Hedonic Price Analysis of Easement Payments in Agricultural Land Preservation Programs

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Abstract

More than 110 state and local governments have implemented agricultural land preservation programs to permanently preserve farmland. Assigning a value to the development rights to determine the cost of acquiring an easement on farm properties is difficult and can be costly. Data was collected on 409 preservation transactions from three Maryland counties and supplemented with farm-level spatial data via GIS. A hedonic price analysis is conducted to determine the marginal return to different farm characteristics using a spatial econometric model to correct for spatial correlation. Parcel characteristics such as distance to city and town, number of acres, prime soils and current land-use explain 80 percent of the variation in easement values. As expected, characteristics perform least well in explaining easement values in transfer of development right programs. This information can help formulate policy decisions and selection criteria to maximize the preservation of the agricultural economy and/or maximize public preferences. A supply curve is constructed using simulations that determine nonparticipant parcels' easement values. To preserve the remaining eligible acres in the three counties, $167 million would be needed. This method can support programs choosing to use a point system rather than the more costly and difficult-to-apply standard appraisal methods.

Hedonic Price Analysis of Easement Payments in Agricultural Land Preservation Programs

More than 110 governmental entities have implemented transfer of development rights (TDR) and purchase of development rights or purchase of agricultural conservation easements (PDR/PACE) programs to permanently preserve farmland (American Farmland Trust (AFT) 2001a, AFT 2001b, AFT 2001c).[i] The sale of development rights results in an easement on the land restricting the current and all future owners from converting the parcel to residential, commercial or industrial uses. These preservation programs can help sustain a local farm economy, provide environmental amenities such as wildlife habitat, groundwater recharge, and scenic views, and contribute to growth control efforts (Gardner 1977). Several analyses have been conducted to determine the value to society of the public goods provided by preserved lands (Bergstrom, Dillman, and Stoll 1985; Kline and Wichelns 1996). Studies have examined what the optimal number of preserved agricultural acres should be (Brunstad, Gaasland, and Vardal 1999; Lopez, Shah, and Altobello 1994). U.S. voters have passed many ballot initiatives designed to preserve parks, open space, and farmland (Land Trust Alliance 2000).

Yet, even with public support, many programs do not have sufficient resources to preserve all offered parcels. Thus, to maximize social welfare, program administrators should choose those parcels that offer the highest level of social benefits given the cost of purchasing their development rights. Like Wichelns and Kline (1993), this paper examines the cost side of the social welfare equation by analyzing the effect of the various parcel characteristics on the price paid by the preservation programs using a hedonic econometric model.

Preservation programs preserve farmland and woodland to provide sources of agricultural products, control urban expansion, and protect open-space land (Maryland Department of Agriculture (MDA) 2001). The preservation of a farm with a given set of characteristics may achieve all of these goals; however, trade-offs between the goals may be needed if farms have some, but not all, of the desired characteristics. Social welfare considerations may result in higher weights for some goals; for example, the public may value open space preservation more than provision of local agricultural products (Kline and Wichelns 1996). Providing information on the marginal contribution of the different characteristics to the easement value could help formulate policy decisions and selection criteria, which would maximize preservation of the agricultural economy and/or maximize public preferences.

The analysis serves two additional purposes. It allows a supply curve to be constructed that reflects the necessary easement price per acre to purchase future acres, allowing for better planning. Second, a hedonic model illustrates what monetary values have been attached to the previously purchased parcels' characteristics. Weibe, Tegene, and Kuhn (1996) found that standard appraisal methods are difficult to apply to the valuation of development rights as neither the future development rents nor the time of development are observed. Program administrators have proposed using a point system that assigns monetary values to different parcel characteristics rather than using the more expensive and time-consuming appraisal process. A hedonic model can provide a defense of an alternative valuation system if programs seek characteristics to maximize society's welfare different from those valued in the land market. For example, appraisal methods may discount the price for a property with wetlands, riparian buffers or other resource features that the state or local communities wish to encourage.

Given that the prices paid for development rights are often unavailable, Plantinga and Miller (2001) used the observed farmland prices and rents to value conservation easements, assuming that to elicit participation a landowner must be paid for the difference between the parcel's maximum value and the agricultural use value. However, we have data on the prices paid for development rights and parcel characteristics to directly estimate the hedonic equation.

Wichelns and Kline's 1993 study examined the appraised value of thirty-four preserved Rhode Island parcels. This paper differs from their analysis in several ways. First, the data set includes the easement prices of 409 preserved parcels. Second, the study area has different types of PDR and TDR programs. Parcels preserved under programs with different eligibility criteria and payment mechanisms may receive different values for the characteristics. For example, a PDR program with an appraisal/bidding system may pay less for prime soils than a PDR program with a characteristic-weighted point-based payment scheme. In a TDR program, the development rights are purchased by developers, not the government, and thus may be unrelated to the parcel characteristics. Third, given these parcels' proximity to one another, the data may exhibit spatial dependence. Anselin (1988) suggests that spatial autocorrelation of the errors will produce unbiased but inefficient estimates. We test and correct for spatial correlation.

