2002 American Agricultural Economics Association Annual Meetings
July 28-31
Long Beach, CA

The Effects of Farmland, Farmland Preservation and Other Neighborhood Amenities on Proximate Housing Values: Results of a Conjoint Analysis of Housing Choice*

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Abstract: Using stated-preference data from a choice-based conjoint analysis instrument, we estimate willingness to pay for the presence of neighboring land that is dedicated to agricultural use (versus a developed land use) and for the preservation of surrounding farmland as permanent cropland. The data also elucidate how individuals balance the values associated with nearby agricultural land patterns with other key neighborhood characteristics such as neighborhood parks, housing density, commute times, school quality and neighborhood safety. The median respondent from a randomly chosen sample of Columbus, Ohio homeowners was willing to pay $843 annually to avoid immediate conversion of 10 percent of agricultural land within one mile of the house valued in the conjoint experiment while the same respondent was willing to pay $277 annually to preserve the same amount of farmland as permanent cropland. We find provision of neighborhood parks within housing developments to be a strong substitute for farmland preservation.

Key words: Farmland preservation, conjoint analysis, land use, willingness to pay

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* Irwin and Roe would like to acknowledge financial support from the Ohio Agricultural Research and Development Center and Irwin and Morrow-Jones would like to acknowledge support from the Ohio State Center for Urban and Regional Affairs, the Swank Program for Rural-Urban Affairs and the National Science Foundation.

The Effects of Farmland, Farmland Preservation and Other Neighborhood Amenities on Proximate Housing Values: Results of a Conjoint Analysis of Housing Choice

Programs designed to alter agricultural land use are proliferating, particularly in rapidly urbanizing metropolitan areas and states. Private conservation easements, development right transfer programs and other farmland preservation programs recognize that benefits may accrue to society by preventing parcels of agricultural land from being converted to other, more developed, uses. Central to the success of developing and implementing such programs is understanding the value that the public places on amenities of agricultural land under different programs.

Using stated preference data from a choice-based conjoint analysis instrument (Louviere), we estimate willingness to pay for the presence of neighboring land that is dedicated to agricultural use (versus a developed land use) and for the preservation of surrounding farmland as permanent cropland. The conjoint analysis format provides further insight into how individuals balance the values associated with nearby agricultural land patterns with other key neighborhood characteristics such as neighborhood parks, housing density, commute times, school quality and neighborhood safety.

Unlike analysis of revealed preference data in a hedonic framework (Irwin and Bockstael), in which potential endogeneity and unobserved spatial variation make it difficult to identify the marginal effects of neighboring open space amenities, the use of the conjoint methodology allows for amenity bundles evaluated by the respondent to follow an experimental design that decouples such natural correlations. By capturing the benefits of farmland preservation to neighboring residential property owners, such estimates provide a lower bound of the value of implementing farmland preservation measures and, as such, are beneficial to local and regional policy makers. That is, one would logically expect that neighboring residential property owners would absorb a large portion of the total use benefits generated by farmland preservation efforts. Furthermore, the use of conjoint analysis techniques, which were first used to assess the commercial appeal of consumer goods (Green and Srinivasan) and have been applied to the analysis of housing and neighborhood decisions (Rouwendal and Meijer 2001; Earnhart 2001; Molin, Oppewal and Timmermans 1999; Schellekens and Timmermans 1997; Joseph, Smit and McIlravey 1989), allows us to gauge possible pricing implications for developers who create residential communities with various land use designs. For example, these results can be used to gauge how much housing prices could be increased if a developer were to undertake private conservation easements near the development and how pricing might be altered if the developer instead focused on providing neighborhood park space in addition to or instead of private farmland preservation. Because conjoint techniques require respondents to assess price as one of the attributes, discrete welfare measures can also be derived from the estimated utility structure (Roe, Boyle and Teisl 1996).

Survey and Methods

Sample

The data used in this paper are drawn from responses to a survey instrument featuring many questions concerning home ownership and neighborhood satisfaction. During August of 2001 survey instruments were mailed to a random sample of 2,600 homeowners living in Franklin County, Ohio. Reminder postcards were sent to non-respondents two weeks later. A week later a final mailing that included a second survey instrument was sent to those who did not respond to the first two mailings. An incentive in the form of entry into a raffle for several prizes (football tickets, dining certificates, etc.) was offered to those who returned complete surveys within a month of the initial mailing. One thousand two hundred and fifty-seven respondents returned complete surveys; after subtracting non-deliverable surveys, this represents 52 percent response rate.

Survey and Question Design

The survey begins with questions concerning the respondent's current residence, neighborhood, local schools and likelihood of moving. After these questions the respondent sees two conjoint instruments. The preface to the conjoint question (Figure 1) asks the respondent to suppose they were moving and that they had narrowed the choice down to two possible homes. Two housing profiles, presented side-by-side, provide information on: neighborhood configuration (cul de sac vs. grid organization); availability of a local park (relayed graphically in the neighborhood configuration picture); neighborhood housing density (more dense vs. less dense); surrounding land uses (percent in agricultural uses and if the land is permanently dedicated to cropland); one-way commute time to work in minutes; rating of neighborhood school quality (four categories ranging from fair to excellent); rating of neighborhood safety (four categories ranging from somewhat unsafe to very safe); average income of neighborhood households; and purchase price of house. The conjoint instrument also listed county average values for most attributes to provide respondents with a point of reference for attributes that might be quantified in an unfamiliar metric. The full listing of attributes and their experimental levels is listed in Table 1.

