

ANALYSIS

Measuring heterogeneous preferences for preserving farmland and open space

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Abstract

Public preferences for environmental policies often vary among individual citizens according to their socio-economic characteristics and attitudes toward environmental programs. Most researchers account for socio-economic characteristics when conducting public preference surveys, but do not account for differences in preferences that transcend socio-economic categories. Identifying the public's attitudes regarding environmental programs and the role they play in shaping individuals' preferences for policy alternatives can assist policy makers in developing programs that are consistent with public expectations. This paper uses factor analysis and a discrete choice model to describe differences in public preferences that result from different attitudes regarding the goals of programs designed to preserve farmland and open space. Results describe policy implications that are not apparent when using models that address socio-economic characteristics alone. © 1998 Elsevier Science B.V. All rights reserved.

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1. Introduction

The econometric models used to estimate public preferences regarding environmental amenities usually include a utility function that is assumed to be the same for all individuals, with a random

error term to account for stochastic effects on individual preferences (Hanemann, 1984; Sellar et al., 1986; Cameron, 1988; Boyle, 1990; McConnell, 1990). Socio-economic variables are often included to account for differences in preferences among individuals in different age, income, education, and gender categories (Swallow et al., 1994). The data required for this task are usually gathered directly by asking survey

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respondents to answer a set of categorical socio-economic questions. This procedure enables analysts to estimate preferences for policy alternatives that are consistent with the demographic composition of residents within a state or region (Edwards and Anderson, 1987; Loomis, 1987), and to transfer valuation estimates to other regions with similar demographic characteristics (Walsh et al., 1989; McConnell and Bockstael, 1990). However, public preferences may also vary among individuals according to attitudes that transcend socio-economic categories. In such cases, accurate estimation of preferences may necessitate a conceptual framework that allows for different attitudes among individuals concerning the environmental amenity in question.

Many governments preserve farmland and open space by purchasing land or its development rights (Schnidman et al., 1990; Buist et al., 1995), or by reducing tax rates on selected parcels (Aiken, 1989). The political support for preservation programs typically is motivated by a variety of interests each possessing different attitudes as to why preserving land is important. Environmental groups often wish to preserve habitat for wildlife or to protect groundwater resources. Agricultural groups wish to maintain local crop production and to preserve a region's agricultural heritage (Northeast Farmland Preservation Project, 1986). Residents and public officials in rapidly developing areas may wish to slow the rate of growth (Kline and Wichelns, 1994) and to maintain open space and scenic vistas (Lopez et al., 1994). Attitudes regarding preservation may influence individual or group preferences regarding preservation policies and the actual types of land preserved. Environmental groups may prefer that farmland preservation programs require participating farmers to use farming practices that protect groundwater and enhance wildlife habitat. They might also prefer that preservation programs focus on open space such as wetlands and woodlands, rather than farmland, when open space provides better resource protection. Agricultural groups may prefer to preserve land having the most productive agricultural soils or to focus program efforts on agricultural zones where large areas of contiguous parcels can be preserved

without placing restrictions on farming activities. Local planning officials may prefer preserving land that has significant scenic or recreational value, or is threatened by development.

Contingent valuation studies have estimated the public's willingness-to-pay to preserve farmland and open space in the United States (Halstead, 1984; Bergstrom et al., 1985; Beasley et al., 1986) and in Europe (Drake, 1992; Dubgaard, 1994; Merlo and Puppa, 1994; Riera, 1994; Pruckner, 1995). However, these studies largely have ignored the heterogeneity of individuals' attitudes toward preservation. While value estimation is useful for evaluating the benefits and costs of preserving land, identifying heterogeneous attitudes can be useful for designing programs that are consistent with public expectations.

Incorporating different attitudes into a functional form for utility to account for differences in preferences among individuals is more appropriate than assuming that the utility function is constant for all members of society, with adjustments only for random errors and socio-economic characteristics. However, it is difficult to collect data describing attitudes using standard survey methods. Focus groups can reveal differences in preferences among different groups and individuals prior to collecting survey data, but this information cannot always be used to develop appropriate survey questions. Researchers can ask survey respondents to report membership in selected organizations, but membership alone may not adequately describe preference characteristics. Additionally, not all survey respondents will be members of the organizations with whom they share common attitudes. Researchers need a way to quantify differences in preferences without asking survey respondents to describe their attitudes directly.

This paper presents a method for describing heterogeneous preferences that transcend socio-economic categories. Factor analysis and a discrete choice model are used to examine the components of preferences for preserving farmland and open space. Factor scores are computed from principal component analysis of data describing individuals' relative importance ratings of criteria used to select land for preservation. The

scores are used to create interaction terms in a logit specification of a discrete choice preference model. Likelihood ratio tests indicate that explanatory power is improved when interaction terms involving factor scores and variables describing land parcels are included in the model.