Description of the Farmland Preservation Programs

Maryland has lost 50% of its farmland in the last 50 years, dropping from 4 million to 2.2 million acres. In the late 1970s, policymakers responded to the rapid conversion of farmland by instituting agricultural preservation programs. Data used are for land preserved in Howard, Carroll, and Calvert Counties in Maryland which rank among the top 13 counties in the U.S. for number of preserved acres (Bowers 2000). Howard had 18,088 preserved acres (45% of county farmland), Calvert had 14,804 acres (33%), and Carroll had 31,284 acres (18%) (United States Department of Agriculture, 1997, Bowers 2000). A description of the institutional structures of the programs which vary in both payment mechanism and eligibility criteria follow.

In 1977, Maryland established Maryland Agricultural Land Preservation Foundation (MALPF) to purchase permanent easements of farmland. MALPF sets the easement value as the lower of 1) a calculated easement value equal to an appraised fair market value minus the agricultural value and 2) a bid made by the landowner. The agricultural value is determined by a formula based on land rents and soil productivity or the county's 5-year average cash rent. If insufficient funds exist to purchase all sell offers, the parcels are ranked by the ratio of the bid to the easement value. Those parcels with the highest value per dollar are accepted first.[2] MALPF has minimum eligibility criteria: parcels must have at least 100 contiguous acres or be contiguous to another preserved parcel and must have at least 50 percent of the soil classified as USDA Class I, II or III soil or Woodland group 1 or 2.

MALPF receives approximately 14.5% of a state real estate transfer tax that is applied to all real estate transactions and 25-67% of the agricultural transfer tax to fund farmland preservation.[3] Using a county-level matching fund financed by the agricultural transfer tax, individual counties can contribute 40% of the easement cost to increase easement acres. During 1996-2000, MALPF had sufficient funds to purchase easements for 35% of the submitted bids (MDA, 2001). The competitive bidding has saved MALPF $91 million. Thus, theoretically, the State could purchase easements on 51,896 additional acres (MDA 2001). Landowners in all 3 counties can participate in MALPF. Carroll parcels are preserved primarily through the MALPF program. Between 1979-1997, MALPF paid an average price per acre of $1,961 for Calvert, $1,165 for Carroll, and $1,603 for Howard (1997$s).

Calvert began a TDR program in 1978 under which farmland owners can sell their rights to build houses to a developer, who then uses the rights in a planned growth area to increase building density. The price is negotiated by the landowner and the developer. The number and price of TDRs sold are not constrained by available program funds but by developers' demand for increased density. Eligibility criteria include a minimum of 50 acres and of 50 percent Class I, II or III soils. The average TDR price per acre is $2,517.

Started in 1978, Howard's PDR program initially used appraisals and had an average easement payment of $2,316 per acre. In 1989, the program switched to using a parcel characteristic-based point system to determine the easement value. Between 1989 and 1997, the average price increased to $6,420 per acre. Funding came from a quarter of the county's 1% real estate transfer tax levied against all Howard real estate transactions, and from three-quarters of the 5% agricultural transfer tax on all Howard farmland converted to another use. The eligibility standards are 100 acres or contiguity to another preserved parcel and at least 50% of the soil on two-thirds of the farm must be classified as Class I, II, or III.

The Model

Land ownership may be thought of as a bundle of rights, one of which is to develop the land up to the allowable zoning density. One can sell this particular right without relinquishing ownership of the land. In areas with land preservation programs, a farmland owner can extract the value of these development rights, receive a net easement payment, and continue to farm the land forever. Alternatively, the landowner can choose to exit farming at some optimal date and sell the farmland on the land market for the market price. On the demand side, program administrators evaluate whether the offered farm satisfies the eligibility requirements and determine what parcel characteristics they are able to purchase given the range of offered farms.

A hedonic model is estimated to explain the easement payments paid to the landowners whose parcels were selected for preservation by the programs, i.e., actual transactions or equilibrium points between the supply of offered farms and the demand of preservation programs. Knowing the effect of various parcel characteristics on the easement price and the trade-offs between characteristics, program administrators may be better able to select which of the farms offered to be preserved will contribute most to social welfare. The empirical form of the easement value model can be specified as

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where *E* is a vector of the natural log of the easement price paid per acre, *X* is a matrix of exogenous parcel characteristics influencing the value of development rights and ongoing agricultural rents from the land, *β* are parameters to be estimated, and *ε* is a vector of random error terms representing unobserved characteristics and is assumed to be normally distributed.[4] However, parcel characteristics that affect the easement value may be spatially correlated. If some of these characteristics are not observable, then there may be spatial dependence across error terms. Many of the preserved parcels are located near one another and would share these unobservable characteristics. If this is the case, the empirical problem becomes

