Hedonic Price Analysis of Easement Payments in Agricultural Land Preservation Programs

by

Lori Lynch and Sabrina J. Lovell

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Lori Lynch and Sabrina J. Lovell

Department of Agricultural and Resource Economics
2200 Symons Hall
University of Maryland
College Park, Maryland 20742
(301) 405-1264
(301) 314-9091 (fax)
llynch@arec.umd.edu

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Abstract

More than 110 state, county, and local governments have implemented agricultural land preservation programs to permanently preserve farmland. Assigning a value to the development is difficult and can be costly. Data was collected on 409 preservation transactions from 3 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 eighty 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 non-participant parcels' easement values. To preserve the remaining eligible acres in these 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).[1] Whether through a TDR or PDR/PACE program, the sale of the development rights results in an easement attached to the title of 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 rural and scenic views, and contribute to growth control efforts (Bromley and Hodge 1990; Fischel 1985; Gardner 1977; McConnell 1989; Wolfram 1981). Contingent valuation analyses have been conducted to determine the value to society of the public goods provided by preserved lands (Pruckner 1995; Drake 1992; Beasly, Workman, and Williams 1986; Bergstrom, Dillman, and Stoll 1985; Halstead 1984). Several studies have examined what the optimal number of preserved agricultural acres should be (Brunstad, Gaasland, and Vardal 1999; Lopez, Shah, and Altobello 1994; McConnell 1989). According to Land Trust Alliance data, U.S. voters have passed numerous ballot initiatives designed to preserve parks, open space, farmland, and other amenities: in 2000, $7.4 billion in conservation funding was authorized; in 1999, $1.8 billion; and in 1998, $8.3 billion.

Yet, even with elevated funding levels, many of these programs do not have sufficient resources to preserve all the parcels that landowners would like to enroll or that the general public may wish protected. 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. Both social benefits and the cost of development rights for a particular parcel will depend on its characteristics. 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 agricultural land and woodland to provide sources of agricultural products, control urban expansion, and protect open-space land (Maryland Agricultural Land Preservation Foundation, 2001). Lynch and Musser (2001) translated these goals to maximizing the number of acres preserved; preserving productive farms (large farms, prime soils, crop use); preserving contiguous farms (large blocks of land); and preserving farms most threatened by development (close to the city or town). The preservation of a farm with a given set of characteristics may achieve all of these goals; however, program administrators may have to make trade-offs between the goals 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 cost could help formulate policy decisions and selection criteria, which would maximize preservation of the agricultural economy and/or maximize public preferences. For example, appraisal methods may discount the price for a property with wetlands, riparian buffers or other resource features. Yet the state or local communities might wish to encourage enrollment of land with these attributes and thus include a positive weighting mechanism for them.

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 assuming the underlying conditions remain the same, and thus allows 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 expend limited program dollars and time using the more expensive and difficult appraisal process. These point systems need to be justified to county commissioners and state authorizing authorities, such as the Maryland Board of Public Works. In addition, 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.

Given that the prices paid for development rights are often unavailable, Plantinga and Miller (2001) used the observed agricultural land 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 value in agricultural use. However, given that we do have information on the prices paid for development rights and parcel characteristics, we can 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, we have a larger data set including the easement prices of 409 preserved parcels. Second, the State and urbanizing Maryland counties have established different types of PDR and TDR programs that preserve agricultural parcels

(Lynch and Horowitz, 1998). Therefore, we determine whether parcels preserved under different programs with different eligibility criteria and payment mechanisms receive different values for the included characteristics. For example, a PDR program with minimum eligibility requirements and an appraisal/bidding system may pay less per acre for larger parcels and prime soils than a PDR program with a characteristic-weighted point-based payment scheme. In addition, the price paid for development rights in a TDR program, under which development rights are purchased by developers rather than a government entity, may be unrelated to the parcel characteristics. Third, given these parcels' proximity to one another and the spatial nature of the problem, the data may exhibit spatial dependence. Anselin (1988a) suggests that spatial autocorrelation of the errors will produce unbiased but inefficient estimates. We test and correct for the spatial correlation problem.

