

**Multifunctionality and Land Use Policy: An Application of Nonmarket Valuation to Urban Fringe Farm and Forest Preservation**

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## **Abstract**

This paper describes the results of a choice experiment which estimates willingness to pay for a large set of land-preservation amenities, including preservation policy attributes. Such amenities represent an important category of nonmarket outputs of multifunctional agriculture. Results suggest that preservation benefits are highest for lands at a high risk of development and for those that provide moderate levels of public access. Conservation easements dominate the use of fee simple purchase. Specific land uses, in contrast, are found to have little impact on benefits. The results suggest that preservation benefits can be large, but that they also vary widely and may be low or even negative for some types of preservation. Implications of model results and suggestions for developing prioritization strategies for land preservation are discussed.

**Keywords:** Choice Experiment, Farmland preservation, Nonmarket valuation.

## **Introduction**

Although the term “multifunctionality” is more familiar in Europe (Batie 2003), residents on both sides of the Atlantic recognize and appreciate non-production, or multifunctional, outputs from agricultural land. Public policies increasingly seek to supply multifunctional benefits, especially through the creation of new and more innovative policies or by better aligning existing policies to promote stewardship (Dobbs and Pretty 2004). This paper focuses on policies that help achieve an important facet of stewardship—the provision of landscape and open space amenity benefits (Abler 2004).

Many policies affect the provision of such amenity benefits (Duke and Lynch 2006), but land preservation policies represent the principal interventions affecting their allocation by land markets. The most common types of land preservation policies include: (1) regulatory methods, including conservation-oriented zoning; (2) purchase of agricultural conservation easements (PACE); and (3) acquisitive or fee-simple purchase. At risk of considerable oversimplification, it is generally presumed that European policy places greater emphasis on regulatory programs, while U.S. policy is more likely to promote policies that favor market incentives. Nevertheless, both approaches would benefit from more systematic evidence about amenity benefits derived from various types of policy intervention; the European approach could then better balance the social value of competing land uses, while the U.S. approach could gain greater recognition of the value of amenity benefits resulting from market incentive programs.

Economists have been estimating the value of amenity benefits for two decades. In a comprehensive review of the literature, Bergstrom and Ready (2005) found that these values can be significant. Benefits vary with location, land use, and public access.

Johnston and Duke (2007a) show that values also vary with the policy selected to achieve the preservation outcomes. Such results naturally lead to efficiency calculations on the margin, i.e., would preserving parcel X produce benefits that exceed cost? This paper discusses a prioritization strategy conceptually and when interpreting empirical results.

Given recent progress in estimating benefits associated with farmland preservation, it is surprising how little impact valuation research has made on the associated policy process. Research on benefits is mainly disseminated through academic journals and not in a policy-relevant form, i.e., one in which benefit estimates allow policymakers to better understand relative marginal values for a wide class of preserved land attributes. As a result, land use policy rarely reflects the amenity values held by the broader public.

This shortcoming goes beyond considerations of efficiency. Indeed, it is a broader problem of the land use policy process that preservation decisions are made without systematic consideration of public values or even preferences. Consider the example selection criteria used in PACE programs to prioritize parcels for preservation. Such programs, like Land Use Site Assessment (LESA), use criteria that focus largely on attributes of parcels associated with profitable agricultural production (soil quality, size, proximity to other agricultural operations, etc.) and very little on amenity provision. In effect, PACE creates a market in which the public buys amenities but has little say in the type of parcels preserved—in what other market would the buyer pay for a good but not require that their preferences affect the choice among goods? The policy process would likely improve simply by enhancing the recognition of public preferences.

Many economists would further argue that the process would also become more effective if parcels selected for preservation were valued more highly by the public than those not selected. This, in part, would be due to the resultant increased public support for the actions of public and private preservation entities, thereby potentially reducing conflict resolution costs (e.g., costs of legal challenges, hearings, public correspondence, coalition building, etc.) associated with more controversial or less highly valued preservation options. Hence, greater attention to public preferences would not only increase the benefits of land preservation directly (by engaging in those preservation options that generate the greatest social welfare), but also indirectly through the potential to render the policy process itself more procedurally efficient.

Notwithstanding the benefits of greater integration of valuation research into the policy process, policymakers remain almost universally unaware of the existence of such information. There is a clear need for a bridge between valuation research and a user-friendly understanding of the public values for farm and forest preservation. To this end, this paper offers a detailed application of valuation research to preservation in Delaware. Using parametric results of community-based and statewide surveys for the preservation of farm and forest parcels, this paper presents results on the benefits of preservation in a fast-growing community in Delaware. The model explicitly allows for benefits to vary as a function of multifunctional attributes and clarifies tradeoffs involved in policies designed to promote multifunctionality.