, which can be estimated as

(Whittle 1954 ; Cliff and Ord 1973), where W is a spatial weight matrix, ρ is a scalar parameter to be estimated, μ is a vector of random error terms assumed to have a mean of 0 and variance-covariance matrix $\sigma^2 I$, and ε is a vector of random error terms with mean 0 and with variance-covariance matrix $\sigma^2(I-\rho W)^{-1}(I-\rho W')^{-1}$ (Bell and Bockstael 2000, Kelejian and Robinson 1993). As the distance between observations increases, the correlation between their errors is assumed to decrease. Thus, the spatial weight matrix is defined as the inverse function of the distance between observations. This distance-decay format is different from the matrix format often used, where spatial dependence is assumed to be *1* for adjacent observations with common borders, and zero for other observations (Anselin and Florax 1995). In this analysis, observations closest to the farm observation are assumed to be more highly correlated. If we set d_{ij} as the distance between parcel i and parcel j, the elements of W are defined as $w_{ij} = 1/d_{ij}$ if d_{ij}<c, and $w_{ij} = 0$ if $i=j$ or if $d_{ij}>c$; c is the distance after which no spatial correlation is expected (Bell and Bockstael, 2000). Research on Maryland land values suggests that the spatial dependence dissipates before 600 meters of distance is reached (Bell and Bockstael, 2000). Given this, and that as c becomes larger the matrix becomes less sparse, we set c=490 meters, or three-tenths of a mile.

Data

Data were collected on number of acres, year of enrollment, and price paid for the development rights for each preserved parcel from the program offices. Prices were discounted using the Index of Prices Paid by Farmers (USDA) to a base year of 1997. These data were merged with Maryland Division of Tax and Assessment data that provided tax identification codes, geographic coordinates and parcel size. Because the Maryland Department of Planning has geocoded the centroid of these parcels, we can access other geographic data. Using a Geographic Information System (ARCINFO), parcel characteristics from digitized maps were added, such as percent of prime soil,[5] distance to nearest city (Washington, D.C., or Baltimore), to nearest town, to the waterfront in Calvert, and to other preserved parcels, and current land use (pasture, row and vegetable crops, and forest). We follow the Maryland soil classification system in defining prime soils as agriculturally productive, permeable, with limited erosion potential, and with minimal slope (Maryland Department of State Planning 1973). The parcel-level data were aggregated to the farm level by weighting each parcel's characteristics by the number of acres in that parcel. Summary statistics are presented in Table 1. The spatial variables are consistent with those used in analyses of farmland values (Shi, Phipps and Colyer 1997, Nickerson and Lynch 2001, Bell and Bockstael 2000).

The dependent variable is the natural log of the easement value paid per acre. Proxies for the development value include the distance to nearest city and to nearest town in a straight line distance. The relationship between distance and easement value could be nonlinear, so a squared term of the distance variables is included. Calvert farms close to the waterfront may have a higher net return for developing the land, so distance to the waterfront is included for Calvert.

Net agricultural returns may influence the easement payment a landowner would accept. Net agricultural returns are proxied by the size of farm, the proportion of farm in agricultural uses, and the percent of prime soils. Preservation programs often have a minimum acreage requirement because large farms are perceived to contribute more to sustaining the agricultural economy. Larger parcels usually receive a lower price per acre when sold on the land market. Smaller parcels are eligible only if close to other preserved parcels as preservation programs strive to preserve contiguous blocks of farmland. Two variables for proximity are included: if the farm is within one-quarter mile of another preserved farm, and the distance to the nearest preserved farm within one-quarter mile. Several programs have eligibility criteria specifying a minimum percentage of prime soils. A higher percent of prime soil would indicate higher productivity and returns. Conversely, prime soils may increase the development value as it is often less costly to build on than lower quality soils. Land in crops, pasture, and vegetable production is expected to have a higher agricultural return than forested land.

Binary variables are included for TDR and PDR. Developers under a TDR program will seek out those farms with the lowest acceptable easement value. MALPF's bidding system, under which the landowner can discount from the calculated easement price, is expected to lower the value relative to a PDR program. Howard's change in the payment mechanism is indicated by HYEAR equaling 1 for PDR parcels purchased after 1988. Counties will have different average returns for selling development rights, county-level services, and permitted zoning densities. Because of the correlation between the county and program variables, they cannot be used in the same regression, so separate county regressions are estimated.

