A Conjoint Analysis of Public Preferences for Agricultural Land Preservation

Joshua M. Duke and Thomas W. Ilvento

Public preferences for the nonmarket services of permanently preserved agricultural land are measured and compared using conjoint analysis. The results from a survey of 199 Delawareans suggest environmental and nonmarket-agricultural services are the most important preserved-land attributes. Results also suggest that open space associated with wetlands on farms is neither an amenity nor a disamenity. On the margin, preserved parcels with agricultural and environmental attributes provide net benefits, which may exceed $1,000,000 for a 1,000-acre parcel. Preserved forestland provides benefits per acre that are statistically equivalent to cropland, though forestland may be less expensive to preserve.

Key Words: agricultural land preservation, nonmarket valuation, Purchase of Agricultural Conservation Easements, Purchase of Development Rights

The purchase of development rights and conservation easements (collectively, denoted as PACE) is a well-known agricultural land preservation tool that may enhance social efficiency by internalizing the external (amenity) benefits of farming. With regard to such amenities, Lopez, Shah, and Altobello (1994) found empirical evidence of a suboptimal allocation of agricultural land in urban-influenced regions. Although the absence of markets prevents the efficient revelation of amenity demand, indirect indicators suggest the public's demand is substantively important. For instance, general support for PACE programs has been inferred through bond referenda (Kline and Wichelns, 1994), dollar and land donations to private trusts, surveys of experts (Pfeffer and Lapping, 1994), and opinion surveys (Furuseth, 1987; Kline and Wichelns, 1996).

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Funding from the Delaware Agricultural Lands Preservation Foundation supported this research. We appreciate the assistance of the Delaware Department of Motor Vehicles and Michael McGrath and Stewart McKenzie at the Delaware Department of Agriculture. The authors benefitted from the graduate research assistance of Keith Horner. Without implication, the authors thank Robert Johnston, Jeff Kline, John Mackenzie, John Pesek, and an anonymous reviewer.

Johnston et al. (2001) found evidence that, though the public values agricultural land preservation for its collective goods, owners of land adjacent to preserved parcels may hold negative values for the farms. Thus, people may anticipate both collective goods generated by preservation (amenity benefits) and private goods (which will provide use values or be capitalized into land values).

Despite existing evidence that public support for preservation derives at least in part from collective goods, PACE programs tend to employ parcel selection criteria favoring land characteristics which are already traded on markets. Indeed, Nickerson and Hellerstein's (2003) recent study of program parcel selection criteria noted the importance of several market-based criteria, such as high-quality soils or large parcel sizes. Their findings showed these criteria were complemented only in part by imperfect measures of amenity production, such as location and development pressure.

Therefore, Gardner's critique from 1977 is still relevant: agricultural land preservation programs will not be efficient if parcel selection is based on criteria already traded efficiently on markets. Instead, efficient preservation arises from matching amenity supply with the public's demand for collective goods,

Agricultural and Resource Economics Review 33/2 (October 2004): 209–219

which are undersupplied by markets. This paper seeks to improve the understanding of public demand for amenities and to offer policy makers better evidence of the sources of public support so that parcel selection criteria can be redesigned to improve the social efficiency of PACE programs.

Recent literature has identified four main—often overlapping—categories of amenity benefits from preserved land (herein, "attributes"): (*a*) nonmarket agricultural services, (*b*) environmental amenities, (*c*) growth control services, and (*d*) open space provision (Kline and Wichelns, 1996, 1998; Rosenberger, 1998; Duke and Aull-Hyde, 2002). Private groups involved in preservation already supply some of these services (Rosenberger, 1998). As such, efficient policy requires more than simply identifying nonmarket land attributes and targeting their acquisition through public programs. If efficiency is to be pursued, governments should only intervene in the conservation easement market: (*a*) to the point where the marginal benefits of these attributes equal their marginal costs, and (*b*) when the existing activities of private groups are insufficiently supplying preserved land attributes.

All types of private preservation must be accounted for, including open space and habitat programs, because nonagricultural programs may also supply the attributes demanded from preserved agricultural land. In addition, efficient public programs require a clear understanding of attribute supply and demand. Measurement of these attributes can be approached using various units: for instance, changes in wildlife counts, water quality, or the number of local farmers directly marketing produce.

This study uses the measure of acres preserved since it is the currency of the PACE transaction and because it allows for commensurability across the different sources of nonuse values. The supply side of PACE programs is typically observed in markets as the difference in land value between agricultural use and the highest-and-best use. The demand side, however, is not fully observed in markets, and therefore efficient policy choices on the margin about purchasing conservation easements require more complete and high-quality information.