Description of the Agricultural Land Preservation Programs

Maryland like other Northeast states has lost almost half of its farmland in the last 50 years, dropping from 4 million to 2.2 million acres. In the late 1970's, state and county governments responded to the rapidly converting agricultural land by instituting agricultural preservation programs. Data used in this study include land preserved by voluntary state and county programs in Howard, Carroll, and Calvert Counties in Maryland. Howard, Carroll and Calvert rank among the top 13 counties in the U.S. for the number of preserved acreage (Bowers 2000). Calvert County has both a TDR and a pseudo-PDR program, Howard County relies primarily on a PDR program, and Carroll County relies on the State PDR program, the Maryland Agricultural Land Preservation Foundation (MALPF). The institutional structures of the programs vary in both payment mechanism and eligibility criteria. The number of acres preserved by state and county programs are reported in Table 1.

Howard had 18,088 preserved acres, Calvert had 14,804 acres, and Carroll had 31,284 acres. Preserved acres were 45%, 33%, and 18% of 1997 farmland in the county, respectively (United States Department of Agriculture, 1997, Bowers 2000). Characteristics of the individual programs are described below.

Maryland Agricultural Land Preservation Program

In 1977, Maryland established MALPF to purchase permanent easements of farmland that prohibit residential, commercial and industrial uses for current and all future owners. 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 agricultural land preservation.[2] Using a county-level matching fund, individual counties can contribute 40% of the easement cost to increase the number of its acres preserved. These local county-level funds are financed by the portion of the agricultural transfer tax each county receives, which in turn depends on how much agricultural land is being converted in that county. The total amount spent in FY 1999 is estimated to have been $43.96 per capita (AFT 2001).

MALPF sets the value of the easements 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 5-year average cash rent in the parcel's county. If insufficient funds exist to purchase all offers to sell easements made in a year, 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.[3] In addition, MALPF has set 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. Landowners in all three counties can participate in MALPF.

During 1996-2000, MALPF received 1,347 applications from landowners. MALPF had sufficient funds to purchase 469 easements, or 35% of the submitted bids (MALPF, 2001). Total expenditures including the county matching funds were $102.5 million. The state program had purchased easements on more than 185,871 acres statewide by June 2000 at a cost of $232.8 million (Chesapeake Bay Commission 2001, AFT 2001b). MALPF claims to have saved $91 million as a result of the competitive bidding which results in a discounting of easement payments. This theoretically allowed the State to purchase easements on 51,896 additional acres (Maryland Department of Agriculture 2001). Between 1979-1997, the average price per acre under the MALPF program was $1,961 for Calvert, $1,165 for Carroll and $1,603 for Howard County (1997 $s).

Carroll County parcels are preserved primarily through the MALPF program. Carroll receives three-quarters of the tax revenue from the 5% agricultural transfer tax on the purchase price of all Carroll farmland converted to another use. It uses this money to cost-share the purchase of development rights with MALPF.

County Programs

Calvert County began a TDR program in 1978. Under this program, farmland owners can sell their rights to build houses to a developer, who then uses the rights in a "receiving" area to increase building density where growth is planned. The price is determined through negotiations between the landowner and the developer. Since landowners sell the TDRs directly to development firms, 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. Calvert has also instituted a PDR program called the Purchase and Retirement (PAR) Fund to purchase TDRs. If developers' demand is low, landowners may sell TDRs to the county government under PAR until program funds are exhausted. Development rights purchased by PAR are not used to increase density elsewhere but are retired. The price paid in the PAR program is based on the average TDR market price. Given that the price paid was determined by the TDR program, we included the parcels sold to the county as TDR parcels.[4] The average TDR price per acre is $2,517. PAR is financed with three-quarters of the 5% agricultural transfer tax on the purchase price of all Calvert farmland converted to another use.

Started in 1978, Howard County's PDR program is funded with a quarter of the county's 1% real estate transfer tax levied against all Howard real estate transactions, and with three-quarters of the 5% agricultural transfer tax on all Howard farmland converted to another use. The average price per acre since 1978 for the PDR program was $5,366. This program initially used appraisals to determine the easement price. During this period, the average easement payment was $2,316 per acre. However, in 1989 the program switched to using a point system based on parcel characteristics to determine the easement value. Between 1989 to 1997, the average price increased to $6,420 per acre. The county leverages the available funds using an installment plan, under which commitments of $55 million were made by 1997. Under the installment plan, the farmland owner receives a county bond that pays tax-exempt interest payments twice a year, with a balloon payment of the principal in year 30. These bonds can be liquidated at any time. The county's 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. As funds for the PDR program are limited, the County has also introduced a modified TDR program, the Density Exchange Option Program, but given the limited enrollment at the time when data for this analysis were compiled (404 acres), this program is not included in the analysis. Recently, Howard County passed a bond initiative of $15 million which should purchase the development rights on 2,500 acres (Bowers 2000). It also has raised its per-acre easement cap from $6600 to $7200.

