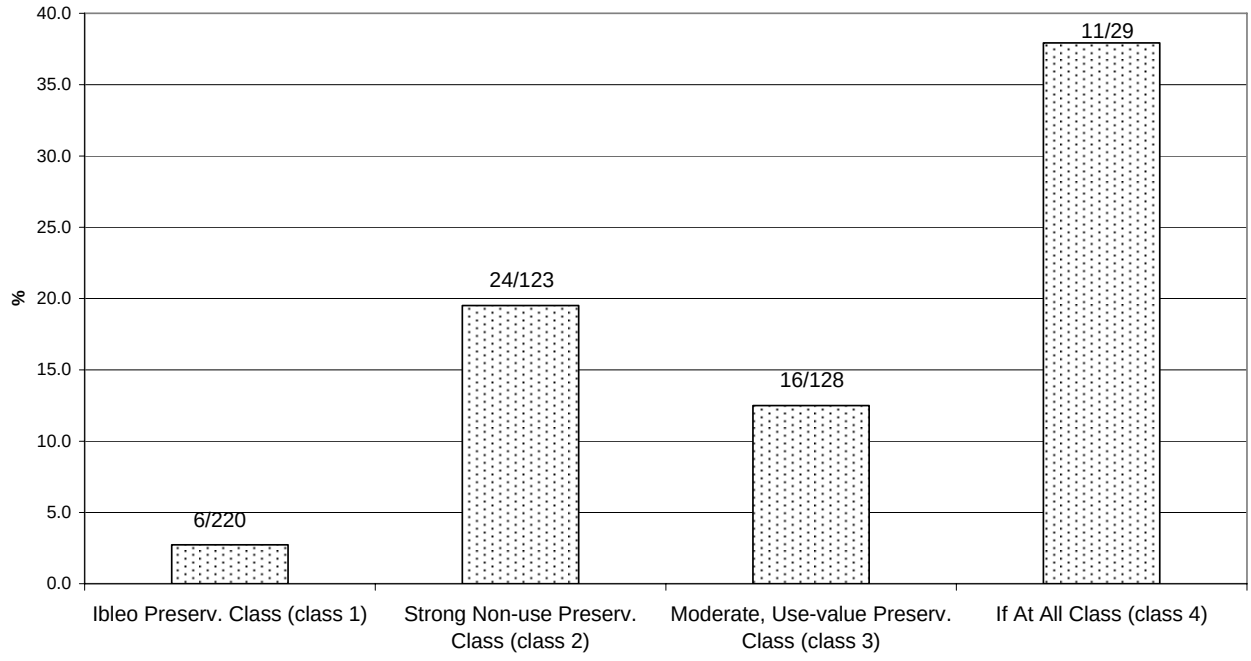
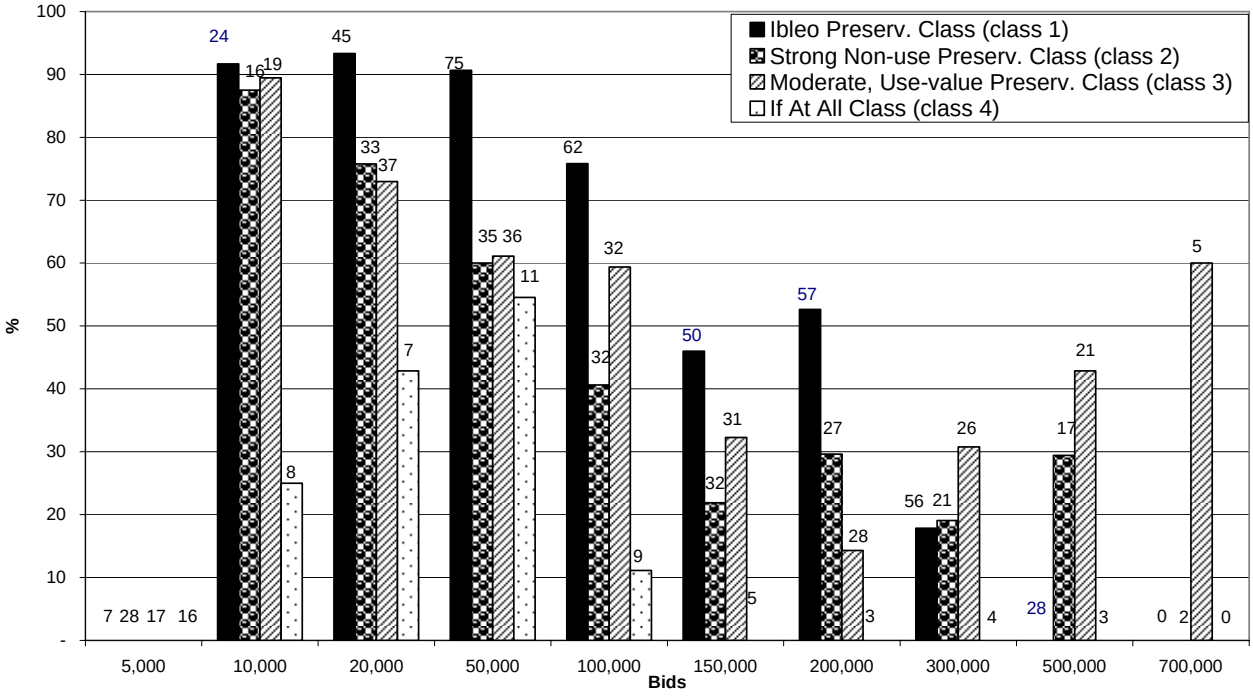


Figure 3 Percentage of respondents who accepted each bid amount, by class*



*The number above each column is the number of people in the class that were offered the bid amount

Figure 4 Estimated logit probabilities for each bid amount, by class.