Several demand-side studies have used contingent valuation to estimate the benefits of discrete changes in the levels of preserved agricultural land or open space (Halstead, 1984; Bergstrom, Dillman, and Stoll, 1985; Beasley, Workman, and Williams, 1986; Bowker and Didychuk, 1994; Ready, Berger, and Blomquist, 1997). Several other contingent choice studies have estimated positive amenity benefits of farmland, but the benefits of wetlands and forestland seem to depend on the context of the study (Kline and Wichelns, 1998; Johnston et al., 2001). Johnston et al. also compared hedonic and contingent choice methods and demonstrated how the subtleties of use and nonuse values limit reliance on single benefit-estimation methods. Using an analytic technique without a generally accepted utility-theoretic basis, Duke and Aull-Hyde (2002) identified the proportion of public support for Delaware's PACE program associated with each attribute: agricultural (33.4%), environmental (27%), growth control (21.2%), and open space (18.4%). The conjoint analysis also produces preference results, but focuses on estimating the marginal benefits of preserved-land attributes.

Conjoint analysis (Luce and Tukey, 1960) is increasingly employed to inform public demand for multiattribute goods. Estimating demand for multiattribute *nonmarket* goods may be difficult for respondents because the potential consumers have no market experience with the good. Although preferences are stated, conjoint analysis nevertheless greatly simplifies the evaluation of complex decisions through the experimental design, which maximizes the information available to researchers for a minimal respondent burden with fractional factorial designs, and statistical inference, which controls for individual attributes. The results allow for the estimation of the marginal benefits of each attribute, though the experimental design and statistical analysis introduce other limitations. Respondents must simply make tradeoffs by stating preferences over different bundles of attributes (profiles) for a good. With regard to the problem at hand, conjoint analysis is well positioned to measure the relative importance of the attributes of preserved land because it assumes that consumers evaluate collectively the entire bundle of attributes rather than one attribute at a time (Beall and Perttula, 1991).

This study follows the approaches of previous conjoint studies of environmental and natural resources and makes several extensions. First, a –5 to +5 rating scale is used (suggested in Beall and Perttula, 1991) which makes explicit willingness (unwillingness) to pay with positive (negative) ratings. This scale also allows the rating of zero to indicate indifference. As such, although the rating scale has cardinal properties, positive, negative, or zero ratings convey economic meaning explicitly. Second, the ratings data were derived through an in-depth interview in which the respondent first ranked, then stated willingness to pay (WTP), and finally rated the profiles. This process improved the data quality because the ordinal results are verified and there is an economic meaning to the lower, middle, and upper portions of the ratings scale. Third, this analysis uses a grouped regression estimation technique, which accounts for full censoring of the ratings scale, and is more general than the Tobit model.

The new empirical results substantially affirm previous investigations and lend validity to their measures and results. The main conclusion is that PACE programs in densely populated and urbanizing areas provide net benefits for parcels preserved on the margin. The law of demand therefore suggests that, in the past, parcels preserved with similar attributes enhanced social efficiency.

The remainder of the paper is organized as follows. The next section provides a discussion of the conjoint experimental design, the decision problem, and the way in which choice is modeled. The measurement of the variables is then described, followed by an examination of the survey procedures. Next, the quality of the population sample is assessed. Statistical results are then documented and estimates of marginal benefits are offered. Conclusions are given in the final section.

Experimental Procedures and the Conjoint Decision Problem

Various applications of conjoint analysis have been developed. These mainly differ in terms of the experimental design, the specifics of the choice problem, the number of decisions sought from each respondent, and the statistical analyses. This analysis uses an orthogonal, main-effects design to generate profiles. During intercept interviews, each respondent stated preferences over five profiles and supplied rankings and ratings data. Clearly, the use of ratings data violates restrictions on the cardinal measurement of respondent-preference intensities. The theoretical basis and statistical properties of rankings and ratings data have been assessed in other studies (e.g., Mackenzie, 1993; Roe, Boyle, and Teisl, 1996; Boyle et al., 2001).

The conjoint decision problem was communicated to respondents by enumerators using a script, visual aids, and question-and-answer interactions. As an introduction, the enumerator read a script that defined preservation as preventing a farm from being "sold for future development." Although the script did not clarify what would happen to parcels that were not preserved, the enumerator answered respondent questions about the status quo (unpreserved farms are exposed to market forces which may result in conversion) and the future (unpreserved farms may or may not be converted). Therefore, respondents were expressing preferences for perpetuating agricultural land use rather than the status quo of leaving this decision to the market. Profiles (in color) were shown to respondents; a sample is presented in figure 1 and is described in detail in the next section. More specific interview procedures are described in a separate section below. The specific method of preference elicitation consisted of three steps.

- STEP 1. *Ranking:* The enumerator selected two of five profiles in a block and respondents were asked to select the one they preferred. This procedure mimics the "choose one" format, but the status quo alternative was not made available until the second step. The initial comparison revealed a first-best and second-best profile ranking. Respondents then compared a third profile to the first-best profile in the "choose one" format. If this third profile was preferred, it became the first-best, and other ranked profiles were adjusted. If it was not preferred, then the third profile was compared to the second-best profile, and so on until all five profiles in the block were ranked. The enumerator allowed respondents to revise previous choices during this ranking process.