Other Programs

Maryland has introduced other programs to preserve agricultural lands and woodlands. In 1997, the Rural Legacy Program was started as part of the Smart Growth and Neighborhood Conservation Initiative, with a goal of preserving 200,000 acres by 2011. This program strives to preserve large, contiguous blocks of farmland. Land trusts, county governments and other groups submit applications to preserve land in their areas. This program is funded through bonds, general funds and Program Open Space funds. The program so far has spent $8.2 million to preserve 2,141 acres with easements and buy 510 acres outright (Chesapeake Bay Commission 2001). Given the recent nature of the easement purchases, this program's parcels are not included in the analysis.

Carroll County has begun a Critical Farms Program to help young farmers purchase land by providing cash now for potential easements later. This program purchases an option, at 75 percent of the easement price, which provides the new owners with cash until the MALPF program purchases the easement. If within 5 years MALPF has not purchased an easement, the landowner can buy back the County's option or have a County easement placed on the land for the amount already paid.

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. The sale of development rights liquidates part of the land asset. In areas with land preservation programs, an agricultural land 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 for a net payment from the land market. On the demand side, program administrators evaluate whether the offered farm satisfies the eligibility requirements and determine what type of parcel characteristics they are able to purchase for the range of offered farms given the easement cost.

A hedonic model is estimated to explain the easement payments paid to the landowners who were selected to preserved their parcels by the programs, i.e. actual transactions or equilibrium points between the supply of offered farms and the demand of preservation programs. With information about the influence 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 the most to social welfare. The empirical form of the easement value model can be specified as

1. $E = Xb + e$,

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, $ß$ are parameters to be estimated, and g is a vector of random error terms representing

unobserved characteristics and is assumed to be normally distributed.[5] 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

2a. $E = Xb + e$
$e = rWe + m$, which can be estimated as

2b. $E = Xb + (I - rW)^{-1}m$

(Whittle 1954 ; Cliff and Ord 1973), where W is a spatial weight matrix, ? 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 s^2I, and ɡ is a vector of random error terms with mean 0 and with variance-covariance matrix $s^2(I-?W)^{-1}(I-?W')^{-1}$ (Bell and Bockstael 2000, Kelejian and Robinson 1993). As the distance between observations increases, the correlation between their errors is assumed to decrease. Thus, we define our spatial weight matrix to be the inverse function of the distance between observations or a distance decay format. A distance-decay matrix is different from the format often used in the spatial literature, where spatial dependence is assumed to be *1* for adjacent observations such as those with common borders, and zero for other observations (see Anselin and Florax (1995) for a review). A distance-decay form of the spatial weight matrix assumes that those observations closest to the farm observation

are more highly correlated than those observations further away. If we set d_{ij} as the distance between parcel i and parcel j, the elements of W for the inverse distance matrix are defined as $w_{ij} = 1/d_{ij}$ if d_{ij}<c, and $w_{ij} = 0$ if $i=j$ or if $d_{ij}>c$, where 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 result, 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 parcel in the state and county programs 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 and geographic coordinates as well as data on parcel size and location. The Maryland Department of Planning has geocoded the centroid of these land parcels which permits us to access other geographic data. Using a Geographic Information System (ARCINFO), parcel characteristics from digitized maps were added, such as percent of prime soil,[6] distance to nearest metropolitan area (Washington, D.C., or Baltimore), to nearest town, to the waterfront (Chesapeake Bay or Patuxent River) in Calvert County, and to other preserved parcels, and current land use (pasture, row crops, 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 for the data are presented in Table 2. The spatial variables are consistent with those used in previous analyses of farmland values, which included proxies for agricultural and development values that may impact easement values (Bell and Bockstael 2000; Nickerson and Lynch 2001; Shi, Phipps and Colyer 1997).