Model results illustrate the benefits of preserving different types of farms, using different types of policies. These results support several conclusions. First, preservation benefits can be substantial, but can also vary greatly, and may *sometimes* be lower than

the costs of preservation. Second, preservation benefits vary according to many attributes of preserved acreage but, surprisingly, not by land use. Third, public access has a large, positive impact on preservation benefit estimate. These and other conclusions imply that economic research can help guide policy makers in their preservation decisions. Not only do the results have clear implications for parcel prioritization, but they also suggest that some parcels should not be preserved at all. The benefits of prioritizing preservation activities based on associated multifunctional benefits would be many. Effective prioritization would target parcels, which generate the maximum total net benefits from collective preservation efforts. We also suggest, however, that prioritization would help align expectations among stakeholders in the policy process. This helps avoid conflict and associated conflict resolution costs. Rather than preservationists and developers arguing for all-or-nothing solutions, more effective prioritization would allow accommodations of both sides to be made in a more systematic and efficient manner.

### **Conceptual Framework**

The economic theory of land preservation (Gardner 1977) and the role of stated preference analysis in estimating land preservation values (Bergstrom and Ready 2005) is mature and, though not entirely settled, is available in numerous other papers. Hence, it will only be briefly summarized here. Some utility associated with agricultural land use decisions accrues to people who are not involved in decision making on the farm parcel and who do not compensate the decision maker for the utility gained. These positive externalities accrue outside existing markets and, to the extent that they are nonrival in consumption, take on the character of a public good. These benefits will be provided at

an inefficiently low level by markets and require some form of collective action to increase their supply. From an economic perspective, this is the primary justification for government action to preserve farmland parcels (Gardner 1977).

Common policies for land preservation include conservation zoning or similar regulatory methods, PACE, and fee-simple purchase. Duke and Lynch (2006) argue that institutional issues complicate the comparison of the social efficiency of regulatory policies, which establish markets, and governmental-participatory policies, which enhance demand for certain land uses. For this reason, this paper will not treat preservation as a means to provide the socially efficient amount of agricultural land use, i.e.,  $q^*$ . Rather, efficiency refers to enhancements *on the margin*—where benefits of preservation exceed the costs. The paper also includes a discussion of prioritization and targeting of preservation actions; the prioritization discussion will expand marginal efficiency calculations beyond simple one-parcel efficiency decisions to include options for selecting among multiple parcels. Operationally, this means that parcels with the greatest total net benefits should be selected for preservation; alternatively, parcels with the highest benefit-to-cost ratios should be preserved in a sequential process until the budget is expended. This prioritization strategy may be readily implemented when benefit measures are available. Nevertheless, when implementation constraints are also important, a binary linear programming model has been shown to produce the same or superior prioritization (Messer 2006).

Framing preservation policy questions in this way is standard practice in environmental economics, though it is acknowledged that answers to these questions may not be associated with ecological sustainability, because they do not recognize feedback

from biological processes (Bromley 2007). Hence, results of research into public preferences may provide the most useful insight when viewed within the context of realistic policy sets defined by models of natural biological processes. Examples of models that coordinate economic and ecological research to prioritize environmental policies are provided by Johnston et al. (2002a,b).

Valuation research is driven by the assumption that if people gain utility from preservation, then the maximum amount they would be willing to pay (WTP) for the change measures the benefits they receive. Many caveats and debates come from such an assumption (Bromley 2007), but those issues are well documented in existing literature. Stated preference methods are used to elicit this WTP measure. Since land preservation is a multiattribute good, this study uses a choice experiment (CE) to estimate associated willingness to pay. This capitalizes on the ability of CEs to explicitly estimate tradeoffs and WTP associated with multiattribute policy options (Adamowicz et al. 1998). Individual demands for preservation are aggregated vertically because preservation is assumed to be nonrival in consumption, following the public goods argument presented above. This also reflects standard practice in the literature. This paper builds an economic model of choice in the standard manner, using a random utility model (Hanemann 1984).

In this model, household  $h$  may gain utility from preservation attributes. Parcels vary in terms of the specific levels of amenities provided and thus are modeled as multiattribute goods. A key attribute of parcels is their relative proximity to  $h$ , and so the jurisdictional scale  $k$  is modeled separately—preservation either occurs somewhere within the household’s community or simply within the state.<sup>i</sup> Thus, preservation occurs

via a program  $i$  that will preserve a hypothetical parcel at jurisdictional scale  $k$  is given by

$$U_{ihk}(\mathbf{X}_{ik}, \mathbf{W}_{ik}, Y_h - Fee_{ihk}) = v_{ihk}(\mathbf{X}_{ik}, \mathbf{W}_{ik}, Y_h - Fee_{ihk}) + \varepsilon_{ihk} \quad (1)$$

where

- $\mathbf{X}_{ik}$  = vector of variables characterizing attributes of preservation program  $i$  at jurisdictional scale  $k$ ;
- $\mathbf{W}_{ik}$  = a vector of variables describing the policy process of preservation program  $i$ ;
- $Fee_{ihk}$  = cost to household  $h$  of preservation plan  $i$  at jurisdictional scale  $k$ , through a mandatory payment vehicle;
- $Y_h$  = disposable income of household type  $h$ ;
- $v_{ihk}(\cdot)$  = function representing the empirically measurable component of utility;
- $\varepsilon_{ihk}$  = unobservable component of utility, modeled as econometric error.