Both the preface to the conjoint profiles and again before the choice question, the respondents were informed that the two houses were identical in all other aspects including age, design and size and reminded of their household budget constraint. Respondents were then asked to state that they: preferred house A, preferred house B or that neither house was within current budget. Then each respondent was asked if the house they preferred was: better than their current house, similar to their current house or worse than their current house. This additional question allowed us to better mimic the data collected from actual housing transactions as real transactions are only made by individuals who are 'in the market' for the house. Hence we test if the stated preferences for housing profiles differ between those who are in or out of this particular hypothetical housing market. The survey also elicited key demographic variables including household income (summarized in Table 2).

Experimental Design

To generate the housing profiles used in the survey the authors used a modified full-factorial design. A full factorial design would generate housing profiles such that the respondent pool observes all possible permutations of attribute levels. Given the inclusion of several variables that are potentially continuous, such as price and commute time, this would create a number of permutations greater than the potential pool of respondents. We modified the full-factorial design such that the respondent pool observes all possible permutations for the subset of discrete attributes with random assignment of the levels for the continuous attributes.

Specifically, we divide the attributes into two categories: discrete attributes, which include neighborhood design (four levels), housing density (two levels), surrounding land use (six levels), neighborhood school quality (four levels), neighborhood safety (four levels), and potentially continuous attributes, which include commute time, average neighborhood household income and price. The discrete attributes feature a distinct list of possible levels that yields $4^3*2*6 = 768$ possible permutations. These permutations can be reduced to 384 permutations because the housing density variable was perfectly collinear with the neighborhood design attribute (all grid neighbor hoods were classified as more dense). The values of the remaining three variables were then drawn from a random multivariate normal distribution. The levels of price, commute time and average neighborhood household income were then checked to ensure they fell within the ranges listed in Table 1 and rounded according to the descriptions provided in Table 1.

Ten thousand, four hundred housing profiles were generated in order to create two pairs of housing profiles for the pool of 2,600 possible respondents. To make the design more efficient, housing profile pairs were individually checked; we removed pairs that featured identical housing profiles or that featured one dominating profile (e.g., one house featured a much lower price, a much shorter commute time and much better safety and school ratings). The average values of these attributes are summarized in Table 2.

Model and Statistical Analysis

We assume the individual's indirect utility functions can be approximated as a quadratic function of net income, housing attributes and housing attribute-respondent characteristic interaction terms:

(1) $V_j^i(M - P_j, \mathbf{A_j}, \mathbf{S}_j^{\,i}) = \boldsymbol{\alpha}'\boldsymbol{L} + \boldsymbol{\beta}'\boldsymbol{Q} + e_j^i$

where V_j^i denotes individual *i*'s indirect utility from choosing house *j*; *M* is respondent annual household income; P_j is the annualized purchase price[1] of house *j*; $\mathbf{A}_j$ denotes a vector of other the attributes associated with house *j*; $\mathbf{S_j}^i$ denotes a vector of interaction terms between household *i*'s characteristics and house *j*'s attributes;[2] $\boldsymbol{L} = [\, M - P_j \quad \mathbf{A_j} \quad \mathbf{S}_j^{\,i}]'$ is a vector of linear regressors; $\boldsymbol{Q} = [(M - P_j)^2 \quad (\mathbf{A_j})^2 \quad (\mathbf{S}_j^{\,i})^2\,]'$ is a vector of quadratic regressors; $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ are conformable vectors of coefficients to be estimated; and e_j^i denotes a disturbance term. Denote α_M and β_M as the individual coefficients associated with the linear and quadratic income terms (i.e., $M - P_j$).

Note that the utility function is concave in income if $\alpha_M > 0$ and $\beta_M < 0$. If $\alpha_M + 2\beta_M M > 0$ then the utility function is also strictly increasing.

When faced with a choice of two houses the individual chooses the one expected to provide the highest utility. Here each individual's choice set contains two houses so we model the choice decision based on relative differences in utility. Thus framed, the utility difference between house *x* and house *y* is:

$$(2) \qquad dV^i_{xy} = -\alpha_M\Delta(P) + \beta_M\{\Delta(P^2) - 2M\Delta(P)\} + \boldsymbol{\alpha_A}\Delta(\mathrm{A}) + \boldsymbol{\alpha_S}\Delta(\mathrm{S}^i) + \boldsymbol{\beta_A}\Delta(\mathbf{A}^2) + \boldsymbol{\beta_S}\Delta((\mathbf{S}^i)^2) + \varepsilon^i_{xy},$$

where $\Delta(k) = k_x - k_y$, $\Delta(k^2) = (k_x)^2 - (k_y)^2$ and $\varepsilon^i_{xy} = (e^i_x - e^i_y)$ and ε^i_{xy} is assumed to be normally distributed. If all $\boldsymbol{\beta}$ parameters are set equal to zero the specification in (2) is linear in all arguments. Linear functional forms have been frequently used in conjoint studies (e.g., Johnson and Desvousges), though such forms have several undesirable characteristics from the standpoint of utility theory including that they impose a linear marginal utility of income. Formulation of the quadratic functional form allows us to test the appropriateness of this assumption.