2. Conceptual framework

Public support for land use programs can be described as a coalition of many groups with specific interests and goals (deHaven-Smith, 1988). Zube and Sell (1986) hypothesize that land use values are shaped by social and cultural contexts. Individuals support land use changes that are consistent with their own personal utility and their value orientations (Zube, 1987). Berry (1976) suggests that individuals may consider functional, contemplative, aesthetic, recreational, and ecological factors when expressing values for open space. For example, the value an individual places on land preservation likely results from any one or all of these factors, and the relative importance of each factor varies among individuals. A given land parcel may be valued differently by two individuals if they disagree on the factors that contribute to value. Two individuals may also assign the same value to a parcel of land, but for different reasons. Some participants in preference surveys may place more emphasis on the public good aspects of environmental decisions than on direct consumption benefits, when choosing among hypothetical policy alternatives (Sagoff, 1988; Blamey et al., 1995). Others may be unwilling to tradeoff increases or decreases in environmental goods against losses or gains in income (Spash and Hanley, 1995). A conceptual framework that allows for a variety of attitudes regarding land preservation is desired.

In many states and localities, land preservation funding is approved by public referenda. Once approved by individual voters, program administrators have an endowment of funds with which to preserve land parcels as they become available. If we also allowed individuals to determine how that endowment is spent, their choices among candidate parcels would likely reflect their percep-

tion of the benefits derived from the preservation of each parcel, relative to the preservation costs. For some individuals, utility may be based only on their own personal welfare, while for others utility may include perceptions of what is best for society or future generations. We assume that an individual's indirect utility $u_i(x_i, c_i; y)$ describing their preference for preserving any parcel i , is a function of a vector of parcel attributes x_i , the scalar parcel cost c_i , and characteristics y describing the individual, including socio-economic characteristics and their attitudes regarding land preservation. Because an endowment of preservation funds is assumed to be approved and available, an individual would not incur incremental costs, such as increased taxes, by selecting to preserve a parcel. The indirect utility function is conditional on the individual's income which remains unchanged by their preservation choices. This utility specification is consistent with the individual's role as a voting citizen rather than as a consumer and may provide a more acceptable context in which to evaluate policy alternatives regarding the environment.

Contingent choice surveys that include paired comparisons can be used to construct utility indices that are consistent with predicting results of hypothetical referenda based on the attributes of choice alternatives (Opaluch et al., 1993). The utility function includes a measurable component $v_i(x_i, c_i; y)$ and an unobservable random component e_i . The random utility specification (McFadden, 1973; Hanemann, 1984) assumes that for any pair of parcels 1 and 2, an individual will choose to preserve parcel 1 if

$$v_1(x_1, c_1; y) + e_1 > v_2(x_2, c_2; y) + e_2, \quad (1)$$

which can be rearranged as

$$v_1(x_1, c_1; y) - v_2(x_2, c_2; y) > e_2 - e_1. \quad (2)$$

A logit model of the difference function Eq. (2) describes the probability of an individual choosing parcel 1 as

$$P_1 = \frac{1}{1 + \exp\{-[v_1(x_1, c_1; y) - v_2(x_2, c_2; y)]\}} \quad (3)$$

and is estimated using the maximum likelihood procedure (Ben-Akiva and Lerman, 1991). The

Table 1

Cross-correlation coefficients between factors and importance ratings of reasons for preserving farmland and open space^a

| Reason | Open space preservation factors | | Farmland preservation factors | | |
|-------------------------------|---------------------------------|-------------|-------------------------------|-------------|-------------|
| | Environmental | Aesthetic | Environmental | Aesthetic | Agrarian |
| Protect wildlife habitat | 0.82 | 0.16 | 0.82 | 0.11 | 0.12 |
| Protect groundwater quality | 0.76 | 0.03 | 0.82 | 0.03 | 0.05 |
| Preserve natural places | 0.75 | 0.32 | 0.64 | 0.24 | 0.37 |
| Provide public access | -0.08 | 0.83 | -0.03 | 0.76 | 0.18 |
| Preserve rural character | 0.34 | 0.75 | 0.10 | 0.70 | 0.43 |
| Preserve scenic quality | 0.29 | 0.70 | 0.31 | 0.79 | -0.08 |
| Provide local food | — | — | 0.10 | 0.07 | 0.86 |
| Keep farming as a way of life | — | — | 0.19 | 0.20 | 0.76 |
| Eigenvalue | 2.73 | 1.15 | 3.09 | 1.28 | 1.05 |
| Proportion variance | 0.45 | 0.19 | 0.39 | 0.16 | 0.13 |

^a Based on factor analysis of 503 observations. Kaiser's overall measure of sampling adequacy is 0.76 for the open space model, and 0.78 for the farmland model.

impact of preservation attitudes on preferences can be estimated empirically by selecting a functional form that includes variables that measure differences in preferences across survey respondents' attitudes toward preservation.

3. Empirical analysis

The present study estimates heterogeneous public preferences for preserving farmland and open space in Rhode Island (USA), where the state legislature has enacted two separate preservation programs. The Farmland Preservation Program authorizes the purchase of development rights to farmland to maintain farming, productive open spaces, and groundwater recharge areas (General Laws of Rhode Island, 1988). The Natural Heritage Preservation Program preserves and protects lands with scenic, natural, and ecological value (General Laws of Rhode Island, 1993). Broad public support for farmland and open space preservation in Rhode Island is apparent by the approval of several referenda that have provided funding for these programs in recent years. One way to describe individuals' attitudes toward preservation is to examine their perceptions of why these public programs are necessary. This information can be incorporated into a preference

model to account for preference heterogeneity resulting from different attitudes regarding preservation program goals.