The dependent variable is the natural log of the easement value paid per acre in 1997 dollars. Proxies for the development value and timing include the distance to nearest city (Washington, D.C., or Baltimore) and the distance to nearest town in a straight line distance. Farms that are closer to the city and its employment opportunities and to the nearest town are expected to receive higher easement payments. This relationship between distance and easement value could be nonlinear. For example, if the parcel is within 50 miles of Baltimore, the city may have a greater influence on the development potential than if the parcel is more than 50 miles away. Therefore, a squared term of distance to the nearest city and nearest town is included to allow for this possibility. Calvert County farms close to the waterfront may have a higher net return for developing the land, which increases the easement value. Therefore, distance to the Chesapeake Bay or major tributary for Calvert farms is included in the analysis.

Net agricultural returns may influence the easement payment a landowner would accept. Therefore, net agricultural returns are proxied by the size of farm, the proportion of farm in agricultural uses, and the percent of prime soils. Land preservation programs often have a minimum acreage requirement because large farms are perceived to contribute more to sustaining the agricultural economy than small farms. Larger parcels usually receive a lower price per acre when sold on the land market. Thus, larger farms are expected to receive a lower per acre easement payment. For smaller

parcels, eligibility for the program may depend on proximity or contiguity to other preserved parcels. Preservation programs prefer farms next to other preserved farms to ensure the existence of large contiguous blocks of farmland. Two variables for proximity are included: a binary variable equal to 1 if the farm is within one-quarter mile of another preserved farm, and a continuous variable equal to the distance to the nearest preserved farm within one-quarter mile. Farms closer to preserved farms are expected to receive a premium for this characteristic.

GIS-computed variables for the percent of prime soils and the percent of land in crops, pasture and vegetables on the farm were included as proxies for agricultural returns. As mentioned above, the Maryland soil classification system is followed in defining prime soil as having high agricultural productivity, good drainage, and little or no slope. Several of the programs have minimum eligibility criteria specifying a certain percentage of prime soils. A higher percentage of prime soil would indicate higher productivity, thus higher net agricultural returns. Therefore, a landowner with a higher percent of prime soils may accept a lower easement payment since the ongoing agricultural returns are expected to be higher. Conversely, prime soils may increase the development value of the farm since it is often the less costly to build on than lower quality soils. The preservation programs strive to enroll these productive farms and may be willing to pay a higher premium for them.

The amount of land in crop land, pasture, and vegetable production is expected to have a higher agricultural return than forested land. Thus the ongoing agricultural return will be higher. However, the cost of removing trees to convert land may make it less desirable to developer than land in other uses, which may decrease the market value and thus the required easement payment to enroll forested land.

Binary variables are included for the TDR and PDR programs, with MALPF being the excluded category. As mentioned above, prices in the TDR programs are determined through negotiation between landowners and developers. Developers will seek out those farms with the lowest acceptable easement value. However, competition among developers for the easements may bid up the prices relative to the MALPF program. Because the MALPF program uses a bidding system under which the landowner can discount from the calculated easement price and the PDR program does not have this feature, the PDR price is expected to be higher. Binary county variables for Calvert and Howard counties account for differences in the average returns landowners expect to receive for selling development rights, county-level services, permitted zoning densities, and preservation programs. Because of the collinearity between the county and program variables, they cannot be used in the same regression. Separate county-level regressions are estimated. We also created a variable for Howard County parcels indicating the enrollment year because of the change in the payment mechanism in 1989. "Hyear" equals 0 for PDR parcels purchased before 1989 in Howard County and 1 otherwise.

Estimation and Results

A general model was estimated with all 409 observations using *SpaceStat* Version 1.9 (Anselin, 1995, 1998). A separate regression model was estimated for each county. Using Chow tests, we found that these county-level regressions were significantly different from the general model. Tests for spatial dependence using a spatial weight matrix were conducted. The spatial matrix contains the inverse distance between parcel *i* to parcel *j* if they were less than three-tenths of a mile apart. The matrix is row standardized. The Robust Lagrange Multiplier (LM) test was used to determine spatial correlation (for reviews, see Anselin 1988a, Anselin and Bera 1997). When the LM test was

significant, a spatial error model was estimated using the iterated Generalized Moments (GM) estimator rather than the maximum-likelihood estimator. Due to the large sample size, the GM estimator provides statistically valid results (Bell and Bockstael, 2000). An estimate of rho, the coefficient on the spatial error matrix, is computed, but because a standard error is not calculated, statistical tests of its significance are not possible.