Following Johnson and Desvousges we include interaction terms; this allows for measurement of differences in preferences for product attributes across different types of individuals. The list of independent variables used in the analysis, along with summary statistics, is given in Table 2.

We implicitly define the annual compensating variation, *C*, for a change in housing attributes from $\mathbf{A_0}$ to $\mathbf{A_1}$ for individual *i* as:

$$V_0\,(M - P_0, \mathbf{A_0}, \mathbf{S_0^i}) = V_1\,(M - P_1 - C, \mathbf{A_1}, \mathbf{S_1^i}).$$

Given the functional form in (2) and assuming that all higher-order terms are equal to zero except for the income term, we derive a closed-form solution for *C*:

(3) $$C = \frac{\alpha_M + 2\beta_M(M - P_0) \pm \sqrt{[\alpha_M + 2\beta_M(M - P_0)]^2 + 4\beta_M[\alpha_A \Delta(\mathbf{A}) + \alpha_S \Delta(\mathbf{S_i})]}}{2\beta_M}.$$

Note that this quadratic functional yields two possible solutions for *C*. Given the maintained hypothesis of concavity the solution featuring the positive sign before the term in the square root bracket is infeasible and is omitted.

Statistical analysis proceeds by pooling observations across individual respondents and estimating the utility difference model.[3] We model the probability that the respondent chooses house A. The models' parameters are estimated via maximum likelihood procedures for a standard probit model. Inclusion of quadratic terms other than the income term failed to improve the fit of the model and, in many cases, appeared to cause problems with multicollinearity. Several key interaction terms, both between two housing attributes and between housing attributes and household characteristics, did yield significant results and were included in the final model.

Most of the housing attributes profiled in the conjoint instrument have well defined expectations with respect to sign. All else equal respondents are expected to prefer houses with a lower price, shorter commute, a local park, better schools and higher safety ratings. Our expectations are not as strong concerning the remaining attributes, particularly those associated with neighborhood design and surrounding land in agricultural use. Our initial expectations are that respondents will prefer more surrounding land in agriculture and prefer if this land is permanently dedicated to cropland rather than available for future development. It is possible, however, that some respondents may associate negative images (e.g., odor, noise) with agricultural operations or prefer certain types of retail development to be near their house. Also, respondents may desire neighborhoods in which the average income is higher and may prefer the denser grid-formation neighborhoods that have regained popularity with urban planners and neighborhood designers rather than the cul de sac design.

Results

Utility Model

Each respondent was asked to complete two sets of conjoint questions for a potential of 2,514 usable responses. Due to non-reported demographic information, 506 responses were dropped. Furthermore, for 457 observations respondents either failed to answer the choice question or answered that both housing choices were outside of their current budget constraint.[4] This leaves 1,551 usable conjoint choices for analysis.[5]

The estimated utility model is globally concave in income and fits the data well: the model predicts 70.3 percent of the sample data points correctly; all linear housing attributes are significant; and several interaction terms are significant as well. We find that most of our expectations are met with respect to expected sign of housing attributes: respondents prefer shorter commutes; more surrounding agricultural land; ag land dedicated to permanent cropland; local parks; neighbors with higher average incomes; and better school and safety ratings.

Among this subset of attributes there exist several significant interaction terms that help elucidate the sample respondents' preferences for local land use variables. For example the negative interaction term, Δ(Commute)*Δ(PermCrop), suggests that preferences for permanent cropland designations wane as respondents' commute times grow longer. Specifically, consider house A that is surrounded by some amount of agricultural land. House B, which has the same amount of land in agricultural use but the land has been preserved permanently as cropland, yields significantly higher utility. However, if the commute from house B to the respondent's workplace is 10 minutes longer than the commute from house A, both houses provide the same level of utility.

The positive interaction term Δ(AgLand)*Δ(PermCrop) suggests that the value of farmland preservation measures is greater when more land near the house is involved in agricultural uses. Conversely, it implies that the marginal value of the farmland preservation is decreasing as the absolute level of nearby agricultural activity decreases. Taking the main effects and interaction terms together for a house with half of the land within one mile still in farmland, we project that one can roughly offset the utility loss from the development of 20 percent of the farmland by preserving the remaining farmland as permanent cropland.

The negative interaction term, Δ(PermCrop)*Δ(Park), is large in absolute value and significantly different from zero. This indicates that respondents may view local neighborhood parks to be a substitute for farmland preservation efforts. The preservation of about 760 acres[6] of agricultural land as permanent cropland yields the same utility as the addition of a neighborhood park. Alternatively, holding farmland preservation constant, we find that utility decrease associated with a loss of 26 percent of surrounding farmland activity can be offset if the neighborhood features a park. The value of a neighborhood park is affected by other neighborhood attributes, however. The significant, positive interaction term Δ(Park)*Δ(Safe), implies that the marginal value of a local park decreases as neighborhood safety decreases.