3.1. Focus groups and survey of residents

Several small groups (focus groups) of Rhode Island residents were assembled early in this study to discuss why preserving farmland and open space is important, and to identify lands and land attributes most valued by the public. Information from focus groups was used to develop an intercept survey of Rhode Island residents who were interviewed at motor vehicle registration sites throughout Rhode Island during February and March, 1995. The survey instrument provided a brief description of farmland and open space preservation programs in Rhode Island, and asked respondents about their opinions and preferences regarding farmland and open space preservation.

One section of the survey presented respondents with a list developed by the focus groups that described several reasons for preserving farmland and open space (Table 1). Survey respondents were asked to indicate on a scale from 1 to 10 (1 = not important, 10 = most important), how important each reason should be when selecting open space parcels for preservation, and how

important each reason should be when selecting farmland parcels. The question was asked for farmland and other open space separately because focus groups identified two additional reasons for preserving farmland. The survey produced 503 usable responses to these questions.

A second section of the survey was designed to elicit information regarding public preferences for preserving different types of land. Survey respondents were presented with descriptions of hypothetical pairs of parcels and were asked to choose the parcel they feel the state should preserve, if they had to choose between the two. Hypothetical parcels were developed using information gathered from focus groups regarding the types of land they feel should be preserved. Nine types of land were described, including six types of open space: beaches, rocky shoreline, ponds, rivers, wetlands, woodlands; and three types of farmland: crop and pasture, turf (sod) farms, and fruit and vegetable farms. Most land in Rhode Island can be placed within one of these categories. In addition to these nine land types, focus group participants wished to preserve specific land attributes including public access, endangered species habitat, and important groundwater resources.

The nine land types were used with different combinations of specific land attributes to describe the hypothetical pairs of land parcels which varied in size and cost. For example, a fruit and vegetable farmland parcel of a given size and cost, with no public access, with normal wildlife habitat, and with important groundwater resources, might be paired with a beach parcel of a given size and cost, with public access, with endangered species habitat, and without important groundwater resources. The paired comparisons were based on a factorial design (Addelman and Kempthorne, 1961) that required 81 different pair combinations. Each survey respondent was presented with several pairs, yielding 2497 observations.

Contingent valuation surveys typically present a payment vehicle in the form of increased taxes or user fees to be paid by each individual. However, the context of the paired comparison questions presented in this contingent ranking study

assumes that an endowment of funds already has been approved by voters, and that unused funds will remain in the state's preservation program. Survey respondents are asked only to systematically rank (or vote for) one parcel over another. As a result, survey respondents will not incur costs by choosing to preserve a parcel and their income will remain unchanged. The paired comparison questions did include the cost to the state to preserve each parcel. Focus group participants suggested that this treatment of preservation costs is consistent with how Rhode Island residents think about public expenditures for land preservation. The paired comparison questions are similar to the public referenda that provide funding to farmland and open space preservation and other public programs in Rhode Island.

3.2. Describing attitudes toward preservation

Factor analysis is used to identify unobservable, hypothetical variables (factors) that help to explain the variance of observable variables (Mulaik, 1972; Harman, 1976). We assume that respondents' ratings of the importance of each reason for preserving land reflect their attitudes about land preservation. Factor analysis of the covariance among ratings enables us to identify a small number of common factors that account for most of the variation in ratings. Respondents' importance ratings of reasons for preserving farmland and open space were analyzed separately using principal component factor analysis and rotated using the VARIMAX method (Kaiser, 1958; Mulaik, 1972), resulting in matrices of correlations between rating variables and factors. Typically, the number of factors retained for analysis is determined by the number of eigenvalues of the correlation matrix that are greater than one (Kaiser, 1960; Harman, 1976). This method identified two factors that together account for 64% of the variation in importance ratings of reasons for preserving open space (Table 1). In the farmland model, three factors were identified that together account for 68% of the variation in importance ratings of reasons for preserving farmland.

The first factor in the open space model has cross-correlation coefficients (or factor loadings)

of 0.82, 0.76, and 0.75 with the variables: protect wildlife habitat; protect groundwater; and preserve natural places, and explains 45% of the variance in importance ratings of reasons for preserving open space (Table 1). Because focus group participants described these variables in terms of preserving environmental quality, the first factor is called an environmental factor. The second factor in the open space model has cross-correlation coefficients of 0.83, 0.75, and 0.70 with the variables: provide public access; preserve rural character; and preserve scenic quality, and explains 19% of the variance in importance ratings. Because these variables involve human interaction with, and enjoyment of open space, this second factor is called an aesthetic factor. Environmental and aesthetic factors are also suggested by the cross-correlation coefficients for variables in the farmland model, and explain 39 and 16% of the variance in importance ratings of reasons for preserving farmland. Cross-correlation coefficients of 0.86 and 0.76 with the variables: provide local food; and keep farming as a way of life, suggest an agrarian factor which explains 13% of the variation in importance ratings.