In both the general model and the Carroll County model, evidence of spatial dependence was found (*Robust* $LM_{(1)}=3.562$; *Robust* $LM_{(1)}=3.036$). Therefore iterated GM models were estimated for both. While spatial correlation was identified as a problem in these two models, qualitatively and quantitatively the estimated coefficients did not change dramatically between the corrected and uncorrected models. In neither the Howard or Calvert models was evidence of spatial correlation found.

The significance of certain variables, the overall fit, and the evidence of spatial correlation varied by county (Table 3). The general model had an R^2 (Buse) of 0.796. The Buse R^2 has been adapted to the error structure of the spatial error model (Anselin, 1988a). For Carroll, the R^2 (Buse) was 0.62, for Howard, the R^2 was 0.87, and for Calvert, 0.32. 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, it is not surprising that 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 (PDR) program, which uses a combination of appraisals and landowners' bids to determine the easement value. Given that the appraisal sets the upper bound on the easement

value but that landowners' bids are important, we can explain more than half of the value based on observable characteristics but not all due to landowner's bidding behavior. On the other hand, the majority of Calvert's parcels have been preserved in a TDR program. Developers would be uninterested in a parcel's characteristics when negotiating a deal with the landowner, therefore we are able to explain less of the easement price paid by the characteristic data. In an overall sense (the general model) we explain 80% of the variation in the easement value using the included characteristics. Yet, we find that the specific programs reward characteristics differently in the county-level regressions, as might be expected by the difference in institutional mechanisms between the programs. However, many of the estimated coefficients on these characteristics were not significant. We attribute this to multicollinearity within the counties. For example, in Howard and Calvert, percent of prime soils and percent of cropland had a correlation coefficient of 0.42. The distance to town and the percentage of cropland were correlated in Carroll and Calvert.

Consistently in all the regression models, the estimated coefficients on the distance to city variable suggests that the closer the parcel is to the 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% further away from the city (Table 4). In Calvert, the closer a parcel is to Washington, D.C., 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 (?=-0.47) with prime soils; thus, for reasons of multicollinearity we did not include distance squared.

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. After 4.4 miles, the proximity to town becomes unimportant. While this is true in the general model, the estimated coefficients on distance to town in each of the county-level models are not significant. The insignificant coefficients on proximity to another preserved parcel suggest that none of the programs are making this characteristic a priority. In the Calvert model, we found that the closer the parcel is to the Chesapeake Bay or Patuxent River, the higher the easement payment. While using a slightly different variable (view of water), Wichelns and Kline (1993) found a similar relationship. Easements that border large bodies of water are more expensive.

The negative coefficient on parcel acres indicates that larger parcels receive lower easement payments per acre, consistent with other land market studies. As acreage increased by 1%, the easement value decreased by 0.059%. This result held in Calvert County: a 1% increase in acreage decreased the easement price by 0.12%; and in Carroll County by 0.16%. Acreage did not affect the easement value of Howard County parcels. Calvert had the smallest parcels (and the lowest acreage requirement).

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. This finding could be due to a higher demand by the program administrators for farms with higher agricultural productivity, as measured by soil type. Apparently, the soil quality between parcels within a county is not sufficiently different to elicit significant coefficients on this variable in the county-level regressions; or insignificant

coefficients could be due to the multicollinearity mentioned earlier. However between counties, there is variation. Calvert County averages 43% of prime soils per parcel, Carroll averages 39%, and Howard, 82%.

The higher the percentage of agricultural land in a parcel, the lower the easement value compared to the excluded land use, percentage of forest land. As the percent of agricultural use increased 1%, the easement value decreased 0.19%. The results suggest that higher agricultural returns appear to outweigh the relative conversion costs of forest lands. Agricultural land was expected to command a higher price per acre because it is easier to convert to residential and commercial uses. This also suggests that the goal of providing agricultural products may not be a priority of program administrators, but rather the provision of open spaces such as forests. 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 much higher in Carroll (85%) and Howard (75%) than Calvert (38%).