Estimation and Results

A general model was estimated with all 409 observations using *SpaceStat* Version 1.9 (Anselin, 1998). A separate regression model was estimated for each county. Using Chow tests, these county-level regressions are found to be significantly different from the general model. Tests for spatial dependence using a spatial weight matrix were conducted. The distance-decay spatial matrix, W, is row standardized. The Robust Lagrange Multiplier (RLM) test was used to determine spatial correlation (Anselin and Bera 1997). When the RLM test was significant, a spatial error model was estimated using the iterated Generalized Moments (GM) estimator. Due to the large sample size, the GM estimator provides statistically valid results (Bell and Bockstael, 2000). An estimate of rho, the spatial error matrix coefficient, is computed, but because a standard error is not calculated, statistical tests of its significance are not possible.

Evidence of spatial dependence was found ($RLM_{(1)}=3.562$; $RLM_{(1)}=3.036$) in the general and Carroll models. Therefore, iterated GM models were estimated for both. However, qualitatively and quantitatively the estimated coefficients did not change between the corrected and uncorrected models. Evidence of spatial correlation was not found in the other two counties.

The significance of certain variables and the overall fit varied by county (Table 2). The general model had an R^2 (Buse) of 0.796; for Carroll the R^2 (Buse) was 0.62; for Howard the R^2 was 0.87; and for Calvert 0.32. The Buse R^2 has been adapted to the error structure of the spatial error model (Anselin, 1988). These overall statistics on the explanatory power match our expectation of how different programs' payment mechanisms would operate. For example, Howard has been using a point system based on parcel characteristics to determine easement payments since 1989. Therefore, we are able to explain much of the variation in the easement prices by including the parcel characteristics as explanatory variables. Carroll landowners participate in the MALPF program, which uses a combination of appraisals and landowners' bids. Landowners might discount because they know their agricultural value is higher than the MALPF estimate or because they derive utility from owning a farm (Lynch and Lovell 2001). These results suggest that while more than half of the value is explained based on observable parcel characteristics some of the explanation is due to landowner's bidding behavior. On the other hand, 80% of Calvert's parcels have been preserved in a TDR program. Developers are uninterested in a parcel's characteristics when negotiating a deal, therefore less of the easement price is explained by characteristics data.

In the general model, we explain 80% of the variation in the easement value using the included characteristics. Yet the specific programs reward characteristics differently in the county-level regressions, as might be expected by the difference in institutional mechanisms. However, many of the estimated coefficients on these characteristics were not significant. We attribute this to multicollinearity and lack of variance for certain variables within the counties.

Consistently in all the regression models, the estimated coefficients on the distance to city variable suggest that the closer the parcel is to the nearest city, the higher the easement value. For the general model, this effect dissipated 45.4 miles out from the nearest city. The easement price will be 1.28% lower if the parcel selected is 1% farther away from the city (Table 3). In Calvert, the closer a parcel is to the city, the higher its easement value up to 37 miles; in Howard, proximity increases easement values up to 18.5 miles. The easement price in Calvert will be 7.1% higher if the parcel is 1% closer to the city; the easement price in Carroll will be almost 1% higher; and in Howard, 1.8% higher. Distance to city was entered into the Carroll model linearly. This variable was correlated (ρ=-0.47) with prime soils; thus, distance squared is not included.

Unexpectedly, the coefficient on distance to town was positive. The closer the parcel is to the nearest town up to 4.4 miles away, the lower the easement price paid. However, the estimated coefficients on distance to town in each of the county-level models are not significant.

In the Calvert model, the closer the parcel is to the waterfront, the higher the easement payment. Wichelns and Kline (1993) found a similar relationship using view of water.

The negative coefficient on parcel acres indicates that larger parcels receive lower easement payments per acre. As acreage increased by 1%, the easement value decreased by 0.059%. This result held in Calvert: a 1% increase in acreage decreased the easement price by 0.12%; and in Carroll by 0.16%. Acreage did not affect the easement value of Howard parcels.

Parcels with a higher percentage of prime soil command a significantly higher easement value in the general model but this variable was not significant in any of the county-level models. A 1% increase in prime soils resulted in a 0.07% increase in easement price in general. Program administrators pay more for higher agricultural productivity, as measured by soil type. However, within a county, the soil quality between parcels is not sufficiently different to elicit significant coefficients on this variable in the county-level regressions. Between counties, there is variation. Calvert averages 43% prime soils per parcel, Carroll averages 39%, and Howard, 82%.

Conversely, the higher the percentage of agricultural use in a parcel, the lower the easement value. As agricultural use increased 1%, the easement value decreased 0.19%. This suggests that the goal of providing agricultural products may not be a priority of program administrators, but rather the provision of open spaces. Again, in the county-level regressions, the coefficients were not statistically significant. The level of agricultural use may not have varied as much within a county as between counties. The percent of agricultural use was higher in Carroll (85%) and Howard (75%) than in Calvert (38%).

Both TDR and PDR programs paid higher prices than MALPF in the general model. This is consistent with the previously stated belief about the PDR programs, but contradicts the prior assumption about the TDR program. Developers may not be finding the least expensive TDR or may be offering higher easement prices to elicit more landowners to sell. Alternatively, MALPF participants may be highly discounting their bids to enroll their land. Howard paid higher easement values in its PDR program when it switched the method used to determine the easement values. The county-level regressions had the same results on program variables.