Factors represent different attitudes among survey respondents regarding land preservation. They can be used to describe differences in preferences for land preservation alternatives by computing factor scores for individual respondents, and using these scores as explanatory variables in a preference model. Factor loading coefficients are used to compute standardized factor scores each having a mean of zero and a standard deviation of one (Reyment and Joreskog, 1993 pp. 222–227). The scores measure the degree to which an individual's attitudes regarding land preservation goals deviate, either positively or negatively, from the sample mean score for each factor.

3.3. Estimating preferences

A plausible functional form must be chosen for estimating an empirical specification of the logit model Eq. (3). Boyle (1990) has shown that the choice of functional form can have a significant influence on parameter estimates. Hanemann (1984) and Sellar et al. (1986) suggest using func-

tional forms that are compatible with economic theory rather than using ad hoc functional forms. Chicoine (1981) and Shonkwiler and Reynolds (1986) present a conceptual model that describes land value as a function of parcel attributes. That model can be modified to describe utility per hectare as a function of parcel attributes as

$$\frac{v_i}{x_{i1}} = \beta_0 x_{i1}^{\beta_1} \exp \left[\sum_{j=2}^n \beta_j x_{ij} \right] \quad (4)$$

where v_i/x_{i1} is utility per hectare for parcel i , x_{i1} is parcel size in hectares, the x_{ij} are measures of land type and other parcel attributes j ($j = 2$ to n), and the β are coefficients to be estimated. The specification allows for diminishing marginal utility of land as parcel size increases ($\beta_1 < 0$), and utility per hectare is zero when the parcel size term (x_{i1}) is zero.

To make the utility specification compatible with the discrete choice model Eq. (3), Eq. (4) is converted to describe total parcel utility as

$$v_i = \beta_0 x_{i1}^{(\beta_1 + 1)} \exp \left[\sum_{j=2}^n \beta_j x_{ij} \right]. \quad (5)$$

A reasonable criterion for ranking different parcels of land would be the utility per unit cost. We modify the Eq. (5) to incorporate preservation costs as

$$v_i = \beta_0 x_{i1}^{\beta_1} c_i^\alpha \exp \left[\sum_{j=2}^n \beta_j x_{ij} \right] \quad (6)$$

where c_i is the total cost to preserve parcel i , and α is the estimated cost coefficient ($\alpha < 0$).

The model is estimated as a linear-in-parameters model by taking the natural logarithm of both sides

$$\begin{aligned} \ln(v_i) &= \ln(\beta_0) + (\beta_1 + 1) \ln(x_{i1}) + \alpha \ln(c_i) \\ &\quad + \sum_{j=2}^n \beta_j x_{ij}. \end{aligned} \quad (7)$$

Logit estimation of Eq. (7) necessitates that we replace Eq. (3) with

$$P_1 = \frac{1}{1 + \exp\{-[\ln(v_1) - \ln(v_2)]\}}. \quad (8)$$

Because logit estimation uses the difference in the natural logarithms of the utility functions describ-

ing the two parcels, the parameter $\ln(\beta_0)$ cancels out and cannot be estimated. However, the scalar impact of this unknown parameter does not affect the relative magnitudes of the utility measure for different parcels, or the relative values of the estimated coefficients for parcel size, cost, and other attributes.

The actual model estimated includes variables describing parcel size and preservation cost, and dummy variables describing the land type of the parcel as beach, rocky shoreline, pond, river, wetland, woodland, crop and pasture farmland, turf farmland, or fruit and vegetable farmland (Table 2). Additional dummy variables describe the interaction between the land type and other variables describing parcel attributes including whether or

not the public will have access to the parcel (e.g. $\text{BEACH} \times \text{ACCESS}$), the presence of endangered species habitat on the parcel (e.g. $\text{BEACH} \times \text{SPECIES}$), and the presence of important groundwater resources (e.g. $\text{BEACH} \times \text{GROUND}$). These interaction variables are included to capture complementarity effects between land types and these attributes (Hoehn, 1991).

The utility specification Eq. (6) can account for differences in preferences among individuals by including variables that describe individuals' socio-economic characteristics and attitudes toward land preservation. Respondents' socioeconomic characteristics are incorporated in the model by interacting variables describing age, gender, education, and income, with variables describing parcel size, cost, land type, and other attributes. Such interaction variables enable the model to estimate variation in preferences for parcel attributes across socio-economic characteristics of survey respondents by varying the slope of the utility function with respect to a parcel attribute. However, likelihood ratio tests conducted at the 10% level confirmed that variables describing gender, education, and income interactions with parcel size and cost add little explanatory power to the model. Interacting the variable describing respondents' ages with parcel size does add explanatory power and is retained. Different variables describing respondents' ages were tested. The form that yields the most explanatory power is one that separates respondents who were born prior to 1945 (12% of the sample) from those born later. The age variable is specified as a dummy variable equal to one for respondents who were born prior to 1945, and zero otherwise.