- STEP 2. *Willingness to Pay:* The enumerator then asked respondents whether they were willing to pay, not willing to pay, or indifferent about the payment level for preservation of each profile. The status quo alternative enters at this point because respondents who are indifferent or not willing to pay to preserve a profile are, in effect, suggesting they prefer to leave preservation decisions about parcels with those attributes (including cost) to the market rather than ensuring preservation with an intervention.[1] In expressing

[1] The status quo was the existing level of state-level preservation activities and the outcomes of other land-use decisions affecting amenity levels at enumeration. Agricultural land for which the status quo is preferred does not mean a parcel will necessarily be converted; rather, preference for the status quo leaves the decision to land markets. A precise definition of status quo land quantity and quality could not be constructed from available data for preserved and unpreserved land, so the authors allowed respondents to compare preservation through the intervention to their own perceptions about the quantity and quality of status quo levels of amenities from land. During the intercept interview, if asked, enumerators offered factual information about the PACE program, such as the current number of acres preserved. This approach seems appropriate since nonuse values held by respondents for new preserved land would likely be derived relative to individual perceptions of the status quo landscape. Nonethe-

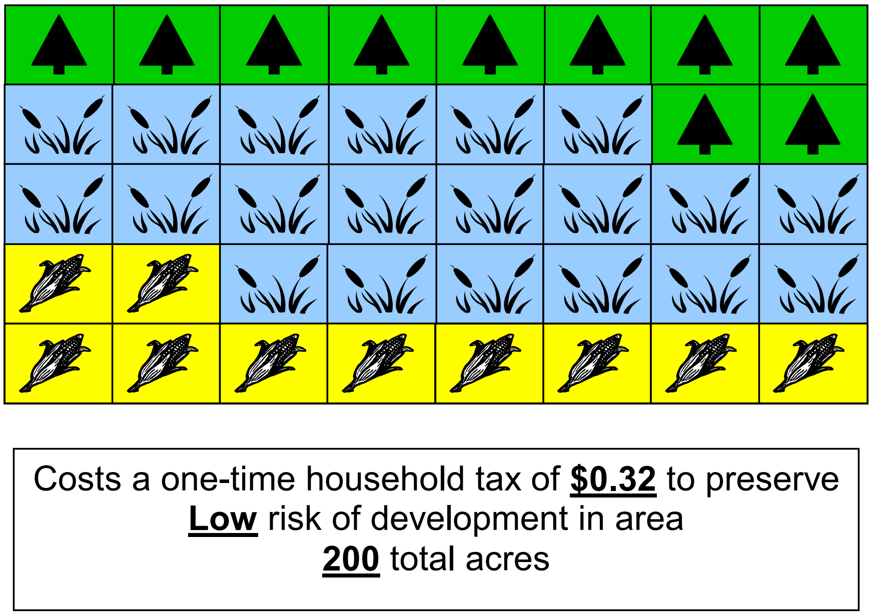

Figure 1. Sample profile for a small, mixed-use "farm"

willingness to pay, it is possible respondents forgot how they ranked each profile—or even changed their minds. For instance, a profile for which the respondent was willing to pay may have been ranked below one for which the respondent was indifferent. The enumerator asked respondents to revise any inconsistencies which arose between the rankings and choices in step 2. Allowing such revisions to be made likely improved data quality because it encouraged respondents to reflect more deeply about their preferences. Moreover, this process captures the status quo option, used in some conjoint studies, because when respondents are not willing to pay to preserve a profile, they are choosing to maintain the existing level of preservation.

- STEP 3. *Ratings:* Respondents were asked to rate the parcels according to a –5 to +5 integer scale to describe their intensity of preference. The enumerator read the following script to each respondent:

  > "*If you are willing to pay the given cost to preserve a farm, give it a positive rating* (+*5 being the highest*). *If you are not likely to pay the given cost to preserve a farm, give it a negative rating* (–*5 being the lowest*). *If you are indifferent about preserving a farm, give it a rating of zero* (*0*)."

  If the respondent was not willing to pay for a profile in step 2, then the rating was a negative integer: $r^i \in \{-5, -4, -3, -2, -1\}$. Indifference implied a rating of 0. If the respondent expressed WTP, then the rating was positive: $r^i \in \{5, 4, 3, 2, 1\}$. Updates and revisions were allowed for any step.

Accordingly, the choice problem reveals a refined ranking, a determination of WTP, and an intensity rating that has been validated for ranking and stated WTP. The ratings choice problem revealed the following data for each respondent:

Profile	q_1^i	q_2^i	···	q_k^i	Price	Rating
1	q_1^1	q_2^1	···	q_k^1	p^1	$$$
2	q_1^2	q_2^2	···	q_k^2	p^2	$$$
3	q_1^3	q_2^3	···	q_k^3	p^3	$$$
4	q_1^4	q_2^4	···	q_k^4	p^4	$$$
5	q_1^5	q_2^5	···	q_k^5	p^5	$$$