Several other housing attributes not directly associated with farmland preservation also feature significant interaction terms. The positive coefficient on Δ(Commute)*Δ(NeighInc) implies that respondents will tolerate a longer commute if the neighborhood to which they return features a higher average income. The positive interaction term Δ(School)*Anychild suggests that improved school ratings are nearly twice as important to households with children.

With respect to the housing density variable we find that, for a wide range of demographic characteristics, it is insignificant. While the main effect variable, Δ(Density), is negative and significant, we must balance this against the positive, significant signs on the two attribute-demographic interaction terms, Δ(Density)*Education and Δ(Density)*Nonwhite. Evaluated at mean education levels, housing density is insignificant for both white ($\chi^2(1) = 0.20$, p-val > 0.10) and nonwhite ($\chi^2(1) = 0.25$, p-val > 0.10) sub-samples. White respondents with fewer than 9 years of formal education find dense neighborhoods to be significantly less desirable while nonwhite respondents with more than 17 years of formal education prefer the traditional grid neighborhoods with more dense housing patterns. This suggests that the choice of a densely aligned grid neighborhood design or a less densely aligned cul de sac design will have a much smaller effect than many of the other housing attributes considered.

Compensating Housing Prices

To understand how the sample respondents' preferences for housing attributes, as estimated in the preceding utility model, might translate into the market for housing and into annual willingness to pay for farmland preservation programs, we utilize the compensating variation calculation from expression (3). Due to the nonlinearity of the utility model in income and price and due to significant attribute-demographic interaction terms, any compensating value estimates will depend upon the absolute value of the housing prices under consideration and household income and demographic variables. Hence point estimates and corresponding 90 percent confidence intervals[7] listed in Table 4 are calculated for three different demographic and housing profiles.

Across the three examples considered the conversion of 10 percent of all existing agricultural land within one mile of the house (about 188 acres) into permanent cropland has a value ranging from 1% to 4% of the value of the house being considered. For the median respondent and the median valued house this corresponds to an annual mortgage payment increase of $277, which translates to a $3,607 increase in price of the median house.

The confidence interval for this scenario, and for most of the scenarios considered, does not include zero but does include an upper value that is two orders of magnitude larger than the point estimate. This suggests that we can be confident that the true compensating variation estimates are different than zero, but that there exists a large range in which the true value lies. Wide confidence intervals are not uncommon in stated preference (Boyle 1990) or revealed preference (Adamowicz, Fletcher and Graham-Tomasi 1989) studies that use nonlinear functional forms. Indeed, note that the confidence intervals are markedly narrower for the scenarios based upon an individual household with a lower annual income (scenarios 10 - 18).

The value of preserving a single acre of agricultural land as permanent cropland ranges from $1 to $3 on an annual basis and from $12 to $38 on a per-house purchased basis. The price of the median house bought by the median respondent would be $19 if an additional acre of land were preserved. For a residential development of 100 median houses purchased by 100 median respondents, the additional aggregate housing value sums to $1,900 dollars. The 2000 estimate for the price of Ohio farmland is $2,250 per acre, suggesting that if the implicit increase in property values could be captured and applied to farmland preservation effort it would roughly offset the cost of acquiring land at the going market price. Note, however, that individual plots of land near such a development would likely be valued more highly than the average plot of Ohio farmland, making it more likely that the value from increased housing prices would be less than the cost of preservation. Larger or more densely populated neighborhoods may have a larger aggregate increase in housing values from the same preservation effort, however, which could offset this natural tendency for prices to rise near future development.

The transformation of agricultural land to developed uses constitutes a substantial loss to the value of nearby houses. Scenario 3 quantifies the loss in value from 10 % of surrounding land (about 188 acres) being converted from agricultural land to developed uses. Point estimates range from $520 to $1,600 on an annual basis and from $6,754 (4%) to $16,400 (12%) on a per-house basis with the greater losses coming from richer households. In absolute terms the loss in housing value associated with the development of 10 percent of agricultural land is greater than the gain from preserving 10 percent of agricultural land as permanent cropland (scenarios 4, 13, and 22). However, only for the low-income example does the confidence interval for this scenario exclude zero. Hence, while the current use seems to be more important than potential use, we cannot say this finding is a statistically significant for all demographic and housing profiles or even the median demographic and housing profile.

Neighborhood park availability dramatically increases housing values as well, with annual values ranging from $1,320 to $3,691 and per house values ranging from $17,166 (10%) to $47,984 (21%). Hence, designation of land within the neighborhood for use as a public park can boost housing values substantially.