It is likely that individuals who hold more ecocentric views about nature may express greater marginal utility for preserved land than those who hold less ecocentric views. To characterize respondents' degree of ecocentrism, each survey respondent was asked to select one of three statements to describe his or her view of nature: (1) 'Nature exists only to satisfy the needs of humans, and should be managed for that purpose'; (2) 'Nature should be managed to satisfy the needs of humans, but sometimes should be preserved in its natural state'; and (3) 'Nature has a right to exist

Table 2
Variables used to describe land parcels and respondent characteristics

| Variable name | Definition |
|---|---|
| Variables describing land parcels | |
| SIZE | Parcel size in ha |
| COST | Preservation cost in US\$ millions |
| BEACH | 1 If beach, 0 otherwise |
| ROCKY | 1 If rocky shoreline, 0 otherwise |
| SHORE | |
| POND | 1 If pond, 0 otherwise |
| RIVER | 1 If river, 0 otherwise |
| WETLAND | 1 If wetland, 0 otherwise |
| WOODLAND | 1 If woodland, 0 otherwise |
| CROP/PASTURE | 1 If crop and pasture farmland, 0 otherwise |
| TURF | 1 If turf farmland, 0 otherwise |
| FRUIT/VEG | 1 If fruit and vegetable farmland, 0 otherwise |
| ACCESS | 1 If public access provided, 0 otherwise |
| SPECIES | 1 If endangered species habitat, 0 otherwise |
| GROUND | 1 If important groundwater resource, 0 otherwise |
| Variables describing survey respondents | |
| AGE | 1 If respondent born before 1945, 0 otherwise |
| NATURE | 1 If respondent has more ecocentric view of nature, 0 otherwise |
| ENVIRO | Respondent's environmental factor score |
| AESTHETIC | Respondent's aesthetic factor score |
| AGRARIAN | Respondent's agrarian factor score |

without human intervention regardless of how it benefits or harms humans'. Of the 503 observations used in this analysis, 2% of respondents selected statement (1), 50% selected statement (2), and 48% selected statement (3). A variable (NATURE) is included in the model to distinguish respondents who hold more ecocentric views about nature from those who hold less ecocentric views, and is set equal to one if the respondent selected statement (3), and zero otherwise. The variable is interacted with the parcel size variable to account for differences in the perceived marginal utility of preserved land, among respondents possessing different views of nature.

Three variables (ENVIRO, AESTHETIC, and AGRARIAN) are constructed using the environmental, aesthetic, and agrarian factor scores for each survey respondent. Respondents' attitudes toward preservation are incorporated in the model by multiplying these factor score variables by variables describing parcel attributes. These interaction variables enable respondents' preferences for preserving different types of land and land attributes to vary as a function their attitudes toward different preservation goals. For example, the variable ENVIRO is interacted with BEACH (ENVIRO \times BEACH) to account for potential variation in preferences for preserving beaches due to environmental attitudes toward preservation. The variable AESTHETIC is interacted with the pond access variable POND \times ACCESS (AESTHETIC \times POND \times ACCESS) to account for the influence of aesthetic attitudes on preferences for pond access. Likelihood ratio tests conducted at the 10% level confirm that variables representing interactions between factor score variables, and land type and open space access variables add significant explanatory power to the model. Factor score interactions with farmland access variables do not add significant explanatory power, and are omitted from the model. Likelihood ratio tests also confirm that factor score interactions with variables describing important groundwater resources or endangered species habitat do not add significant explanatory power, and are omitted.

Table 3

Estimated coefficients: size and cost variables^a

| Variable | Estimated coefficient | <i>t</i> -Statistic |
|----------------------|-----------------------|---------------------|
| SIZE | 0.229** | 2.59 |
| SIZE \times AGE | -0.175** | -2.32 |
| SIZE \times NATURE | 0.135** | 2.65 |
| COST | -0.241* | -1.9 |

^a Estimated using 2497 observations. Value of the log-likelihood function is -1485.9 and the χ^2 is 490 with 67 degrees of freedom.

* and ** denote significance at 0.10 and 0.05 levels.

4. Results and discussion

Estimated model coefficients are given in Tables 3–5. The estimated coefficient value for parcel cost (α) is -0.241 and is significant at the 6% level ($t = -1.90$), indicating a negative relationship between the utility measure and the expenditure of public funds (Table 3). The coefficient value for parcel size ($\beta_1 + 1$) is 0.229 and is significant at the 1% level ($t = 2.59$). The coefficient describing the interaction between respondents' ages and parcel size is -0.175 and is significant at the 2% level ($t = -2.32$). Respondents who were born prior to 1945 have a lower marginal utility for preserved land than respondents who were born after 1945. The coefficient describing the interaction between the variable NATURE and parcel size is 0.135 and is significant at the 1% level ($t = 2.65$). Respondents with more ecocentric views about nature have a greater marginal utility for preserved land than respondents with less ecocentric views about nature. Adjusting the coefficient value for parcel size ($\beta_1 + 1$) for the proportions of the entire sample in each age and nature category results in a coefficient value of 0.272, indicating a positive relationship between the utility measure and parcel size. Converting the parcel size coefficient to a per-acre basis results in a value of -0.728 ($\beta_1 = 0.272 - 1$), which is consistent with diminishing marginal utility as parcel size increases.