Here, q_j^i is the jth attribute of the ith commodity, and p^i is the individual household cost of preserving

less, the status quo was not ranked and rated separately because it already is supplied and subsumes a level of conversion risk. Individual perceptions about the expected future levels of amenity provision allowed the status quo to be a basis against which preferences were stated.

the hypothetical farm represented by the profile. In its simplest form, the empirical model derived from this choice is a linear[2] parametric summation of all q_j^i, p, and an intercept:

$$(1)\quad r^i = a + b_1 q_1^i + \ldots + b_k q_k^i + b_p p^i + \boldsymbol{\Gamma}\mathbf{X}^i + \varepsilon^i,$$

where r^i is the rating the respondent gives to a profile, a is an intercept, the vector $\mathbf{X}^i$ controls for the experimental design and sample selection, and ε^i is an error term matching the estimation procedure used. As in other conjoint studies with repeated measures, a strong assumption is maintained that the errors are independently drawn.

Equation (1) is estimated using two-tailed Tobit and grouped data regression models—both of which make different assumptions about the dependent variable. The use of alternative models provides a check on the validity of each approach and gives more confidence in the overall approach. Following Greene (2002, p. E21-3), the Tobit model assumes a latent regression underlies equation (1):

$$(2)\quad r^{i*} = a + b_1 q_1^i + \ldots + b_k q_k^i + b_p p^i + \boldsymbol{\Gamma}\mathbf{X}^i + \varepsilon^i,$$

where $\varepsilon^i \sim N[0, \sigma^2]$, and r^i is the observed rating. This model also allows for lower-tail censoring (if $r^{i*} \leq -5$, then $r^i = -5$) and upper-tail censoring (if $r^{i*} \geq 5$, then $r^i = 5$). If $-5 < r^{i*} < 5$, then $r^i = r^{i*}$ as expressed in equation (2).

While the –5 to +5 integer scale is reasonable a priori, it may pose problems in subsequent analyses. The respondent may have wanted to score a lower or higher rating, but was constrained by the scale. Indeed, the mean sample rating turned out to be 3.2, which suggests the possibility of censoring on the upper bound. In such cases, the ordinary least squares model yields biased results, with the bias toward one or both of the censored values. Tobit has been used in other conjoint studies with ratings data (Roe, Boyle, and Teisl, 1996; Boyle et al., 2001; McDermott et al., 1999).

This study extends these efforts to include a more general version of the Tobit model, which also accounts for interval censoring. Specifically, respondents were constrained to state their preference intensities using only 11 integers rather than a continuous scale with no censoring at the lower and upper bounds. The grouped model uses the additional information of the threshold values of the ordered categories to help with estimation, and thus provides better estimates of the respondent preferences between the ordered categories. As adapted from Greene (2002, p. E21-54), the grouped model also assumes a latent regression underlies equation (1):

$$(3)\quad r^{i*} = a + b_1 q_1^i + \ldots + b_k q_k^i + b_p p^i + \boldsymbol{\Gamma}\mathbf{X}^i + \varepsilon^i,$$

where $\varepsilon^i \sim N[0, \sigma^2]$, and r^i is the observed rating. This model assumes complete censoring of the dependent variable so that the observed ratings arose from a latent model as follows:

$$r^i = \begin{cases} 1 & \text{if } -\infty < r^{i*} < -4.5, \\ 2 & \text{if } -4.5 \leq r^{i*} < -3.5, \\ & \ldots \\ 11 & \text{if } 4.5 \leq r^{i*} < +\infty. \end{cases}$$

The grouped regression model is therefore a more general form of the Tobit model. The coefficients for the Tobit and grouped regression models are directly comparable.

Variables and Measurement

The dependent variable, r^i, is one of the 11 integers between –5 and +5. This variable is measured carefully using the interactive protocol, which moves from rankings to WTP to ratings. Negative ratings indicate the respondent, i, does not have WTP, p^i, to preserve the farm profile, while positive ratings indicate a WTP. The intensity of WTP or lack of WTP is expressed by increasing the absolute value of the ratings up to a maximum of 5. Respondents also may indicate indifference: $r^i = 0$. One advantage of this ratings protocol is that, although the intervals between integers are cardinal, the differences between positive and negative ratings have economic meaning. Ratings of zero also have economic meaning.

The reference levels of the indicator variables are subsumed in the coefficient for the intercept, a. However, a statistically and substantively significant intercept also may capture symbolic responses. For instance, respondents may collectively use the survey as an opportunity to express preferences for a host of symbolic activities—perhaps, a preference for environmental activities such as preservation ($a > 0$) or lack of preference for environmental

[2] A modeling decision was made not to include interactions because of a low expected number of observations from the intercept interview format. Hence, the results assume that price and quantity measures are linearly separable.

Table 1. Farm Attribute Levels

Cost per Acre	Number of Acres	Land Use Percent: Cropland, Forest Cover, and Wetlands	Rate of Growth
$400	40	100%, 0%, 0%	Low
$1,000	120	50%, 25%, 25%	Moderate
$1,500	200	0%, 50%, 50%	High
$4,000	280		
$20,000	500		

programs funded through increased state income taxes ($a < 0$). The intercept coefficient, therefore, will not be interpreted since it may have many interpretations.