Commuting distance is also a critical to housing values. A 10-minute reduction in one-way commute time translates to an annual value of $1,833 for the median profile. Assuming a 50-week work year, this translates to nearly $37 a week or based upon a 240-day work year, this translates to $7.64/day. If 20 fewer minutes spent traveling per day reduces total travel by 10 miles per day (implying a 30 mile per hour average speed during these 20 minutes) the implied value translates to $0.76 per mile, or roughly double the 2001 tax deductible car mileage rate allowed by the US Internal Revenue Service of $0.345. If 20 fewer minutes per day only reduces travel by 5 miles per day (or about 15 miles per hour average speed) the implied value translates to $1.52 per mile. Hence, the implied value respondents placed on commuting times is within a feasible range of values.

School quality has a large impact on the compensating housing prices calculated for this sample. The annual compensating values for a one-category improvement in public school quality (four categories were possible) ranged from $2,583 to $6,592 with larger values for households with higher incomes and children. Households dissatisfied with public schools may consider sending their children to private schools. The average cost of private schools in the United States averaged $3,116 for the 1993-94 school year, the most recent year for which such figures were available (US Department of Education, 2000). Hence, the implied value for a relatively large improvement in public school quality falls in the range of private per pupil tuition rates. A one-category improvement in neighborhood safety produced similar ranges of compensating housing values.

Discussion

The value of farmland preservation found in this study is much higher than the previous contingent valuation studies. Heimlich and Anderson (2001) review six different stated preference studies focused on farmland preservation and find that annual per-household values for the preservation of 1,000 acres of farmland ranges from $0.21 to $49.80 (adjusted for inflation and expressed in 2000 dollars). The range of annual per-household values estimated from this study for a substantially smaller preservation effort (188 acres) ranges from $170 to $533 (expressed in 2001 dollars).

The higher values found in this study could arise for several reasons. First consider the issue of physical proximity. Most of the stated preference instruments reviewed by Heimlich and Anderson (2001) ask respondents to value the preservation of land that may not be in the immediate vicinity, whereas the land valued in this study is clearly within close proximity and, hence, should offer a greater level of use amenities.

A second difference may be that of the quality of preserved land. The act of preserving agricultural land in this study involves conversion of farmland to permanent cropland, whereas other studies generally refer to maintaining farmland in its present agricultural use. This might be particularly important when respondents are within one mile of the land because it rules out the citing of livestock operations that may generate both positive and negative (e.g., odor) externalities. This may have been particularly important for this study's sample population because local news media had provided extensive coverage of a 'bad actor' in the local livestock sector that caused significant disamenities for proximate neighbors (e.g., Lafferty 2001).

A third difference might be classified as a difference in specificity of the preservation attributes. The conjoint profiles viewed by respondents are subtle in their description of key amenities. For example, the specifics of the program that would create 'permanent cropland' instead of land in general agricultural use are never communicated to the respondent. Rather respondents draw their own inferences between the operational differences between 'land in agricultural use' and 'land in permanent cropland.' Furthermore, unlike many contingent valuation studies in which the exact acreage of land slated for preservation is communicated, the conjoint profiles communicate the agricultural land area in terms of a percent of land within a one-mile radius, leaving much room for differing interpretations of the exact amount of land dedicated to a particular land use and preservation status. Similarly, the notion of a neighborhood park is conveyed only with an artistic alteration of the architectural drawings that communicate the design of the neighborhood to include an area with grass and trees and the printed word “Park.”

This approach differs from a contingent valuation questionnaire, in which the research interest lies with one specific amenity and that amenity is described in great detail in the questionnaire seen by the respondent. Conjoint analysis methods more closely mimic market conditions because several attributes of the good are described and respondents are less likely to focus on just one attribute. While more realistic, such an approach is more cognitively demanding and respondents may not fully process the information concerning each attribute. Hence, final decisions made in the hypothetical context of the conjoint experiment may involve substantially less contemplation than final decision made in real markets, calling into question the value of marginal values derived from the estimated utility function.

Nonetheless, the conjoint methodology appears quite promising in eliciting marginal and discrete values associated with alterations in key neighborhood attributes. Indeed, implicit values for reductions in commuting times and public school improvements calibrated to realistic values observed in private market contexts. Furthermore, despite the subtlety of the communication of the farmland and park amenities, each amenity and interaction terms were highly significant in the estimated utility model.

Furthermore, the values derived in this study are smaller than figures derived in recent hedonic analyses of the value of neighboring open space in Maryland. Irwin (2002) estimates that residential lot prices would increase by $4,523 or 2.6 percent of the mean property price if a 10-acre parcel of land was preserved as cropland, pasture or forest, which is similar to the value we estimate for the preservation for a 188-acre parcel of land preserved as cropland.

Conclusions

The implications of the conjoint analysis results for farmland preservation programs are several. First, the development of agricultural land has a strong negative impact on the values of surrounding homes. We estimate that conversion of 10 percent of the land base within one mile of a house from agricultural use to developed use can decrease housing values by four to twelve percent. The implication for housing markets is that houses in new developments initially surrounded by agricultural land will likely lose substantial value as the additional development takes place. The fact that the sample respondents significantly value farmland preservation efforts implies that the potential for local development and its associated disamenities is already built into housing market prices.