The jurisdictional scales reflect community preservation ( $k = C$ ) and statewide preservation ( $k = S$ ). The policy process attributes allow the model to reflect preferences for preservation secured through alternative strategies, such as PACE and zoning.

Following standard methods for CEs, the household is assumed to choose among three preservation plans, ( $j=A,B,N$ ). It may choose option  $A$ , option  $B$ , or may reject both options and choose the status quo (neither plan,  $j=N$ ). A choice of neither plan would result in zero preservation ( $\mathbf{X}_{ik}=0$ ) and household cost, ( $Fee_{ihk}=0$ ). The household assesses utility resulting from available options and chooses that which offers the greatest

utility. For example, the household will choose plan A if:

$$v_{Ahk}(\mathbf{X}_{Ahk}, \mathbf{W}_{Ahk}, Y_h - Fee_{Ahk}) + \varepsilon_{Ahk} \geq v_{zhk}(\mathbf{X}_{zhk}, \mathbf{W}_{zhk}, Y_h - Fee_{zhk}) + \varepsilon_{zhk}. \quad (2)$$

for  $z = \{B, N\}$ . Model estimates for jurisdictional scales  $k=C, S$  provide two unique estimates of observable utility  $v_{ihk}(\cdot)$ . Econometric approaches depend on assumptions regarding  $\varepsilon_{ihk}$ , and include conditional (CL) or mixed logit (ML) models (Maddala 1983; Greene 2003).

## Data

The data are derived from two parallel CEs conducted in Delaware—one at the community jurisdiction—or policy scale—and one at the state jurisdiction. Details of the survey procedures and measurement are provided in Johnston and Duke (2007a) and will only be summarized here. Community jurisdiction results are drawn from the *Smyrna/Clayton* and *Georgetown Land Preservation Surveys*, which were functionally identical instruments designed to target two similar, growing Delaware communities. Random samples of 750 residents in each community were contacted. The state jurisdiction data are drawn from responses from 1000 residential contacts for the *Delaware Land Preservation Survey*, which was a parallel survey targeted at statewide preservation and which was implemented over a random statewide sample.

The CE questions on the survey provided respondents with two preservation options that would each preserve land with varying attributes and using different policies, “Option A” and “Option B,” as well two status quo options. The key difference between

the community and statewide surveys was the size of the jurisdiction from which land preservation would occur. That is, respondents in the community CE were told that land would be preserved somewhere in their home community, while respondents in the state CE were told that land would be preserved somewhere in their home state. This mimics the context of farmland preservation policy decisions such as voting on preservation bond referenda, in which *specific* parcel locations are unknown when voting choices are made, but individuals are aware of the political jurisdiction within which preservation will occur.

Other attributes varied within the CE included the type of land preserved, the number of acres, the provision of public access, the risk of development of unpreserved parcels, and the cost of preservation to the respondent's household. Choice questions also specified the technique that would be used to preserve the land in question, as well as the agent that would be responsible for implementing preservation techniques. Table 1 describes the attributes that distinguished hypothetical preservation options, including summary statistics for both the community and state survey versions. Additional details are provided by Johnston and Duke (2007b).

To avoid protests and the potential for respondent confusion, it is critical that policies described in survey scenarios are “perceived as realistic and feasible” (Bateman et al. 2002, p. 116). Following guidance from focus groups and policy experts, this led to a small number of differences between the community and state CE. Principal differences between the survey instruments at the two jurisdictional scales involved the levels of the acres, cost, and access attributes. Acres and cost were both higher in state survey versions, which reflected focus group respondents' expectations about the relative

size and cost of community versus statewide programs. Focus groups for the community surveys also revealed that scenarios were viewed as most realistic when allowing for specific types of access (e.g., hunting, walking/biking) on preserved parcels. At the state scale, in contrast, it was perceived as unrealistic that the state could mandate access for any specific activity on all preserved acres. Hence, the statewide survey characterized public access as the percentage of preserved acres for which access would be permitted (i.e., 100%, 50%, 0%). While these differences do not influence model validity (as state and community results are not pooled), they should be considered when interpreting model results. Of 1385 deliverable community surveys, 491 were returned, for an average response rate of 35.5%. Of the 919 deliverable statewide surveys 334 were returned, for a response rate of 36.3%. The reader is referred to Johnston and Duke (2007b) for further details.

### **The Econometric Model**

Besides acreage, all preservation attributes reflect the outcome or policy features of preserved land. Hence, the influence of these attributes on utility should depend on the acreage preserved. This is easily modeled econometrically by entering land type, preservation method, public access, and development risk as multiplicative interactions with the number of preserved acres. Linear variables are limited to preserved acres, program cost, and an alternative specific constant (ASC) for “neither plan.”