Table 1 lists the attributes of preserved land: cost, acreage, cropland, forest cover, wetlands (or natural open space), and the area's rate of growth. The quantitative measures of cropland, forestland, and wetlands act as proxies for the agricultural, environmental, and natural open space attributes, respectively. Although all land types involve open space, the survey enumerator emphasized that wetlands provide natural open space. The connections between attributes and their proxies were reinforced though a script read to the respondents and question-and-answer interactions with the enumerator.

The levels of the attributes were selected to be consistent with the design, previous research, and historical data on actual preserved parcels in Delaware. Each profile combines the acreage attribute with the three land-use attributes, revealing the three levels of the attribute variables (q_j^i): *AGACRE*, *FORACRE*, and *WETACRE*. One sample profile is presented in figure 1. *AGACRE*, *FORACRE*, and *WETACRE* measure the number of respective acres in the parcel that are in agricultural production, forestry, and wetlands. Three of the parameters, b_i, estimate the marginal impact of these preserved-parcel attributes.

Growth-control indicators are also used, but do not depend on acreage: *GROWTH2* and *GROWTH3*. Growth control was measured at three levels. *GROWTH2* indicates a moderate rate of growth (i.e., residential and commercial development) in the area around the parcel. Similarly, *GROWTH3* indicates a high-growth area, while the reference category is low growth. The estimated models reveal rather coarse preferences for growth control in that they measure preservation efforts on the margin, which are restricted to one of the three levels. Accordingly, the estimated parameters from equations (2) and (3) assume preserved acres are located in low-growth areas. The estimated parameters on *GROWTH2* and *GROWTH3* suggest how much more or less the public prefers marginal preservation activities in moderate- or high-growth areas.

The price attribute, p, is represented by *HHCOST*, which measures the household cost associated with the preservation of a given profile. The cost is calculated as a share for each of Delaware's 250,000 households (a close approximation) of the total cost to preserve the profile. The total cost levels were derived from historical data on preservation costs, although one high cost per acre ($20,000) was included so as not to censor high WTP. Of parcels actually enrolled in Delaware's PACE program, only 9.3% had market values over $5,000 per acre, and less than 3% were valued between $10,000 and $20,000 per acre.[3] For individual households, the payment ranged from $0.06 to $40 per farm. The importance of *HHCOST* is estimated by b_p, which, as Roe, Boyle, and Teisl (1996) note, assumes constant marginal utility of income.

A parameter vector, $\mathbf{\Gamma}$, tests for the statistical effect of the experimental-design and sample-selection controls, vector $\mathbf{X}^i$. This design does not include a full profile of all attribute levels for each respondent due to the length and complexity of such a survey. The design reduced the 675 unique full-factorial profiles[4] to a more simplified format of 25 farm profiles, arranged into five blocks of five farm profiles. Each respondent examined all five profiles in a single block. The orthogonal design used in this project was performed using the "Conjoint Designer" package (Bretton-Clark, Inc., 1996). The block acts as an attribute in the experimental design, and so it is useful to test whether the experimental design had a statistically significant effect on ratings. The coefficients on *BLOCK1*, *BLOCK2*, *BLOCK3*, and *BLOCK5* were estimated (the fourth block became the reference category). In addition, indicators of county of residence (*SUSSEX* and *NEWCASTLE*) test for preference differences. The reference county is Kent County. This control is important because the sample was not balanced in terms of population across the counties.

The unit of analysis is the profile that was evaluated. The survey was administered to 199 people,

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[3] These figures come from data made available to the authors by the Delaware Agricultural Lands Preservation Program. More precise figures will not be presented so as to protect participants' anonymity.

[4] This figure is derived from the product of five household cost measures, five acreage levels, three forestland percentages, three wetland percentages, and three growth control levels. Cropland percentages were defined by acreage, forestland percentage, and wetland percentage.

yielding 995 useable data points for the subsequent analysis. The data are similar to a repeated measures design, with five measurements for each subject. Although this clearly violates assumptions about the independence of ε^i, it may be justified because of the high setup costs in extracting one comparison from a respondent, either via mail or in-person instruments. In effect, any given rating should be a function of the respondent's preference over the given attributes *and* the respondent's overall tendency to be in favor of or opposed to preserving farm profiles.

This analysis uses *RATEMEAN* to adjust for respondents who may anchor their ratings at different points on the scale. *RATEMEAN* is calculated as the average rating given by this respondent to the other four profiles—not the profile rated in the instant observation. In an earlier study, Mackenzie (1993) used a similar mean rating as an independent variable. However, the present paper extends *RATEMEAN* by excluding the current profile under consideration. Other approaches to the repeated measures problem include a normalized respondent rating, using z-scores (McDermott et al., 1999). Models estimated without *RATEMEAN* may observe its effect through the intercept.