Table 4

Estimated coefficients: land type variables and land type variables interacted with variables describing other parcel attributes^a

| Land type variables | Estimated coefficients | | | |
|---------------------|------------------------|--------------------|---------------------|--------------------|
| | Land type | Land type × ACCESS | Land type × SPECIES | Land type × GROUND |
| BEACH | 1.626** (5.46) | −0.322 (−1.40) | 1.379** (5.51) | — |
| ROCKY SHORE | 0.865** (2.99) | 0.553* (2.38) | 0.555** (2.02) | — |
| POND | 0.643* (2.07) | 0.427* (1.95) | 0.848** (3.49) | 1.048** (4.78) |
| RIVER | 1.034** (3.85) | 0.140 (0.65) | 0.636** (2.53) | 0.962** (3.95) |
| WETLAND | 0.235 (0.66) | 0.125 (0.51) | 0.548** (2.29) | 1.017** (4.40) |
| WOODLAND | 0.584 (1.52) | 0.476 (1.62) | 0.860** (3.89) | 0.285 (1.21) |
| CROP/PASTURE | 1.513** (6.94) | −0.537** (−2.55) | — | 1.536** (5.62) |
| TURF | — | 0.377 (1.49) | — | 1.439** (6.07) |
| FRUIT/VEG | 1.530** (6.80) | 0.035 (0.17) | — | 0.752** (3.24) |

^a Estimated using 2497 observations. Value of the log-likelihood function is −1485.9 and the χ^2 is 490 with 67 df.

* and ** denote significance at 0.10 and 0.05 levels, and *t*-statistics are given in parentheses.

4.1. Parcel attribute coefficients

Most of the coefficients describing land type and parcel attributes are significant at the 10% level, and many are significant at the 5% level (Table 4). The dummy variable for turf farmland is omitted for model estimation. Therefore, the signs and values of the land type coefficients are interpreted relative to turf farmland. All land type coefficient values are positive, suggesting that turf farmland is the least preferred land type. The poor significance levels of the wetland and woodland coefficients suggest that utility per acre for these land types may not differ greatly from utility per acre for turf farmland. Many focus group participants and survey respondents commented that wetlands in particular should not be preserved by open space programs because developing wetlands should be illegal. The coefficient value for beaches is highest followed by the coefficient for fruit and vegetable farmland, crop and pasture farmland, rivers, rocky shoreline, and ponds.

The coefficients representing public access to preserved land are positive for all land types except beaches and crop and pasture farmland. The mean survey respondent has negative preferences for allowing public access on preserved beaches and crop and pasture farmland. Respon-

dents may feel that existing access to beaches is sufficient and that access to crops and pasture farmland is unnecessary. The coefficients describing public access to rocky shorelines and ponds have the greatest positive magnitudes and are significant at the 10% level. Survey respondents may desire greater access to lands that have rocky shoreline and ponds, but feel that existing access to other lands is sufficient. All coefficients representing lands that include endangered species habitat or important groundwater resources are positive and most are significant at the 1% level. Survey respondents have strong preferences for lands with these specific characteristics.

4.2. Factor score interaction coefficients

Many of the coefficients describing factor score interactions with land type and public access variables are significant at the 10 and 5% levels (Table 5). These coefficients describe differences in preferences for land types and public access, that are correlated with respondents' attitudes regarding land preservation goals. For example, the coefficients describing the interaction between respondents' environmental factor scores (ENVIRO) and variables describing open space land types are positive. Respondents who hold stronger than average attitudes that land preservation should

Table 5

Estimated coefficients: land type variables and public access variables interacted with environmental, aesthetic, and agrarian factor score variables^a

| Land type variables | ENVIRO × | | AESTHETIC × | | AGRARIAN × | |
|---------------------|----------------|--------------------|------------------|--------------------|----------------|--------------------|
| | Land type | Land type × ACCESS | Land type | Land type × ACCESS | Land type | Land type × ACCESS |
| BEACH | 0.397* (1.90) | -0.474** (-2.13) | -0.140 (-0.77) | 0.462** (2.24) | — | — |
| ROCKY SHORE | 0.229 (0.76) | -0.012 (-0.04) | 0.161 (0.84) | 0.122 (0.65) | — | — |
| POND | 0.704** (2.96) | -0.653** (-2.70) | -0.332 (-1.57) | 0.510** (2.35) | — | — |
| RIVER | 0.728** (3.61) | -0.412** (-1.97) | -0.634** (-3.20) | 0.308 (1.44) | — | — |
| WETLAND | 0.806** (3.22) | -0.194 (-0.71) | 0.100 (0.49) | -0.351 (-1.54) | — | — |
| WOODLAND | 0.544* (1.88) | -0.396 (-1.33) | -0.316 (-1.31) | 0.142 (0.56) | — | — |
| CROP/PASTURE | -0.026 (-0.19) | — | -0.048 (-0.40) | — | 0.464** (4.47) | — |
| TURF | 0.282* (1.93) | — | -0.101 (-0.78) | — | 0.386** (2.99) | — |
| FRUIT/VEG | -0.002 (-0.01) | — | -0.232* (-1.81) | — | 0.431** (4.11) | — |

^a For example, the estimated coefficient for the interaction variable ENVIRO × BEACH is 0.397 while the coefficient for ENVIRO × BEACH × ACCESS is -0.474. Estimated using 2497 observations. Value of the log-likelihood function is -1485.9 and the χ^2 is 490 with 67 df.