Simulations

Simulations were performed with the nonparticipant parcels to make comparisons.[6] To ensure eligibility criteria were met, only those parcels that exceeded the minimum size requirements of 100 acres for the MALPF and PDR programs and 50 acres for the TDR programs were included. Parcels with fewer acres were included if they were located within one-eighth of a mile to another preserved parcel. For Howard, the predicted price is for enrollment after 1989. A predicted easement price was calculated based on each eligible parcel's characteristics and the county-level estimated coefficients.

In Carroll, 44 parcels are eligible for MALPF, with an average price per acre of $1,302. In Howard, 22 nonparticipant parcels are eligible. The highest paying program is the Howard PDR program, with an average price of $7,327. In Calvert, 71 nonparticipant parcels are eligible for the higher paying TDR program, with an average price of $2,453.

Carroll participants received $1,200 per acre for 100-acre parcels but closer to $900 per acre for parcels greater than 400 acres. Nonparticipants with 100-acre parcels were predicted to receive an average of $1,400 per acre. As nonparticipant parcels increased in size, the predicted prices aligned more closely to those paid to participants. Nonparticipant parcels may receive higher prices due to other characteristics, such as being closer to the city (28.8 miles compared to the 32 miles of participants parcels) and having a slightly higher average percent of prime soils (43% compared to 39%).

In Howard, recent participants 10 miles from the nearest city were paid almost $7,000 per acre, whereas nonparticipants would have commanded $7,600 per acre. As distance from the city increases, these prices coincide at 19 miles as the effect of distance dissipates. Nonparticipant parcels have a higher number of acres on average (150 acres compared to participants' 116 acres), have a slightly higher average percent of prime soils (86% percent compared to 82%), and are closer to the city (14.7 miles compared to 17.9 miles for participants). The results suggest that had nonparticipants volunteered their parcels to the preservation programs they may not have been enrolled due to the higher cost of purchasing their easements.

The supply curve of future parcels was developed using the predicted easement values. We extrapolated from the simulated results on the eligible parcels up to the expected number of unpreserved eligible acres at the county level.[7] Howard's expansion factor is 2.66. This expansion factor suggests that 8,802 agricultural acres out of the remaining 22,000 agricultural acres could be preserved given the current eligibility requirements. For Carroll, the expansion factor is 4.84 (29,794 more acres), and for Calvert, 3.53 (27,077 more acres). Figure 1 shows these supply curves. Howard parcels are the most expensive. To increase enrollment by 5,000 acres, Howard will have to pay almost $7,000 per acre. Another 3,802 acres are even more costly, possibly because they are closer to the city. The total cost of preserving these 8,802 acres is estimated to be $65,766,099. Calvert has a similar pattern, with the first 5,000 acres at $2,000 per acre (the average easement value paid to participants is $2,403). Calvert's nonparticipants are farther from the waterfront (1.67 miles compared to .94 miles for participants) and are larger (108 acres compared to 97 acres), which may explain the initial lower easement value. Easement values increase to $2,400 for another 10,000 acres. The total cost of preserving 27,077 more acres in Calvert is $63,352,607. Carroll can preserve another 5,000 acres for $1,000 per acre, then preserve 15,000 more acres for approximately $1,500 per acre. The total cost of preserving 29,794 acres would be $37,992,295. If preserving the maximum acres is a goal of the state, targeting farmland in Carroll rather than Howard or Calvert would be the optimal strategy.

Conclusions

Information on the marginal contribution of the different characteristics to the easement value are provided to help formulate policy decisions and selection criteria to maximize the preservation of the agricultural economy and/or maximize public preferences. Using spatially explicit data, hedonic models corrected for spatial correlation were estimated for three Maryland counties. Overall, our models of easement prices in the three counties performed well. While spatial correlation was identified as a problem in two of the estimated models, Carroll and the general model, the estimated coefficients did not change dramatically either qualitatively or quantitatively between the corrected and uncorrected models. Thus while spatial correlation limited the efficiency in these two models, an uncorrected model would have similar results.

Distance to city was a major factor in determining the easement value, similar to the results of Wichelns and Kline (1993) and Plantinga and Miller (2001). Farmland farther from a city receives a lower easement price. Therefore, if program administrators wanted to maximize the number of acres for the provision of agricultural products, they could buy land farther away. However, this land is less likely to be threatened by development, i.e., no one wishes to convert it to a non-agricultural use in the immediate future. This strategy would therefore not fulfill the goal of controlling urban sprawl. In addition, if providing openspace for the general public is an important goal, the state and counties may want to preserve farms closer to urban areas, where more people could benefit.