Using this specification, household utility from policy option  $k$  is given by:

$$v_{ik}(\cdot) = \beta_{i0}(\text{Neither}) + \beta_{i1} \text{Acres}_k + \sum_{n=2}^N \beta_{in} (\text{Acres}_k)(X_{kn}) + \beta_{i(N+1)} (\text{Fee}_k), \quad (3)$$

where *Neither* is the alternative specific constant (ASC),  $Acre_{sk}$  is the number of acres preserved by option  $k$ ,  $X_{kn}$  are attributes of preserved acres,  $Fee_k$  is the unavoidable household cost of the plan, and the betas ( $\beta$ ) are coefficients to be estimated. The subscript  $i$  reflects the fact that coefficients may differ across jurisdictional scale  $k = \{C, S\}$ .

Mixed logit (ML) is used for estimation with random coefficients on two variables (ASC and *Fee*). A normal distribution is assumed for the coefficient on *Neither*; a lognormal distribution is assumed for the coefficient on *Fee*, with sign-reversal used to adjust the cost variable prior to estimation (cf, Hensher and Greene 2003). These conventions follow standard approaches for variables of these types (Hensher and Greene 2003; Hu et al. 2005).<sup>ii</sup> Two ML models are estimated—one at the statewide jurisdictional level and one from pooled Delaware community data. Log-likelihood tests (Mazzotta and Opaluch 1995) fail to reject the appropriateness of pooling individual community data ( $p=0.38$ ). Specifications are identical for all models, subject to caveats noted in the previous section concerning the differences in variable definitions between state and community surveys. All models are estimated using maximum likelihood with Halton draws applied in the simulation. The statistical fit of ML models is superior to parallel conditional logit (CL) models at  $p<0.01$ , in both cases; so ML results are illustrated below.

## **Results**

This paper focuses on WTP, so the individual ML results for each of the two

models are only discussed briefly. Table 2 presents model results. Both models are statistically significant at  $p < 0.01$ , with statistically significant coefficients conforming to prior expectations, where expectations exist. In addition, coefficient estimates imply that per acre welfare effects associated with community scale preservation exceed those associated with state scale preservation, *ceteris paribus*. One might expect lower per acre WTP measures at the state scale both because of the lesser degree of expected proximity to preserved land, and also due to diminishing marginal utility; the statewide survey incorporated much larger acreages, such that the marginal utility per acre would be expected to decline relative to the community scale analysis. Table 3, discussed below, shows that household WTP per acre for preservation in the community is between one and two orders of magnitude above the value of preservation at the statewide level. In addition, community and state coefficient estimates vary in significance, which may reflect different preference patterns and scarcities at the local level relative to the statewide level.

To calculate WTP from random coefficients, the approaches in Hu et al. (2005) and in Johnston and Duke (2007a) were followed. Welfare estimates are the mean of a coefficient simulation of 1000 draws, each of which was the median WTP calculated from 1000 draws of the coefficient simulation. This approach prevents unrealistic mean WTP estimates, which are unduly influenced by the lognormal distribution (long right-hand tail) of the program cost coefficient (Hensher and Greene 2003). As discussed by Hu et al. (2005), there is no theoretical justification for choosing between mean or median welfare measures. Nevertheless, it is important to note that when aggregating WTP across households, this method using the mean-of-medians will not necessarily

match aggregation over a set of means. Since the medians used are less than the means for the welfare simulations (as one would expect given the lognormal distribution of the cost parameter), the resulting aggregate WTP estimates provide conservative welfare estimates.

The experimental design included four attributes that can be used to distinguish per-acre WTP: (1) Land type at four levels; (2) preservation policy at five levels; (3) development risk at three levels; and (4) access at three levels. Thus, there are  $4 \times 5 \times 3 \times 3 = 180$  possible combinations of amenity attributes that characterize a hypothetical acre to be preserved.

For the present analysis, WTP for all 180 options is estimated, for both the community and state scale analyses and then aggregated to a total value. In order to render associated numbers more easily interpretable for policy purposes, it is necessary to transform the per-acre, per-household, per-year welfare measures derived from simulation results to capitalized, per-jurisdiction values. This involved two steps. First, the present value of per year WTP estimates was calculated as the perpetuity of yearly estimates (derived directly from welfare simulations), assuming a discount rate of 6%. The resulting per household present values were then aggregated to the jurisdictional scale by multiplying by the number of households in the jurisdiction (community or state). These two present values were then added together; however, it should be noted that this is a somewhat conservative assumption because it assumes that households right outside the community are more similar to the state itself than the community. In actuality, there is more likely a benefit gradient. Our model cannot capture this gradient, so our assumptions remain conservative.

Over all 180 combinations, the mean present value of aggregated (i.e., state and community) WTP per acre was \$49,954. The range was from -\$87,063 to \$134,436. One-half of the combinations have estimated WTP of \$52,136 or more. These benefit measures are substantively significant (i.e., large). Given that past preservation costs in Delaware do not typically exceed \$20,000 and the historical average cost is \$1,447<sup>iii</sup>, results imply that many parcels preserved will have high net benefits.