Each type of program paid significantly different easement values. 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 from parcels or may be offering higher easement prices to elicit more landowners to sell. Alternatively, landowners in the MALPF program may be highly discounting their bids to enroll their land. Howard County paid higher easement values in its PDR program when it switched the payment mechanism and the method used to determine the easement values. These results held in the county-level regressions as well. In the Howard County

regression, the PDR program paid more than MALPF; in the Calvert County regression, the TDR program paid more than MALPF. Even though developers may not be using appraisals to determine the price of development rights in a TDR program, they appear to be paying a higher per acre value, and thus landowners participate in this program to a higher degree than in the MALPF program

From the results, distance to Washington and Baltimore is an important and consistent determinant in easement price. Distance to the city proxies the development pressure on the land and farmers demand higher compensation when development pressure is greater. The number of acres was also important. In the general model, we found that prime soils, the percent of agricultural land, and distance to a preserved parcel were important, but these results were not duplicated in any of the county models. In aggregate, these factors affect easement price but may vary too little in a given county to clearly reflect their overall importance.

Simulations

To compare preserved parcels to unpreserved parcels,[7] simulations were performed with the nonparticipant parcels. To ensure eligibility criteria to preserve their land given the program's requirements were met, we included only those parcels which exceeded the minimum size requirements of 100 acres for the MALPF and PDR programs, and 50 acres for the TDR programs. Parcels with fewer acres were included if they were located within one-eighth of a mile to another preserved parcel. For Howard County, we computed the predicted price for enrollment after 1989. Once eligible parcels had been identified, a predicted easement price was calculated based on the parcel's characteristics and the county-level estimated coefficients reported in Table 3.

Descriptive statistics of the nonparticipating parcels and the results of these simulations are shown in Table 5. The table indicates the number of eligible parcels and the price they would receive under each of the different programs. In Carroll County, 44 parcels would be eligible for the MALPF program, with an average price per acre of $1,302. In Howard County, 22 of the surveyed non-participants would be eligible. The highest paying program for all parcels would be in the Howard PDR program, with an average price of $7,327. In Calvert County, 71 nonparticipant parcels were eligible for the TDR program, which was the high average easement value at $2,453. Those eligible for MALPF were also eligible for the TDR program.

To clearly illustrate the relationship between characteristics and easement values, graphs were constructed. Figure 1 illustrates the relationship between the easement value paid to participants, the predicted easement value for nonparticipants, and the number of acres in the farm parcel for Carroll County. Carroll participants received approximately $1,200 per acre for small parcels (100 acres) but closer to $900 per acre for parcels greater than 400 acres. Nonparticipants with small parcels were predicted to be more highly rewarded, at an average of $1,400 per acre. As nonparticipant parcels increased in size, the predicted prices aligned more closely to those already paid to participants. This suggests that the smaller nonparticipant parcels may have desirable characteristics and thus would receive a higher price. Nonparticipant parcels are closer to Baltimore (28.8 miles compared to the 32 miles of participants parcels) and have a slightly higher average percent of prime soils (43% compared to 39%).

Figure 2 illustrates the non-linear relationship between easement prices paid to participants (pre- and post-1989), predicted easement values for nonparticipants, and the distance to the nearest

city for Howard County. At 10 miles from the nearest city, recent participants were paid almost $7,000 per acre, whereas nonparticipants would have commanded $7,600 per acre. As distance from the city increases, these two groups intersect at 19 miles, where the effect of distance to city dissipates in the estimated model. 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 nearest city (14.7 miles compared to 17.9 miles for participants). Both Figure 1 and Figure 2 suggest that had nonparticipants volunteered their parcels to the preservation programs they may not have been selected due to the high easement value to enroll their parcels.