Similar to Wichelns and Kline (1993), we found that the easement price declines with size; purchasing development rights on larger parcels will be less expensive than purchasing rights on an equal number of acres on smaller farms. Parcels with a high percentage of prime soil received a premium. This characteristic makes the land more desirable for agricultural use, and for residential or commercial use. Parcels with a high percentage of agriculture use received lower easement prices. MALPF explicitly subtracts out the agricultural value; therefore, the model may be reflecting that these parcels receive a lower payment because the difference between their fair market value and the capitalized agricultural returns is lower. Or the model could be demonstrating that the provision of agricultural products is not a priority for these programs. Lynch and Musser (2001) found that in Calvert and Howard counties the percent of cropland was not as important a constraint to program administrators as parcel acres and prime soils, so that even if the parcel had a lower percentage of cropland it would still be selected for preservation. In Carroll, however, it was a binding characteristic in three-quarters of the selected parcels. Administrators will need to consider these quality and cost tradeoffs between the different attributes of a parcel when deciding if an easement should be purchased.

TDR and PDR county-level programs paid more per acre than the state MALPF program in the individual counties. In Calvert, given that 80% of the preserved parcels enrolled under the TDR program, parcel characteristics explained less of the variation in the easement value (32%). On most parcel characteristics, nonparticipants and participants were similar except that Calvert nonparticipants were farther from the waterfront and had more acres per parcel. The TDR program can pay a higher price than an appraisal/bidding program (MALPF), but the price appears to have little relationship to the parcel's contribution to the program's stated goals. The PDR program paid a higher price than the MALPF program in Howard and explicitly considered parcel characteristics. The parcel characteristics explained 87% of the variation in easement values. Although appraisals were made for all MALPF parcels, the bidding system also affects the price, and only 62% of the variation in prices could be explained in the Carroll regression.

These results can be used in models along with measures of amenity benefits to determine the optimal number of acres and the most cost-effective location to target (Brunstad, Gaasland, and Vardal 1999; Lopez, Shah, and Altobello 1994). Targeting of limited resources is an important consideration. More acres could be preserved in Carroll for the same dollars than in Howard. Contiguity was not highly valued according to these regressions but could be given more priority. Thus, if maximizing the number of acres and contiguity is desired, targeting resources to a particular region may be the best strategy. Conversely, for political goodwill, administrators may need to select parcels from different regions of the state and closer to cities.

MALPF's funding, the counties' matching preservation funds, and the Howard PDR program are funded at least in part by the continued conversion of farmland to other uses. The agricultural transfer tax is generated when farmland leaves an agricultural use for a residential, commercial or industrial use. Through simple calculations, one can determine that to preserve one acre of land at the average easement price per county using the agricultural transfer tax as the sole funding mechanism, in Calvert $64,080 worth of farmland would have to be converted, in Carroll $31,067 worth, and in Howard $124,933. Using the 1997 value of land and buildings per acre of $3,584 in Calvert, $3,694 in Carroll, and $5,518 in Howard (United States Department of Agriculture, 1997), we find that the conversion of almost 17.9 farmland acres in Calvert, 8.4 acres in Carroll, and 22.6 acres in Howard would be needed to finance the preservation of one acre. The actual sale prices may be higher than the Agricultural Census value though. For example, Nickerson and Lynch (2001) found that the average arm's-length sales price of unpreserved farmland sold between 1990 and 1997 in these three counties was $8,998 per acre. However, even at this price, the conversion of 7.1 acres in Calvert, 3.5 acres in Carroll, and 13.9 acres in Howard would be needed to finance the preservation of one acre. Given that the total cost to preserve the additional acres was computed as $66 million for Howard, $63 million for Calvert, and $38 million for Carroll, additional funding sources will be needed if farmland preservation programs are to be successful. Society could determine that the preservation of these additional acres would not provide $167 million worth of amenities.

Program administrators can use these results to determine if point-based systems are a better approach to easement determination. Using hedonic models to determine the marginal value of certain land characteristics can also benefit other programs, especially those wishing to avoid costly appraisals for each parcel. Programs also may need to adjust the payments and/or eligibility requirements to encourage participation by a larger number of the remaining unpreserved farms. These programs have evaluated their progress and have made some adjustments. For example, Calvert has determined that if it does not preserve farmland close to Washington, D.C., today, this land will become part of urban sprawl. Therefore the county decided to pay a premium for farmland nearer the city. Similarly, MALPF has decided to reduce its acreage requirement to 50 acres to attract more participants.