Nevertheless, these results suggest that some parcels may not pass a benefit-cost test or may be low priority for preservation. Thirty-two (32) of 180 WTP estimates were negative, and six more estimates were less than \$10,000. Most (18 of 32) of the negative WTP estimates were associated with preservation achieved through conservation zoning—an unsurprising result given focus group evidence suggesting negative public preferences associated with such regulatory policies. The future cost of preservation may frequently exceed \$10,000—an estimate that is likely for PACE and fee simple policies, but estimates are unknown for zoning. If costs exceed \$10,000, however, these results suggest that approximately 21% of parcel types would not pass a benefit-cost test. Preservation costs are likely to be somewhat heterogeneous, varying with development potential, preservation policy, and land characteristics. Nevertheless, the results suggest that the net benefits of preservation vary widely. Effective preservation policy would require that parcels be prioritized so that those with the maximum benefits-to-cost ratios are selected first. Model results indicate that certain preservation options will provide markedly greater benefits, suggesting that such prioritization can have substantial implications for public welfare and support for preservation policy.

Ideally, prioritization would proceed through a sequential series of marginal decisions, where the amenity values of all parcels are known. Actual policy processes, however, are more likely to establish less precise selection criteria. For this reason, it is important to understand how the attributes of preserved land tend to affect WTP in a more general sense. A more effective program will use these demand-side tendencies in designing a prioritization strategy. A subset of the 180 combinations (Tables 3 and 4) are selected to illustrate key patterns in how these attributes affect WTP for preservation.

### *Development Risk*

Table 3 shows how development risk may affect WTP for the preservation of cropland or livestock acreage. Results show that the highest WTP tends to be associated with the preservation of high-risk acreage at both the community and statewide jurisdiction. For example, when no access is provided, aggregate WTP for a high-risk acre is \$54,691 and WTP for an identical acre at low risk is only \$2,233. As development risk lessens, this relationship can vary in a surprising, asymmetric manner. At the statewide level, WTP tends to fall as development risk declines; however, at the community level, the lowest values are associated with the intermediate development risk category. In other words, communities appear to prefer high-risk, then low-risk, acreage over intermediate-risk acreage. Although this result may appear counterintuitive, it was also found in a previous Delaware conjoint study by Duke and Ilvento (2004) who rationalized that residents may want to focus their preservation efforts on relatively undeveloped areas where agriculture has a critical mass (low-risk) before preserving the areas that are at the suburban-rural fringe (moderate-risk).

## *Access*

Table 3 shows the clear, positive impact that access has on WTP for preservation. The highest benefit estimates, however, are associated with *moderate* levels of access. For the community, this implies walking, biking or similar passive recreational access to preserved parcels. At the state level, this implies that the preservation program would provide access on 50% of the parcels preserved. The point-estimate WTP values for high access levels are slightly below moderate access, but both exceed the no-access level by substantial (and statistically significant) amounts. A large component of the highest WTP estimates is due to access. Of the 180 combinations, the highest WTP for a no-access parcel was \$54,691—at the 52<sup>nd</sup> percentile.

These results suggest that the public recognizes that access can potentially provide an additional set of preserved land amenities, i.e., multifunctional agriculture has an additional output. However, there seems to be a subtle recognition that too much access can degrade resources. This suggests that the public would be willing to pay for access on some parcels, but may want others preserved in a more traditional state. Several caveats are in order. First, access to preserved parcels in Delaware is not common, except when purchased fee simple. Hence, the WTP estimates for access represent a marginal level of provision that is on the highest part of the demand curve. These values should be high, but it is unknown how elastic this demand may be. Second, the costs of providing access are likely to be high. As a result, the benefit-to-cost ratio of providing access with a preserved parcel may be far lower than the benefit-to-cost ratio of simply preserving without access.

### *Land-Use Type*

Table 4 shows the impact of land use on WTP. The principal result here is that land use has a small and generally statistically insignificant impact on benefits—the public seems to simply demand preservation services but does not have strong preferences for the type of land preserved. This result accords with Duke and Ilvento (2004), who found that preferences for preserving forest and cropland in Delaware were statistically indistinguishable. It, however, contradicts findings of some prior stated preference research demonstrating statistically significant public preferences associated with agricultural productivity and/or type of farmland (Kline and Wichelns 1996; Ozdemir et al. 2004).

The main implication of this result is that effective preservation may also prioritize the preservation of forest and idle land because the costs of preservation may be less. Delaware's PACE program currently uses criteria that emphasize prime agricultural land and the most financially viable farms. These parcels tend to have high agricultural use values but also high development values. The results suggest that a low-productive forest parcel may provide approximately the same benefits, *ceteris paribus*, but may cost less to preserve. Irwin, et al. (2003, p. 22) drew a similar conclusion in a review of the preservation valuation literature, "The most efficient approach may be to target marginal, cheaper farmland that generates substantial rural amenities." Intuitively, any preservation strategy that prioritizes parcels based on demand-side characteristics will likely diverge from current programs and their supply-oriented selection criteria.