Second, the value of preservation activities, while significant, is still outweighed by the actual conversion of land from agricultural uses to developed uses. Roughly speaking, to hold neighboring residential household's utility constant, for every acre of farmland that is converted three of the remaining acres must be preserved or protected against future development. Consider the possibility that the mere announcement of a future preservation program triggers rapid development of agricultural land. If substantial development takes place before the program is implemented, the net impact on local housing values could very well be negative. Hence announcements of preservation programs that trigger a development rush could backfire.

Another key point is that the marginal value of farmland preservation is increasing in the total amount of land still dedicated to farming within the vicinity. Hence, contrary to standard economic intuition, preservation of land in neighborhoods with little remaining farmland appears to be of less value at the margin than preservation in neighborhoods with much remaining farmland. An alternative interpretation is that farmland preservation has a higher marginal valuation when the more land is at risk of being developed.

An important relationship between commuting times and farmland preservation also emerges from this analysis: farmland preservation is less valuable at the margin as commute time increases. This suggests that, while farmland preservation programs might be more cheaply implemented in areas further from major employments centers, such programs will also have less value to those neighbors who absorb the amenities because commute times will typically increase as well. Hence, this leaves several unsavory tradeoffs. Might not improvement of roads to areas with preserved farmland increase the marginal value of preservation activities? Or will such infrastructure improvement activities merely ratchet up the demand for land such that implementing farmland preservation is more costly? Perhaps continued movements towards telecommuting means that the marginal value of farmland preservation will increase.

A final insight is that the provision of a neighborhood park has a similar value to the implementation of a large-scale farmland preservation effort and that provision of such a park decreases the marginal value of farmland preservation efforts. Hence, land use programs that entice developers to include neighborhood parks in residential developments could greatly reduce the demand for farmland preservation programs. This is an important addition to the farmland preservation literature because most previous work has not expressly considered how the availability of other land-use based substitutes affects the value of farmland preservation activities, though Heimlich and Anderson (2001) allude to such substitution possibilities as reasons for regional differences in previous stated preference studies of farmland preservation.

Future research using this approach should investigate importance of the finer details of preservation policies (cropland vs. any agricultural use) and investigate respondents' sensitivity to the proximity of land use alterations (1 mile radius vs. larger areas).

Table 1. Conjoint Housing Attributes and Levels

Attribute	Levels
Neighborhood Design	Cul de sac – no park Cul de sac – neighborhood park Grid – no park Grid – neighborhood park
Housing Density	Less dense More dense
Surrounding Land Use	None of the land within one mile in agricultural use Half of the land within one mile in agricultural use Most of the land within one mile in agricultural use None of the land within one mile in permanent cropland Half of the land within one mile in permanent cropland Most of the land within one mile in permanent cropland
Commute time	5 to 60 by 5 minute increments
School Quality	Fair (1), average (2), good (3), excellent (4)
Neighborhood Safety	Somewhat unsafe (1), somewhat safe (2), safe (3), very safe (4)
Ave. Household Income in Neighborhood	$35,000 to $70,000 by $5,000 increments
House Price	$129,000 to $219,000 by $1,000 increments

Table 2. Summary Statistics of Explanatory Variables and Household Characteristics

Variable	Definition	Mean	Std Dev	Min	Max
Choice*	=1 if chose house A	0.56	0.50	0	1
P_A	Purchase price house A ($)	169,268	15,509	129,000	216,000
P_B	Purchase price house B ($)	169,342	16,352	129,000	228,000
$AgLand_A$	% land within 1 mile of House A in ag land	0.51	0.41	0	1
$AgLand_B$	% land within 1 mile of House B in ag land	0.43	0.41	0	1
$PermCrop_A$*	=1 if $AgLand_A > 0$ and is in permanent cropland	0.54	0.50	0	1
$PermCrop_B$*	=1 if $AgLand_B > 0$ and is in permanent cropland	0.51	0.50	0	1
$Commute_A$	Commute time house A (min.)	33.72	18.73	5	60
$Commute_B$	Commute time house B (min.)	30.98	18.65	5	60
$NeighInc_A$	Neighborhood average income house A ($)	52,060	11,931	35,000	70,000
$NeighInc_B$	Neighborhood average income house B ($)	51,934	12,084	35,000	70,000
$Safety_A$	Neighborhood safety rating house A**	2.49	1.06	1	4
$Safety_B$	Neighborhood safety rating house B**	2.50	1.08	1	4
$School_A$	School quality rating house A**	2.81	1.04	1	4
$School_B$	School quality rating house B**	2.84	1.02	1	4
$Density_A$*	=1 if houses more densely aligned (i.e., grid layout) in house A's neighborhood	0.46	0.50	0	1
$Density_B$*	=1 if houses more densely aligned (i.e., grid layout) in house B's neighborhood	0.54	0.50	0	1
$Park_A$*	= 1 if neighborhood A has park	0.50	0.50	0	1
$Park_B$*	= 1 if neighborhood B has park	0.50	0.50	0	1
Δ(P)	$P_A - P_B$	-0.01	1.43	-3	3
Δ(Commute)	$Com_A - Com_B$	2.74	32.35	-55	55
Δ(NeighInc)	$Inc_A - Inc_B$	125.50	15,608	-35,000	35,000
Δ(Safety)	$Safe_A - Safe_B$	-0.01	1.50	-3	3
Δ(School)	$School_A - School_B$	-0.03	1.41	-3	3
Δ(Density)	$Dense_A - Dense_B$	-0.08	1.00	-1	1
Δ(AgLand)	$AgLand_A - AgLand_B$	0.08	0.74	-1	1
Δ(PermCrop)	$PermCrop_A - PermCrop_B$	0.03	0.72	-1	1
Δ(Park)	$Park_A - Park_B$	0.00	0.69	-1	1
Education	Formal education in years	15.04	2.58	1	22
Age	Respondent age in years	48.27	13.60	16	89
White*	=1 if respondent Caucasian or Asian	0.84	0.37	0	1
HH Income	Respondent household annual inc. ($1,000)	77.30	44.75	10	210
Anychild*	=1 if household houses any children	0.41	0.49	0	1