* and ** denote significance at 0.10 and 0.05 levels, and *t*-statistics are given in parentheses.

protect the environment, have stronger than average preferences for beaches, ponds, rivers, wetlands, and woodlands. The negative coefficients describing environmental factor score interactions with public access variables show that these same respondents prefer preserving many land types without public access.

The coefficients describing the interaction between respondents' aesthetic factor scores (AESTHETIC) and variables describing public access to open space land types are positive. Respondents who feel more strongly than average that land preservation decisions should be guided by aesthetic factors, have stronger than average preferences for lands which allow public access. Aesthetically minded individuals have stronger than average preferences for beaches, ponds, and rivers on which public access is allowed. The positive coefficients describing interactions between agrarian factor scores (AGRARIAN) and farmland type variables are positive and significant at the 1% level. Respondents who have stronger than average attitudes that land preservation should pursue agrarian objectives, also have stronger

than average preferences for preserving all types of farmland.

4.3. Impact of attitudes on preservation choices

The estimated model coefficients (Tables 3–5) can be used to calculate utility indices for actual land parcels that are consistent with how survey respondents would choose farmland and open space to be preserved. For discussion purposes, utility indices are calculated for each land type using mean parcel sizes and preservation costs (based on mean per-hectare costs) of actual land parcels preserved in the past by the state of Rhode Island (Table 6). Indices are presented for parcels that do not have endangered species habitat or important groundwater resources. The indices represent survey respondents' preferences for preserving land parcels whose sizes and costs are typical of past preservation efforts. Preferences for actual parcels would vary with different values of size, cost, and other characteristics.

Utility indices representing the mean respondent are computed using Eq. (6) excluding the term β_0 , and the model coefficients presented in

Table 6
 Estimated utility indices and ordinal rankings of farmland and open space parcels for the mean respondent and adjusted for positive environmental, aesthetic, and agrarian attitudes^a

| Land type | Mean respondent | | Environmental positive | | Aesthetic positive | | Agrarian positive | |
|-----------------|------------------|--------------------|------------------------|--------------------|--------------------|--------------------|-------------------|--------------------|
| | No public access | With public access | No public access | With public access | No public access | With public access | No public access | With public access |
| Utility indices | | | | | | | | |
| Beach | 7.8 | 5.7 | 11.6 | 5.2 | 6.8 | 7.8 | 7.8 | 5.7 |
| Rocky shoreline | 5.0 | 8.8 | 6.3 | 10.9 | 5.9 | 11.6 | 5.0 | 8.8 |
| Pond | 5.5 | 8.5 | 11.2 | 8.9 | 4.0 | 10.1 | 5.5 | 8.5 |
| River | 7.8 | 9.0 | 16.1 | 12.3 | 4.1 | 6.5 | 7.8 | 9.0 |
| Wetland | 5.1 | 5.7 | 11.3 | 10.6 | 5.6 | 4.5 | 5.1 | 5.7 |
| Woodlands | 8.8 | 14.2 | 15.2 | 16.5 | 6.4 | 11.9 | 8.8 | 14.2 |
| Crop/pasture | 13.7 | 8.0 | 13.4 | 7.8 | 13.1 | 7.7 | 21.8 | 12.8 |
| Turf | 3.0 | 4.4 | 4.0 | 5.8 | 2.7 | 4.0 | 4.5 | 6.5 |
| Fruit/Vegetable | 14.0 | 14.5 | 13.9 | 14.4 | 11.1 | 11.52 | 1.52 | 2.3 |
| Ordinal ranking | | | | | | | | |
| Beach | 10 | 13 | 8 | 17 | 9 | 7 | 10 | 14 |
| Rocky Shoreline | 15 | 7 | 15 | 11 | 12 | 3 | 16 | 8 |
| Pond | 14 | 8 | 10 | 13 | 16 | 6 | 15 | 9 |
| River | 10 | 5 | 2 | 7 | 15 | 10 | 10 | 6 |
| Wetland | 15 | 12 | 9 | 12 | 13 | 14 | 16 | 13 |
| Woodland | 6 | 2 | 3 | 1 | 11 | 2 | 7 | 4 |
| Crop/Pasture | 4 | 9 | 6 | 14 | 1 | 8 | 2 | 5 |
| Turf | 18 | 17 | 18 | 16 | 18 | 16 | 18 | 12 |
| Fruit/Vegetable | 3 | 1 | 5 | 4 | 5 | 4 | 3 | 1 |

^a Based on hypothetical parcels of mean size and per-ha cost of those preserved by the Rhode Island Department of Environmental Management and the Rhode Island Agricultural Land Preservation Commission.