### *Preservation Policy*

The most significant finding is that the choice of preservation policy has a substantive impact on WTP. Table 4 shows that, when one holds all the attributes of preserved acreage constant, WTP can be reduced by up to 62% if a less-preferred preservation policy is chosen, *ceteris paribus*. In all cases presented, preservation benefits secured through conservation zoning are substantively lower than other forms of preservation, *ceteris paribus*. Fee-simple preservation by a state agency or a land trust is preferred to the same preservation achieved through zoning by a factor of approximately two. PACE preservation is the most preferred, with state preservation slightly preferred to that of land trusts. The impact of these results on stated preference research is discussed in Johnston and Duke (2007a).

These results suggest, again, that residents may have subtle, sophisticated preferences for preserved-land attributes. Although fee-simple preservation provides a more complete set of legal rights to land, the public tends to preserve preservation through PACE—even when all else is held constant. This suggests that the public’s interest in preserved-land amenities truly accords with the concept of multifunctionality; the public wants to preserve land that will continue to be owned and operated by a private owner. The public seems to value those ownership and autonomy amenities more than having the same lands be owned by the state or a nonprofit group. Since fee-simple purchase should be costlier than PACE, this result suggests that the total net benefits of preservation via PACE will tend to dominate that of fee simple under a variety of land uses. As such, marginal efficiency criteria suggest that the public should emphasize preservation through PACE relative to fee simple purchase.

Nevertheless, one should be cautious in interpreting the WTP results on zoning. Duke and Lynch (2006) argue that the efficiency of a large preservation plan through zoning cannot be compared to that of PACE and fee simple purchase. And even though the WTP estimates here represent preservation of a small number of acres *on the margin*, zoning does not typically operate in that manner. Instead, zoning tends to change the permitted uses on land over a large, *nonmarginal* area. Some hybrid preservation techniques, such as agricultural preservation districting, have many of the characteristics of zoning and can be adopted on a parcel-by-parcel basis. WTP estimates apply in these cases. However, the WTP estimates do not necessarily imply that PACE should be prioritized over zoning. Although the benefits of preservation through zoning are relatively low, the costs are likely to be low, too. The results suggest that researchers and planners should undertake the difficult task of developing estimates of the social costs of rezoning parcels, including the opportunity costs of complex incentives—agricultural preservation districts may offer protection from nuisance suits and the ability to avoid real estate transfer taxes. Only with these cost estimates can the net benefits of marginal preservation via conservation zoning be compared to those of PACE.

## **Conclusions**

This paper describes the results of a CE on the WTP for agricultural land preservation at two different jurisdictional scales. A set of attributes allowed the CE to control for a large set of land and open space amenities, including preservation policy attributes. These amenities represent an important part of the nonmarket outputs of agricultural land and thereby constitute an important component of multifunctional

agriculture. Policies to reward multifunctionality can be improved by better understanding the relative importance of these preserved land amenities. This study focuses on WTP in order to provide the most direct, quantitative measure of these amenities for use in policy.

Empirical results suggest definitive relationships and general tendencies in the WTP for preservation amenities. WTP is highest for high-risk acreage and for moderate access. Low-risk acreage is preferred to moderate-risk, and high access is preferred to none. Land use is found to have very little impact on WTP. Moreover, PACE is found to be preferable to preservation via fee simple purchase. Overall, the results suggest that WTP for preservation can be substantive, but it varies widely and may be low or negative for some acreage. The most complicated relationship discovered is between preservation via PACE and zoning. WTP for PACE exceeds zoning dramatically, but one may find that in practice zoning is much less expensive to implement. Hence, this paper suggests that additional research on the costs of zoning is needed.

The results are also interpreted in terms of economic guidance for policy. In terms of efficiency on the margin, the results suggest that many parcels will likely have positive net benefits from a preservation intervention. However, these net benefit estimates will vary widely, are significantly affected by heterogeneous cost patterns, and may be negative in a significant number of cases. Thus, an efficient program will tend to prioritize parcels so that preservation does not occur when net benefits are negative. WTP estimates can be used to derive a systematic prioritization plan. With high-quality cost data—which tends to be available for PACE preservation—the WTP estimates can be used to rank parcels so that limited preservation budgets can target those parcels with

the highest total net benefits. In practice, it may be too costly to estimate benefits and costs on each parcel, so the general relationships described above can help guide the design of prioritization strategies that emphasize demand-side criteria.