* Indicates a dummy variable coding.
** Higher ratings are more desirable.

Table 3. Estimated Housing Utility Model.

Parameter	Estimate	Std. Error
Intercept	0.190	0.034*[A]
HH Inc – Price (α_M)	0.167	0.056*
(HH Inc – Price)^2 (β_M)	-1.07E-03	2.83E-04*
Δ(Commute)	-8.63E-03	2.02E-03*
Δ(NeighInc)	1.90E-05	8.95E-06**
Δ(Density)	-0.456	0.233**
Δ(AgLand)	0.388	0.122*
Δ(PermCrop)	0.126	0.047*
Δ(Park)	0.100	0.060***
Δ(School)	0.102	0.046**
Δ(Safety)	0.119	0.032*
Δ(Commute)*Δ(NeighInc)	1.32E-07	6.63E-08**
Δ(Commute)*Δ(PermCrop)	-8.42E-03	2.69E-03*
Δ(AgLand)*Δ(PermCrop)	0.219	0.117***
Δ(Park)* Δ(Safety)	0.063	0.034***
Δ(PermCrop)* Δ(Park)	-0.121	0.069***
Δ(School)*Anychild	0.097	0.052***
Δ(NeighInc)*Age	-3.75E-07	1.67E-07**
Δ(Density)*Education	0.028	0.014**
Δ(Density)*Nonwhite	0.203	0.109***
N	1,551	
Likelihood Function Value	956.72	
% Correct Predictions	70.3	
Chi-Square of Covariates	207.4*	
Psuedo-R^{2}[B]	0.13	

A - *, **, *** denotes parameter significance at the 1%, 5% and 10% levels, respectively as measured by a Wald Chi-square test.

B – Psuedo-R^2 is defined as $1 - \{L(\alpha = 0)/L(\alpha = \hat{\alpha})\}^2$ where L(.) is the value of the likelihood function and α is the vector of coefficients to be estimated.

Table 4. Compensating Values for Key Housing Attributes

Housing Attribute	Annual Mortgage Payment	House Price	% of Base Price
Base = Median Household and Housing Profile[A]			
1. 10% of land within 1 mile of house preserved as permanent cropland	$277 [76 to 21,781][B]	$3,607 [992 to 283,148]	2% [1 to 168]
2. 1 acre of land within 1 mile of house preserved as permanent cropland	$1.48 [0.4 to 20,989]	$19 [5 to 272,853]	0.01% [0.002 to 119]
3. 10% of land within 1 mile of house converted from agricultural use to developed use	-$843 [-263 to -23,044]	-$10,954 [-3,424 to 299,568]	-6% [2 to 177]
4. Scenario 1 and 3 simultaneously	-$616 [-1,728 to 21,919]	-$8,009 [-22,457 to 284,950]	-5% [-13 to 168]
5. Improve neighborhood school quality ratings by 1 category (4 categories total)	$2,145 [582 to 25,591]	$27,884 [7,570 to 332,679]	16% [4 to 197]
6. Improve neighborhood safety rating by 1 category (4 categories total)	$2,496 [924 to 26,772]	$32,452 [12,008 to 348,039]	19% [7 to 206]
7. Add a neighborhood park	$2,105 [175 to 26,790]	$27,360 [2,278 to 348,274]	16% [1 to 206]
8. Reduce one-way commute by 10 minutes.	$1,833 [684 to 24,989]	$23,829 [8,896 to 324,863]	14% [5 to 192]
9. Increase ave. neighborhood income $10,000	$303 [-1,158 to 22,901]	$3,933 [-15,049 to 297,708]	2% [-9, 176]
Base = Poorer with Children and Less Expensive House[C]			
10. 10% of land within 1 mile of house preserved as permanent cropland	$170 [58 to 1,647]	$2,205 [759 to 21,409]	1% [1 to 14]
11. 1 acre of land within 1 mile of house preserved as permanent cropland	$0.90 [0.31 to 12]	$12 [4 to 150]	0.01% [0.002 to 0.07]
12. 10% of land within 1 mile of house converted from agricultural use to developed use	-$520 [-4,407 to -191]	-$6,754 [-57,293 to –2,481]	-4% [-38 to –2]
13. Scenario 10 and 12 simultaneously	-$372 [-1,346 to 14]	-$4,832 [-17,498 to 183]	-3% [-12 to 0]
14. Improve neighborhood school quality ratings by 1 category (4 categories total)	$2,583 [1,255 to 11,577]	$33,576 [16,314 to 150,499]	20% [11 to 100]