Survey Procedures

The conjoint survey was administered via intercept interviews at all four Department of Motor Vehicles (DMV) locations in Delaware. The DMV-intercept approach was used in Kline and Wichelns (1998) and provides a relatively inexpensive mechanism for intercepting an approximately random cross-section of residents. Potential respondents were approached in the drivers license renewal areas. This minimizes a potential bias with intercepting persons using the automobile registration area—buyers of new cars do not complete on-site registration. The respondents were chosen at random, and their participation was voluntary.

The interview began with a description of the research project. All potential respondents were read a brief phrase concerning the purpose of the survey and were given instructions as to what they would be asked to evaluate. For those willing to participate, enumerators offered an interactive description of the problem using a poster board, which included pictures of different kinds of agricultural and undeveloped lands with keys to the symbols in the profiles. The pictures were taken in Delaware just prior to enumeration in January 2001. Respondents were not told details of the Delaware PACE program unless they asked specific questions. The problems and policy issues associated with intense growth-pressure are generally well known to residents in Delaware. Despite suburban growth pressures, Delaware maintains a large and vibrant agricultural economy.

The policy setting was described to respondents in terms of the Delaware Agricultural Lands Preservation Program, which since 1995 has administered a PACE program. At the time of enumeration, 53,783 acres had been enrolled in the PACE program; however, the original funding source was exhausted and future funding was uncertain. Delaware had minimal private agricultural land preservation activity through 2001. Therefore, the choice problem posed to respondents inherently involved a status quo world in which no additional parcels would be preserved. Any additional funding would preserve marginal acres, i.e., those beyond the 53,783 preserved by 2001.

After establishing the problem and policy setting, each participant was asked to review the profiles presented as visual cards, using symbols rather than pictures (see example in figure 1). The purpose of the symbolic representations was to impress upon the respondent the difference in parcel size between profiles and to illustrate the land-use composition of each profile. The respondents were told that the cards were hypothetical farms which could be found in Delaware, but were not suggestive of any actual farm in the State and should not be thought of as being near their residences. Accordingly, respondents expected only nonuse values from preservation. Each profile was printed on 8.5" by 11" paper. Under the graphical depiction of each profile was an informational box listing the profile's total acreage, a one-time preservation cost for the household, and the development risk in area surrounding the farm profile. The amount of acreage in agriculture, forest, and wetlands was represented in symbolic five-acre boxes. The respondent was then asked to complete the three-step ratings procedure described earlier.

Population Sample

In total, 199 Delaware residents responded to the conjoint survey, for an overall response rate of 44.8%. Nonresponse occurred when a person refused to participate after being asked. The highest response rate was found in New Castle County and the lowest was in the Sussex County facility (see

Table 2. Survey Locations, Dates, and Response Rates

Department of Motor Vehicles Location	Survey Dates	No. of Completed Interviews	Response Rate
Georgetown (Sussex County)	February 26–27, 2001	50	30%
Dover (Kent County)	March 1–2, 2001	50	60%
Wilmington (New Castle County)	March 5–6, 2001	49	40%
New Castle (New Castle County)	March 8–9, 2001	50	70%

table 2). Given that respondents were approached during their DMV business, but not while they were waiting in line, the overall response rate was encouraging. However, the 30% response rate at the Sussex County location was markedly low (this location was least conducive to interviews due to space constraints and setup limitations). The interviews took place between February and March of 2001.

Of the 199 respondents, 41% were female, which is less than the State percentage of 51.4% based on the *2000 U.S. Census of the Population* (U.S. Department of Commerce, Census Bureau, 2001). Other socioeconomic measures suggest a higher level of representativeness. The median age in Delaware is 36 years, yet only 75.2% of Delawareans are over 18 years old—thereby approximating the sample of drivers who were approached and voting-age adults who were the target population (U.S. Department of Commerce, Census Bureau, 2001). Unfortunately, the average age of Delawareans over 18 is not reported. The authors have estimated from Census data that the median age of Delawareans over 18 is a little less than 44 years, which compares well with the sample average age of 46 years. The 73% of the respondents who indicated they owned their own home also compares favorably to the Census estimate of 72.3% home ownership in Delaware. Most respondents reported they had visited a farm in the last three years.

The respondents were also asked to state their level of concern about land preservation in Delaware. The scale used to rank concern ranged from 1 to 9, where 1 = "not concerned" and 9 = "very concerned." The average rating was 7.9, and 40% of the respondents chose the highest level of concern. The average rating across all of the farm profiles was 3.2, indicating high support for preservation.

Results

Equations (2) and (3) were estimated using LIMDEP, version 7.0. Results for the models are given in table 3. There is considerable consistency in statistical significance between the Tobit and the grouped regression models,[5] showing a significant overall fit of the model. The coefficients all agree in sign, and each model indicates the same level of significance for the coefficients with a few exceptions (i.e., significance at the $p < 0.10$ rather than $p < 0.05$ level). Both models show that *HHCOST*, *AGACRE*, *FORACRE*, and *RATEMEAN* are significant at the $p < 0.01$ level, while *GROWTH2* is significant at the $p < 0.05$ level.