Tables 3 and 4. For example, a typical pond parcel is 12.95 ha and costs US \$530912 (13 ac \times \$40997 per ha) to preserve. Given the coefficient value of 0.272 for parcel size (adjusted for the average respondent's age and nature view) and the coefficient value of -0.241 for parcel cost, the utility index of the mean respondent for a pond parcel that provides public access is

$$v = (12.95 \text{ ha})^{0.272} * (\$530912/\$1000000)^{-0.241} \\ * \exp[0.643 + 0.427].$$

The coefficients for factor score interactions provided in Table 5 are used to compute utility indices for individuals or groups whose perceptions of the importance of environmental, aesthetic, and agrarian factors to preservation decisions, deviate from the mean respondent. These are computed by setting each factor score equal to one standard deviation above the sample mean (a value of one), while holding the two other factor scores at their zero mean. As computed, the indices represent the choices of individuals or groups who hold stronger than average attitudes that a particular factor should guide preservation decisions. For example, the utility index for the same pond computed for an individual whose environmental factor score is one standard deviation above the sample mean (labeled environmental positive) is

$$v = (12.95 \text{ ha})^{0.272} * (\$530912/\$1000000)^{-0.241} \\ * \exp[(0.643 + 0.704) + (0.427 - 0.653)]$$

and represents the preference of an individual who has a stronger than average attitude that environmental factors should motivate preservation decisions.

Utility indices for land parcels vary according to individuals' attitudes toward preservation (Table 6). One way to view the impact of individuals' attitudes on their preferences is to observe the ordinal ranking of this set of hypothetical parcels implied by the cardinal utility indices (Table 6). For example, the mean survey respondent's top three choices would be fruit and vegetable farmland with public access, woodland without public access, and fruit and vegetable farmland without public access. Environmental

positive individuals would give priority to woodland with public access, river without public access, and woodland without public access. Aesthetic positive individuals would give priority to crop and pasture farmland without public access, woodland with public access, and rocky shoreline with public access. Agrarian positive individuals would give priority to fruit and vegetable farmland with public access, crop and pasture farmland without public access, and fruit and vegetable farmland without public access. Individuals who differ in their attitudes about preservation goals, also differ in their preferences for the types of land preserved.

5. Conclusions and policy implications

Land preservation programs generally receive broad public support. However, individuals hold different attitudes as to why land should be preserved. Differences in individuals' perceived preservation goals can result in disagreement regarding the types of land and land attributes to preserve. Policy makers and program administrators must consider carefully what it is the public hopes to achieve from land preservation programs to ensure that program policies are appropriate and preservation funds are spent wisely. While land preservation programs often can be designed to balance multiple objectives, some objectives may be achieved more directly by different programs altogether.

Open space preservation programs often focus on purchasing land in fee to provide public access. However, environmentally minded individuals in this study are most concerned with protecting groundwater quality, wildlife habitat, and natural places, and in many cases prefer that land parcels be preserved without public access. The state need not necessarily purchase land to achieve environmental objectives. Existing use-value assessment programs could offer additional property tax credits to landowners who own and maintain lands that include endangered species habitat or important groundwater resources. Purchasing conservation easements may also be more efficient than purchasing land in fee when public access is

not strongly desired. Such policies are less expensive and may pursue desired environmental objectives on a grander scale than is possible through state land acquisition. Providing public access to open space may necessitate state or local acquisition of land parcels that provide desired access benefits. However, preserving trail corridors or rights-of-way, and access points along shoreline, ponds, and rivers, may provide access benefits at a lower cost than preserving larger tracts of land for multiple-uses. Other aesthetic objectives, such as scenery and ruralness, often can be maintained through strict enforcement of land use controls and by clustering development on lands that do not have desired attributes.

Farmland preservation programs are poorly designed to pursue environmental and aesthetic objectives because the criteria used by most programs to select candidate farms favors agrarian objectives. These objectives usually include protecting agricultural resources, maintaining local food production, and preserving family farms. However, purchasing development rights to farmland may fail to achieve agrarian objectives in some locations where farming is no longer viable. Laws that protect farm operations from unreasonable nuisance complaints or promote locally grown agricultural products, address farm viability more directly and require smaller public expenditures than purchasing development rights.

This paper has described one method for estimating differences in preferences regarding public policy that transcend socio-economic categories. These differences result from varying attitudes among the public regarding program goals. Previous studies describe heterogeneous preferences across individuals' socio-economic characteristics. However, heterogeneity resulting from attitudes regarding program goals can reveal policy implications that would not be apparent from models that address only socio-economic characteristics. Results of the analysis suggest that one policy may not always be appropriate to meet the desires of all members of the public when preference heterogeneity results from differences in individuals' attitudes regarding program goals. The policy alternatives desired by one group may even conflict with those desired by another group. Identifying

preference heterogeneity enables policy makers and program administrators to anticipate potential conflicts, and evaluate and modify policies to accommodate different perceptions of program goals.

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