In addition to the explicit relationships of easement value to characteristics, the supply curve of future parcels was developed using the predicted easement values. We construct a supply curve for each county based on available nonparticipant parcels. We extrapolated from the simulated results on the eligible parcels up to the expected number of unpreserved eligible acres at the county level. 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 nonparticipants parcels actually surveyed, multiplied by the number of nonparticipant parcels in the county,. In Howard County, 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. This expansion suggests that 8,802 agricultural acres out of the remaining approximately 22,000 agricultural acres in Howard County could be preserved given the current eligibility requirements. For Carroll County, the expansion factor is 4.84 (29,794 more acres), and for Calvert County, 3.53 (27,077 more acres). Figure 3 shows these supply curves. Howard County parcels are the most expensive. To increase enrollment by 5,000 acres, the county will have to pay almost $7,000 per acre. Another 3,802 acres, however, are even more costly. These remaining unpreserved parcels are closer to the city and thus have more valuable development rights. The total cost of preserving these 8,802 acres is estimated to be $65,766,099. Calvert has a similar pattern, although lower prices. The first 5,000 acres will be $2,000 per acre (the average easement value paid to participants is $2,403). Calvert's nonparticipants are further from the waterfront (1.67 miles compared to .94 miles for participants) and tend to be 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 county would be $63,352,607. Carroll County can preserve another 5,000 acres for $1,000 per acre (the average easement value paid to participants is $1,165), then preserve 15,000 more for approximately $1,500 per acre. The total cost of preserving 29,794 acres would be $37,992,295. Nonparticipants in Carroll County are closer to the city (28.8 miles compared to 32 miles), so if including a squared term had been possible, a steeper slope for the supply curve may have resulted. If preserving a high number of acres on a limited budget is a desired goal of the state, targeting agricultural land in Carroll County 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, if we had left it uncorrected, the results would have been similar.

Distance to population areas, as measured to the nearest city (Washington, D.C., or Baltimore), was a major factor in determining the easement value, similar to the results for the Wichelns and Kline (1993) and Plantinga and Miller (2001) distance measures. Farmland further 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 and on a fixed budget, 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 as it is easier to build on. 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 County, 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 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 County and explicitly considered parcel characteristics. The parcel characteristics explained 87% of the variation in easement values, although few individual characteristics had significant estimated coefficients. Although appraisals were made for all MALPF parcels, apparently the bidding system also affects the price, and only 62% of the variation in easement prices could be explained in the Carroll County 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 County for the same dollars than in Howard County. 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 county or region may be the best strategy. Conversely, as mentioned above, for political goodwill, administrators may need to select parcels from different regions of the state and closer to urban centers.

MALPF's funding, the counties' matching preservation funds, and the Howard County PDR program are funded at least in part by the continued conversion of agricultural land 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 County, $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, 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 (United States Department of Agriculture, 1997). The actual sales 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 agricultural land preservation programs are to be successful. Alternatively, society could determine that the preservation of these additional acres would not provide $167 million of amenity and other benefits.

If enrollment is to increase, program administrators also may need to adjust the payments and/or eligibility requirements to encourage participation by a larger number of the remaining unpreserved farms. And in fact, the programs in these three counties have evaluated their progress and have made some adjustments. For example, Calvert County determined that if they do not preserve farmland close to Washington, D.C., now, this land will become part of urban sprawl. Therefore they decided to pay a premium for farmland nearer the city. MALPF has decided to reduce its acreage requirement to 50 acres.

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. The

Maryland Rural Legacy program introduced in 1997 has decided to permit characteristic- based easement valuation. It uses an easement valuation model to 1) ensure that the payment is sufficient given the parcel's agricultural, forestry and natural resource qualities, which the program is designed to protect, and the fair market value for the area, 2) identify the most desirable properties to preserve, and 3) streamline the process relative to traditional appraisal-based systems (The Rural Legacy Program Grants Manual 2001).

References

American Farmland Trust (AFT). "Status of Selected Local PACE Programs: Fact Sheet" American Farmland Trust, Washington D.C. (2001a).

American Farmland Trust (AFT). "Status of State PACE Programs: Fact Sheet" American Farmland Trust, Washington D.C. (2001b).

American Farmland Trust (AFT). "Transfer of Development Rights: Fact Sheet" American Farmland Trust, Washington D.C. (2001c).

Annotated Code of Maryland. Agricultural Article, 2-501 Subtitle 5.

Anselin, L. *Spatial Econometrics: Methods and Models*. Dordrecht: Kluwer Academic Press. (1988a).

Anselin, L. "Model Validation in Spatial Econometrics: A Review and Evaluation of Alternative Approaches." *International Regional Science Review*, 11:279-316. (1988b).

Anselin, L. *SpaceStat Version 1.80 User's Guide*, Urbana, Il: University of Illinois, http://www.spacestat.com/docs/V180man.pdf. (1995). Version 1.9 Update (1998).