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**Table 1. Variables and Descriptive Statistics**

Variable	Description	Mean Value <sup>a</sup> (std. dev)	
		Delaware Community	Delaware State
<i>Neither</i>	Alternative specific constant (dummy) identifying the status quo option.	0.33 (0.47)	0.33 (0.47)
<i>Acres</i>	Number of acres preserved by preservation plan.	63.10 (70.78)	4007.79 (3956.68)
<i>Acres*Nursery</i>	Multiplicative interaction between <i>Acres</i> and a binary (dummy) variable indicating that the parcel is an active nursery (omitted default is a food or dairy farm).	11.98 (39.52)	846.88 (2464.72)
<i>Acres*Forest</i>	Multiplicative interaction between <i>Acres</i> and a binary (dummy) variable indicating that the parcel is forest (omitted default is a food or dairy farm).	12.80 (41.22)	777.10 (2347.00)
<i>Acres*Idle</i>	Multiplicative interaction between <i>Acres</i> and a binary (dummy) variable indicating that the parcel is idle farmland (omitted default is a food or dairy farm).	13.35 (41.37)	793.02 (2355.59)
<i>Acres*Trust Easement</i>	Multiplicative interaction between <i>Acres</i> and a binary (dummy) variable indicating that preservation is accomplished through conservation easements, implemented by land trusts, using block grant funds from the state (omitted default is preservation by conservation zoning).	6.73 (30.43)	468.16 (1889.80)
<i>Acres*State Purchase</i>	Multiplicative interaction between <i>Acres</i> and a binary (dummy) variable indicating that preservation is accomplished through fee simple purchase of the parcel, implemented by the state (omitted default is preservation by conservation zoning).	20.85 (50.44)	1291.67 (2914.34)
<i>Acres*Trust Purchase</i>	Multiplicative interaction between <i>Acres</i> and a binary (dummy) variable indicating that preservation is accomplished through fee simple purchase of the parcel, implemented by the land trusts, using block grant funds from the state (omitted default is preservation conservation zoning).	21.31 (50.77)	1326.22 (2951.25)
<i>Acres*State Easement</i>	Multiplicative interaction between <i>Acres</i> and a binary (dummy) variable indicating that preservation is accomplished through conservation easements, implemented by the state (omitted default is preservation by conservation zoning).	6.95 (30.53)	450.20 (1847.70)
<i>Acres* Moderate Access</i>	Multiplicative interaction between <i>Acres</i> and a binary (dummy) variable indicating that the preserved parcel would offer moderate levels of public access. This is defined as access for walking and biking in the locality survey, and access on 50% of preserved parcels in the state survey (omitted default is no public access).	14.56 (43.00)	832.32 (2430.74)
<i>Acres*High Access</i>	Multiplicative interaction between <i>Acres</i> and a binary (dummy) variable indicating that the preserved parcel would offer high levels of public access. This is defined as access for hunting in the locality survey, and access on 100% of preserved parcels in the state survey (omitted default is no public access).	12.91 (40.57)	916.67 (2529.63)
<i>Acres*No Development 30 Years</i>	Multiplicative interaction between <i>Acres</i> and a binary (dummy) variable indicating that the land, if not preserved, would likely remain undeveloped for at least 30 years (omitted default is development likely in less than 10 years).	22.00 (52.40)	1357.05 (2991.33)
<i>Acres*Develop ment 10 - 30 Years</i>	Multiplicative interaction between <i>Acres</i> and a binary (dummy) variable indicating that the land, if not preserved, would likely be developed in 10 to 30 years (omitted default is development likely in less than 10 years).	19.79 (47.95)	1290.99 (2911.03)
<i>Fee</i>	Unavoidable household cost of preservation (state/town taxes and fees), with sign reversal.	-43.53 (61.79)	-77.49 (102.24)

<sup>a</sup> Includes zeros for the 'neither' option.

**Table 2. Mixed Logit Results**

	<b>Delaware Community</b>	<b>Delaware State</b>
<i>Neither (ASC)</i>	-0.93298 (0.20365)***	-0.720424 (0.293863)***
<i>Fee (lognormal, sign reverse)</i>	-3.72041 (0.24206)***	-4.520530 (0.323230)***
<i>Acres</i>	-0.00237 (0.00207)	-0.000009 (0.000043)
<i>Acres*Nursery</i>	-0.00106 (0.00123)	-0.000027 (0.000026)
<i>Acres*Forest</i>	0.00008 (0.00124)	-0.000006 (0.000029)
<i>Acres*Idle</i>	0.00066 (0.00126)	-0.000011 (0.000027)
<i>Acres*Trust Easement</i>	0.00171 (0.00226)	0.000098 (0.000047)**
<i>Acres*State Purchase</i>	0.00421 (0.00189)**	0.000089 (0.000041)**
<i>Acres*Trust Purchase</i>	0.00096 (0.00197)	0.000091 (0.000042)**
<i>Acres*State Easement</i>	0.00573 (0.00209)***	0.000091 (0.000050)*
<i>Acres*Moderate Access</i>	0.00803 (0.00156)***	0.000086 (0.000030)***
<i>Acres*High Access</i>	0.00609 (0.00151)***	0.000072 (0.000029)***
<i>Acres*No Development 30 Years</i>	-0.00061 (0.00097)	-0.000106 (0.000023)***
<i>Acres*Development 10 - 30 Years</i>	-0.00149 (0.00116)	-0.000019 (0.000022)
<i>std NE</i>	1.53389 (0.39456)***	1.784680 (0.493429)***
<i>std Cost</i>	2.56899 (0.30388)***	2.677350 (0.443947)***
<i>Log-Likelihood Chi-Square</i>	630.01***	444.83***
<i>Pseudo-R<sup>2</sup></i>	0.20	0.21
<i>N</i>	4308	2952