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Table 1. Descriptive Statistics for Characteristics of Participants by County

	Total (N=409)		Calvert (N=92)		Carroll (N=179)		Howard (N=138)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Price per acre	$2,631	2,162	$2,403	813	$1,165	616	$4,685	2,427
Log of price	7.57	0.79	7.72	0.36	6.94	0.49	8.27	0.65
Distance to city (miles)	28.14	8.91	35.62	6.12	32.17	5.05	17.94	3.82
Distance to town (miles)	3.22	1.52	3.74	1.85	3.28	1.35	2.78	1.35
Distance to nearest preserved parcel (miles)	0.06	0.04	0.07	0.05	0.07	0.04	0.06	0.03
Preserved parcel within 1/4 mile	29%	0.45	33%	0.47	23%	0.42	34%	0.48
Distance to preserved parcel within 1/4 mile (miles)	0.05	0.09	0.06	0.09	0.04	0.08	0.06	0.09
Distance of Calvert parcels to waterfront (miles)	0.21	0.54	0.94	0.78				
Size of farm (acres)	118.18	79.23	97.38	75.86	130.01	69.68	116.49	89.92
Percent prime soils	54%	0.37	43%	0.30	39%	0.35	82%	0.26
Percent agricultural land	71%	0.27	38%	0.30	85%	0.14	75%	0.19
Percent forest	24%	0.27	55%	0.33	11%	0.12	20%	0.17
MALPF	54%	0.50	20%	0.40	100%	0	18%	0.39
TDR	18%	0.39	80%	0.40	0	0	0	0
PDR	28%	0.45	0	0	0	0	82%	0.39
Howard	34%	0.47						
Carroll	44%	0.50						
Calvert	23%	0.42						
Howard parcels that sold 1989 or later	21%	0.40					61%	0.49
Average Year of sale	1988	5	1990	5	1987	5	1989	4