In terms of the control variables, *BLOCK1*, *BLOCK2*, and *BLOCK3* show statistical significance. Respondents had a statistically significant preference for profiles in *BLOCK1* and a lack of preference for profiles in *BLOCK2* and *BLOCK3*. Alternate regressions found that four profiles in these three blocks were responsible for the bias. These "problem" profiles tended to either high-end or low-end *HHCOST* attribute levels—three of the four had the highest *HHCOST* level—which may have inadvertently triggered an enumerator or other unknown bias. The estimated effect of these blocks cannot be cleansed, post hoc, and therefore must be controlled so as not to bias the other policy-relevant coefficient estimates. The coefficients for the county variables reveal there is no significant difference by county, and reflect a lack of bias with the sampling procedure. *RATEMEAN* is substantively and statistically significant, thus demonstrating that respondents anchor their ratings at different places on the ratings scale.

The coefficient for *HHCOST* is negative, which indicates rating and WTP decrease in price. The coefficients for *AGACRE* and *FORACRE* show that respondents support and state a WTP for preservation of cropland and forestland. Yet, the coefficients on *AGACRE* and *FORACRE* are not statistically different. Consequently, one cannot say there was

[5] Moreover, an ordered probit model (not reported), which used rankings data, demonstrated the same statistical significance levels and signs on the coefficients for the policy-relevant variables: *HHCOST*, *AGACRE*, *FORACRE*, *WETACRE*, *GROWTH2*, and *GROWTH3*.

Table 3. Conjoint Survey Statistical Results

Variable	Tobit Model Coefficient	Grouped Regression Coefficient
Constant	0.7997	0.8207*
	(0.4943)	(0.4502)
HHCOST	!0.1921***	!0.1766***
	(0.0210)	(0.0191)
AGACRE	0.0058***	0.0054***
	(0.0016)	(0.0014)
FORACRE	0.0090***	0.0083***
	(0.0019)	(0.0018)
WETACRE	!0.0010	!0.0009
	(0.0019)	(0.0018)
BLOCK1	0.7312*	0.6479*
	(0.4251)	(0.3877)
BLOCK2	!0.8851**	!0.7777**
	(0.4046)	(0.3690)
BLOCK3	!0.8316*	!0.7935**
	(0.4356)	(0.3970)
BLOCK5	!0.2275	!0.2130
	(0.4278)	(0.3902)
GROWTH2	!0.8163**	!0.7535**
	(0.3691)	(0.3366)
GROWTH3	!0.3423	!0.3326
	(0.2891)	(0.2636)
SUSSEX	!0.2055	!0.1746
	(0.3551)	(0.3237)
NEWCASTLE	0.0928	0.0805
	(0.3146)	(0.2869)
RATEMEAN	1.3659***	1.2465***
	(0.0758)	(0.0690)
Log Likelihood	!1,566.9590	!1,513.5980

Notes: *, **, and *** denote $p < 0.10$, 0.05, and 0.01, respectively, for a two-tailed test; $n = 995$ data points. Values in parentheses are standard errors.

a stronger stated preference for forestland than cropland. This result may have policy relevance. Delaware's PACE program, like many across the United States, focused on enrolling cropland, which is typically closer to cities and more expensive to enroll than forestland. At the same time, survey respondents do not seem to prefer, on the margin, more cropland acres. This finding suggests that readjusting selection procedures to select more forestland than is done at present may increase the cost-effectiveness of Delaware's program.

Based on the lack of significance for *WETACRE*, it cannot be concluded that there is support for preservation of wetlands for natural open space provision. This result may be due to an inadequately designed attribute. Although respondents were asked to focus on the open space provision services of wetlands, they may have considered other benefits and costs of that land use. This may have created countervailing tendencies; wetlands provide amenities, such as open space and habitat, but also provide disamenities, such as mosquitoes. Furthermore, respondents may have felt that wetlands warrant less preservation, since they are partially regulated at the state and federal levels.

It may be somewhat surprising that support for preservation falls if growth pressure is in the intermediate category. This result implies respondents may not be demanding continuous growth control services across all growth-pressure levels. Indeed, respondents may be more interested in preserving a critical mass of agricultural land far from development. Respondents may or may not seek protection for the most threatened parcels. Such an argument accords with fears of "leapfrog" development in which land preservation in rapidly growing fringe areas encourages the conversion of lands even farther from population centers as development "jumps" over the preservation boundary.

Although these results do not reveal the entire demand curve for these nonmarket services—and thus the public's WTP for all undeveloped parcels in Delaware—the results do offer insight into the public's value for preservation programs in general, and parcel preservation on the margin. The marginal WTP (MWTP) for a particular parcel attribute—the "part worth"—is the marginal rate of substitution between *HHCOST* and other variables in the model (Mackenzie, 1993; Johnston et al., 2001):

$$MWTP_i = -\frac{b_i}{b_p}, \qquad (4)$$

where b_i is the attribute coefficient for the ith attribute. The coefficients from the Tobit model are used for WTP estimates in table 4. MWTP estimates best apply to the first farm enrolled after survey enumeration; subsequent farms should have lower benefits, according to the law of demand. State-level MWTP is calculated by multiplying household MWTP by the number of households in Delaware used in the original cost per acre calculations (250,000 households). Following Mackenzie (1993), 95% confidence intervals are derived to bound the WTP estimates.