Housing Attribute	Annual Mortgage Payment	House Price	% of Base Price
15. Improve neighborhood safety rating by 1 category (4 categories total)	$1,574 [673 to 9,388]	$20,467 [8,754 to 122,050]	12% [6 to 81]
16. Add a neighborhood park	$1,320 [48 to 8,233]	$17,166 [625 to 106,903]	10% [0 to 71]
17. Reduce one-way commute by 10 minutes.	$1,146 [517 to 7,725]	$14,895 [6,724 to 100,425]	9% [4 to 67]
18. Increase ave. neighborhood income $10,000	$536 [-1,696 to 1,505]	$6,964 [-22,043 to 19,563]	4% [-15 to 13]
Base = Richer with Children and More Expensive House[D]			
19. 10% of land within 1 mile of house preserved as permanent cropland	$533 [110 to 42,012]	$6,931 [1,431 to 546,162]	4% [1 to 237]
20. 1 acre of land within 1 mile of house preserved as permanent cropland	$2.90 [0.59 to 41,602]	$38 [8 to 540,825]	0.02% [0.003 to 235]
21. 10% of land within 1 mile of house converted from agricultural use to developed use	-$1,568 [-42,667 to -352]	-$20,378 [-554,668 to -4,581	-12% [-241 to –2]
22. Scenario 17 and 18 simultaneously	-1,262 [-2,057 to 45,028]	-$16,400 [-26,737 to 585,358]	-10% [-12 to 255]
23. Improve neighborhood school quality ratings by 1 category (4 categories total)	$6,592 [2,143 to 45,902]	$85,690 [27,861 to 596,724]	37% [12 to 259]
24. Improve neighborhood safety rating by 1 category (4 categories total)	$4,311 [1,231 to 44,763]	$56,041 [16,004 to 581,914]	24% [7 to 253]
25. Add a neighborhood park	$3,691 [304, 44,996]	$47,984 [3,952 to 584,994]	21% [2 to 254]
26. Reduce one-way commute by 10 minutes.	$3,252 [916 to 43,760]	$42,271 [11,913 to 568,881]	18% [5 to 247]
27. Increase ave. neighborhood income $10,000	-$729 [-841 to 43,369]	-$9,481 [-10,936 to 563,802]	-4% [-5 to 245]

A – Household inc. of $70,000; without children; 16 yrs education; white; 47 yrs old; $169,000 house.
B – 90% confidence intervals generated by bootstrapping from the original sample data.
C - Household inc. of $55,000; children; 12 yrs education; nonwhite; 40 yrs old; $150,000 house.
D - Household inc. of $85,000; children; 18 yrs education; white; 55 yrs old; $230,000 house price.

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Endotes

[1] The annualized purchase price of the house was calculated by diving the list price of the house by 13. The resulting dollar figure is approximately the annual sum of monthly mortgage payments if the home were purchased with a 10 percent down payment on a 30-year mortgage with a 7.5 percent fixed interest rate.

[2] Included in these interaction terms are attribute-attribute interactions, characteristic-characteristic interactions as well as attribute-characteristics interaction terms.

[3] Correlation of errors across observations contributed by the same respondent is possible. However, estimation of a random effects panel estimator failed to yield a significant random effects coefficient; for simplicity we report the uncorrected model only.

[4] A probit regression of non-response to the choice question implies that people considered their budget constraint while answering. Respondents who had lower household incomes and who faced housing profiles with higher prices were significantly more likely to answer that the two housing options breached their current budget constraint.

[5] For about 45% of these observations respondents answered that they preferred their current housing situation to the preferred housing conjoint profile and, hence, could be classified as being 'not in the market' for the goods being evaluated. We fail to reject the null hypothesis that the utility parameters of the 'in the market' and the 'not in the market' observations were identical using a likelihood ratio test ($\chi^2(20) = 17.06$, p-val = 0.65). Thus we continued the analysis using all 1,551 observations.

[6] The conjoint instrument phrases land area as the percent of land within one mile of the house dedicated to a specific type of use (agricultural purposes, permanent cropland). The amount of land in a circle with a one-mile radius is approximately 2,010 acres. We assume the neighborhood itself occupies an area of 126 acres (a circle of ¼ mile radius), leaving 1,884 surrounding acres not occupied by the neighborhood. Hence a one percent change in land use is roughly equivalent to 19-acre area. We suggest that per-acre figures provided in the analysis be interpreted with caution because individual respondents may have envisioned a smaller or larger neighborhood area or interpreted the absolute area associated with one mile differently.

[7] Confidence intervals are constructed by bootstrapping from the original data. Specifically, we draw (with replacement) 1,551 observations from the original data set (N=1,551), estimate the utility model and calculate the compensating variation values. This is repeated 1,000 times; the fifth and ninety-fifth percentile of the compensating variation values figures are reported.