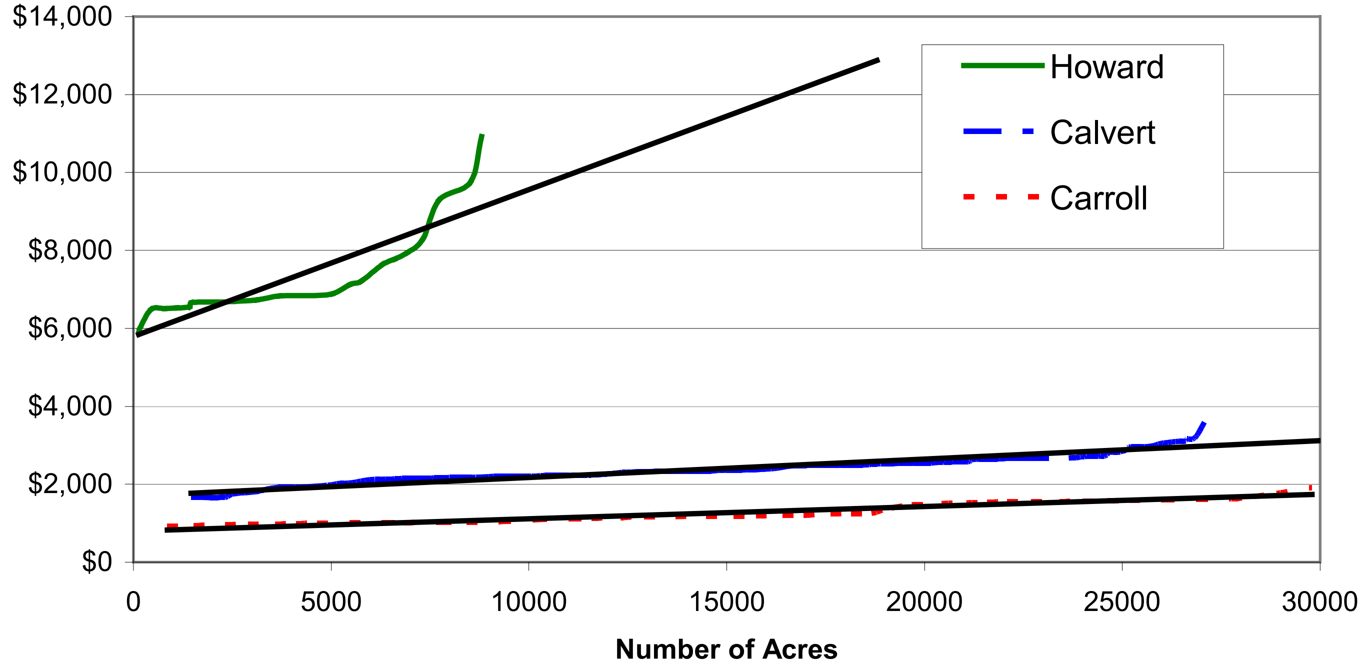
Table 2: Regression Results

	Total (Spatial Error Correction)		**Calvert**		**Carroll (Spatial Error Correction)**		**Howard**	
	Coefficient	ASE	Coefficient	ASE	Coefficient	ASE	Coefficient	ASE
Constant	7.9600 ***	0.29	11.4200 ***	1.85	7.7700 ***	0.43	8.0700 ***	0.49
Distance to city	-0.0454 ***	0.02	-0.1996 ***	0.10	-0.0306 ***	0.008	-0.0996 **	0.05
Distance to city squared	0.0005 **	0.0003	0.0027 ***	0.0014			0.0027 **	0.002
Distance to town	0.1046 ***	0.05	0.1263	0.09	0.1593	0.10	-0.0258	0.07
Distance to town squared	-0.0119 **	0.006	-0.0233 ***	0.01	-0.0176	0.01	0.0057	0.01
Total acres in the parcel	-0.0005 ***	0.0003	-0.0012 ***	0.0005	-0.0012 ***	0.0005	0.0004	0.0003
Distance of Calvert parcels to waterfront	0.0274	0.05	-0.0998 ***	0.05				
Preserved parcel within 1/4 mile	0.1538	0.12	0.1618	0.24	0.2233	0.21	-0.0627	0.11
Distance to preserved parcel within 1/4 mile	-1.1522 **	0.62	-1.6849	1.24	-1.2649	1.10	0.0048	0.59
Percent prime soils	0.1300 **	0.07	-0.0002	0.13	0.0100	0.11	0.1300	0.11
Percent agricultural land	-0.2600 ***	0.1	-0.1500	0.13	-0.0050	0.26	0.0600	0.13
TDR	0.6500 ***	0.08	0.2100 ***	0.09				
PDR	0.3300 ***	0.1					0.3500 ***	0.07
HYEAR- sold 1989 or later	1.1000 ***	0.09					1.0600 ***	0.06
Rho	0.1350				0.1800			
R2 or R2 (Buse)	0.7960		0.3150		0.6200		0.8690	
Robust LM test	3.562		0.1610		3.036		1.0800	
Probability for LM test	.06		0.6900		.08		0.3000	

Table 3. Elasticities from Estimated Models by County

	Total (Corrected)	Calvert (Uncorrected)	Carroll (Corrected)	Howard (Uncorrected)
	Elasticity	Elasticity	Elasticity	Elasticity
Distance to city	-1.277	-7.105	-0.9842	-1.789
Distance to town	0.3367	0.4726	0.5227	-0.0715
Total acres in the parcel	-0.0590	-0.1168	-0.1560	0.0464
Distance of Calvert parcels to waterfront	0.0058	-0.0942		
Distance to preserved parcel within 1/4 mile	-0.0573	-0.1047	-0.0550	0.0003
Percent prime soils	0.0707	-0.0001	0.0039	0.1062
Percent agricultural land	-0.1851	-0.0569	-0.0043	0.0450

Figure 1. Easement Values per Acre to Enroll Additional Acres into the Programs by County



Footnotes

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i. Although there are 50 TDR programs, 22 of them have not protected any farmland.

2. In 2000, the Maryland General Assembly passed legislation to give counties an option to utilize MALPF's existing way of ranking properties for easement sale through the competitive bidding process OR create a county prioritization method for MALPF to use when making easement offers. This proposed change would help to preserve the "better quality" farms over marginal land. Counties could make the "best" farms a priority, given the limited funds. They could also rank land close to other preserved land higher than those parcels farther apart in order to obtain large blocks.

3. When farmland is converted to another use, an agricultural land transfer tax of between 3-5 percent is applied. This tax provided $2.6 million to MALPF and $8 million to counties for farmland preservation in fiscal year 2000. Counties with a certified farmland preservation program receive three-quarters of the agricultural land transfer tax on county parcels. Other counties receive one-third.

4. The trans-log specification was selected because the easement price data have a skewed distribution, with the median per acre price ($1874) less than the mean per acre price ($2631) (Berndt, 1991). A Box-Cox model was also used to determine the validity of a logged dependent variable, logged independent variables, or a double-log model, against an unrestricted Box-Cox transformation or a linear version. The results indicated that a logged dependent variable model was preferred.

5. Maryland soils are categorized around six characteristics: agricultural productivity, erosion susceptibility, permeability, depth to bedrock, depth to watertable, and stability as well as their slope. We follow the Maryland classification system in defining prime soils as agriculturally productive, permeable, with limited erosion potential, and with minimal slope.

6. Nonparticipant observations were obtained from a sample of farmland owners from a 1999 survey in these counties (Lynch and Lovell, 2001).

7. We have the number of nonparticipant agricultural parcels in each county from the Maryland Tax and Assessment database. We calculated the expansion factor used as the inverse of the number of nonparticipant parcels eligible in the drawn sample divided by the number of eligible nonparticipant parcels in the county. The number eligible in the county equals the number of nonparticipant parcels eligible for the survey divided by the number of nonparticipant parcels actually surveyed, multiplied by the number of nonparticipant parcels in the county. In Howard, for example, 273 nonparticipant landowners were surveyed out of 727 nonparticipants. Of these 273 nonparticipants, 22 parcels met the eligibility requirements. The expansion factor is therefore the inverse of 22/{(22/273)*727}, or 2.66.