The value of parcels enrolled at the margin falls with the proportion of moderate-growth risk parcels enrolled. One could also infer the net value of

Table 4. Conjoint Survey Willingness-to-Pay Results (based on Tobit results)

	Household Willingness to Pay ($)			State Aggregate Willingness to Pay ($)		
Variable	Lower Bound (95%)	Mean MWTP	Upper Bound (95%)	Lower Bound (95%)	Mean MWTP	Upper Bound (95%)
Constant	(0.88)	4.16	9.59	221,214	1,040,642	2,398,330
AGACRE (per acre)	0.02	0.03	0.05	3,827	7,586	11,451
FORACRE (per acre)	0.03	0.05	0.07	6,596	11,728	17,934
WETACRE (per acre)	(0.03)	(0.01)	0.02	(6,259)	(1,287)	3,756
BLOCK1	(0.54)	3.81	8.33	(136,030)	951,443	2,083,219
BLOCK2	(9.05)	(4.61)	(0.49)	(2,261,423)	(1,151,753)	(121,323)
BLOCK3	(9.10)	(4.33)	0.12	(2,273,806)	(1,082,135)	29,151
BLOCK5	(5.71)	(1.18)	3.24	(1,428,259)	(295,980)	809,264
GROWTH2	(8.15)	(4.25)	(0.50)	(2,036,901)	(1,062,210)	(124,564)
GROWTH3	(4.87)	(1.78)	1.19	(1,217,930)	(445,471)	297,034
SUSSEX	(4.83)	(1.07)	2.60	(1,207,791)	(267,347)	649,821
NEWCASTLE	(2.78)	0.48	3.79	(695,199)	120,788	948,539
RATEMEAN	5.72	7.11	9.15	1,430,430	1,777,387	2,286,832

representative parcels that entered the program immediately following the survey in 2001. For example, a 1,000-acre farm may provide net benefits between $1,327,000 and $8,951,000. This range assumes it costs $2,500,000 to buy the development rights to this parcel, which provides between $3,827,000 and $11,451,000 in benefits. Other similar calculations can be made, as long as they represent the initial parcels enrolled following enumeration.

The results only suggest Delawareans' values—not those of residents of other states—and thus constitute a lower bound on value. If residents from other states value the preservation services in Delaware, then these values are likely to be higher. For instance, Delaware is an important stop for migratory birds. If bird-watching activities by residents in other states are enhanced by Delaware's land preservation decisions, then the welfare of out-of-state residents could be added to the MWTP values presented here. On the other hand, these results may be overstated due to the hypothetical nature of the choice. Efforts were made during enumeration to impress upon respondents the opportunity cost of their choice. Nevertheless, it is impossible to remove fully incentives for respondents to answer hypothetical questions strategically or to force respondents to account for substitution effects. Keeping these qualifications in mind, the results suggest Delawareans place a high level of support and a high value on the activities of the PACE program.

Conclusions

This study offers results on the sources of public support and marginal benefits of agricultural land preservation in Delaware. The results suggest Delawareans are concerned about land preservation and are supportive of the land-preservation activities of Delaware's PACE program. The marginal net benefits of preserving cropland and forestland are likely to be positive. Moreover, forestland seems to provide benefits equivalent to cropland even though it may be less expensive to preserve. The value of the continuing activities of the PACE program and likely benefits of parcels preserved on the margin are above or within the same order of magnitude when compared to the past preservation activities of the program. This implies criterion validity. Specifically, since 1995, the program has spent $67,380,094 to preserve 64,830 acres on 307 farms (State of Delaware, Department of Agriculture, 2002). These acres include cropland, forestland, and wetlands. When the estimated benefits are compared to the costs, it seems likely that past preservation provided net social benefits, and preservation of cropland and forestland, on the margin, will provide net social benefits in the future.

The conjoint results generally accord with the findings reported by Duke and Aull-Hyde (2002), which resulted from a nonutility-theoretic framework. Both approaches found that agricultural and environmental attributes were the most important, and the open space and growth control attributes generated less support. The results of these and other studies consistently demonstrate that the public holds substantive demand for the nonmarket services of preserved land.

Accordingly, there exists a basis to make efficient land preservation decisions on the margin without resorting to market-based agricultural criteria for PACE selection. The main efficiency argument in favor of PACE programs derives from the external benefits associated with collective goods; however, this analysis demonstrates that parcel selection criteria may not allow PACE programs to take full advantage of their preservation dollars. Distortions in the market for agricultural land are perpetuated by PACE programs which do not sufficiently acknowledge the nonmarket attributes of parcels.

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