Note: Single (\*), double (\*\*) and triple (\*\*\*) asterisks denote p-values of 0.10, 0.05 and 0.01, respectively.

**Table 3: Effect of Development Risk and Access on Per-Acre Willingness to Pay for**

**Preservation**

Risk of Development <sup>a</sup> (in Years)	Estimated WTP		Aggregate WTP <sup>c</sup>
	per household in Smyrna/Clayton <sup>b</sup>	per household in Delaware <sup>b</sup>	
No Access Provided			
Under 10	\$2.41	\$0.13	\$ 54,691
10 to 30	\$1.36	\$0.10	\$ 38,662
Over 30	\$1.99	\$(0.04)	\$ 2,233 <sup>c</sup>
Moderate Access <sup>d</sup>			
Under 10	\$8.10	\$0.27	\$134,436
10 to 30	\$7.05	\$0.24	\$118,407
Over 30	\$7.67	\$0.10	\$ 81,979
High Access <sup>d</sup>			
Under 10	\$6.74	\$0.24	\$117,590
10 to 30	\$5.69	\$0.21	\$101,561
Over 30	\$6.31	\$0.07	\$ 65,132

Note: All values assume a crop or livestock farm and that preservation is conducted via a state-level PACE Program. WTP for forest preservation is not reported, but is no more than 7.1% different than values reported for crop or livestock farms.

<sup>a</sup>For community level survey, these values represented the timeframe during which the parcel being considered was likely to be developed. For the statewide survey, respondents were told that preservation policies emphasized selection of parcels from areas at three levels of development risk.

<sup>b</sup>These values are the mean of medians from ML simulation. The values have been capitalized, using a discount rate of 6%.

<sup>c</sup>Aggregate WTP is calculated as the summation of two numbers: (1) Estimated mean WTP from Smyrna/Clayton times the number of housing units in the community; and (2) Estimated mean WTP from Delaware times the number of households in Delaware, not including Smyrna/Clayton. The U.S. Census (2000) estimates 6,901 housing units in the Smyrna and Clayton zip codes—the same zip codes used to draw the sample—and 291,835 other households in Delaware.

<sup>d</sup>The community and statewide surveys differed in terms of the definition of access (see this paper's data section for details).

<sup>e</sup>If statewide value WTP per household is assumed to be zero, then aggregate WTP is \$13,725.

**Table 4: Effect of Preservation Policy on Per-Acre Willingness to Pay for  
Preservation (by Land-Use Type)**

Preservation Policy Used	Estimated Aggregate WTP			
	(% of PACE by State)			
	Crop or Livestock Land Use	Forest Land Use	Nursery Land Use	Average Estimated Aggregate WTP
Zoning	\$ 61,978	\$ 59,423	\$ 45,140	\$ 56,754
	46.1%	45.1%	38.4%	43.9%
Fee Simple by State	\$125,828	\$108,490	\$ 94,207	\$109,516
	93.6%	82.3%	80.1%	84.8%
Fee Simple by Land Trust	\$111,045	\$115,179	\$100,896	\$110,838
	82.6%	87.3%	85.8%	85.8%
PACE by Land Trust	\$117,735	\$123,272	\$108,989	\$118,580
	87.6%	93.5%	92.7%	91.8%
PACE by State	\$134,436	\$131,881	\$117,598	\$129,212

Notes: All values assume a crop or livestock farm, the highest development risk level, and that the middle-level of access is provided. WTP for idle farmland preservation is not reported, but is no more than 1.7% different than values reported for forest for all five policies.

## ENDNOTES

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<sup>i</sup> Such issues are discussed in greater detail by Johnston and Duke (2007b)

<sup>ii</sup> Preliminary models were also estimated in which the coefficient on preserved acres (*Acres*) was randomized; many of these models showed no statistically significant improvement over specifications in which a fixed (non-random) coefficient was specified. Hence, a fixed coefficient is specified for this variable. In addition, to simplify subsequent welfare simulations (see below) and prevent convergence difficulties, coefficients on multiplicative interactions were also specified as fixed.

<sup>iii</sup> Delaware Department of Agriculture,

[http://dda.delaware.gov/aglands/forms/2007/050107\\_CurSitRpt.pdf](http://dda.delaware.gov/aglands/forms/2007/050107_CurSitRpt.pdf), accessed August 24, 2007.