Anselin, L. and R. Florax. *New Directions in Spatial Econometrics*, Berlin: Springer-Verlag, (1995)

Anselin, L. and A. Bera. "Spatial dependence in linear regression models with an introduction to spatial econometrics." In *Handbook of Applied Economic Statistics*, eds. A. Ullah and D. Giles. New York: Marcel Dekker. (1997).

Bay Journal. "Maryland Enacts Sweeping Growth Management Law," 7 (3) May (1997)

Beasly, S. D., W. G. Workman, and N. A. Williams. 1986. "Estimating Amenity Values of Urban Fringe Farmland: A Contingent Valuation Approach: Note." *Growth and Change* 17(Oct. 1986): 70-8.

Bell, K. and N. Bockstael, "Applying the Generalized-Moments Estimation Approach to Spatial Problems Involving Microlevel Data," *The Review of Economics and Statistics*, (February 2000), 82(1):72-82.

Bergstrom, J. C., B. L. Dillman, and J. R. Stoll. "Public Environmental Amenity Benefits of Private Land: The Case of Prime Agricultural Land." *Southern Journal of Agricultural Economics* 17(July 1985): 139-50.

Berndt, E.R.,1991. *The Practice of Econometrics.* Reading MA: Addison-Welsey Publishing Co.

Blakely, M. "An Economic Analysis of the Effects of Development Rights Purchases on Land Values in King County, Washington. M.S. Thesis, Washington State University (1991).

Bowen, G. 2000. Calvert County Office of Planning and Zoning, personal communication.

Bowers, D. "Sonoma, Berks, Lancaster gain most acres; top 12 named," *Farmland Preservation Report*, 11(9): 1-6, (July-Aug. 2001).

Bowers, D. *Farmland Preservation Report*. 10(9):1-7, (2000).

Bromley, D. W., and I. Hodge. 1990. "Private Property Rights and Presumptive Policy Entitlements: Reconsidering the Premises of Rural Policy." *European Review of Agricultural Economics* 17(2): 197-214.

Brunstad, R. J., I. Gaasland, and E. Vardal. 1999. "Agricultural Production and the Optimal Level of Landscape Preservation." *Land Economics* 75(4): 538-46. (1999)

Chesapeake Bay Commission and The Trust for Public Land. *Keeping Our Commitment: Preserving Land in the Chesapeake Watershed.* Annapolis, MD. (February 2001).

Cliff, A., and J. K. Ord, *Spatial Autocorrelation*. London: Pion Publishing, (1973).

Drake, L. "The Non-Market Value of Swedish Agricultural Landscape." *European Review of Agricultural Economics* 19(3): 351-64. (1992)

Fischel, W. M. 1985. *The Economics of Zoning Laws: A Property Rights Approach to American Land Use Controls*. Baltimore, MD: Johns Hopkins University Press.

Foster, J. H., J. M. Halstead and T. H. Stevens. 1982. *Measuring the Nonmarket Value of Agricultural Land: A Case Study*. Research Bulletin 672, Massachusetts Agricultural Experiment Station, University of Massachusetts, Amherst, Massachusetts.

Gardner, B. D. 1977. "The Economics of Agricultural Land Preservation." *American Journal of Agricultural Economics* 59(Dec.): 1027-36.

Halstead, J. M. 1984. "Measuring the Non-market Value of Massachusetts Agricultural Land: A Case Study." *Northeastern Journal of Agricultural Economics* 14(Apr.): 12-9.

Hushak, L. J., and K. Sadr. "A Spatial Model of Land Market Behavior." *Amer. J. Agr. Econ.* 61(Nov.):697-701, 1979.

Kelejian, H. and D. Robinson. "A suggested method of estimation for Spatial interdependent models with autocorrelated errors, and an application to a county expenditure model." *Papers in Regional Science*, 72, 297-312, (1993).

Kline, J., and D. Wichelns. 1996. "Public Preferences Regarding the Goals of Farmland Preservation Programs." *Land Economics* 72(4): 538-49.

Land Trust Alliance, "More Than $7.3 Billion Committed To Open Space Protection, http://www.lta.org/policy/referenda2000.html.

Lopez, R. A., F. A. Shah, and M. A. Altobello. 1994. "Amenity Benefits and the Optimal Allocation of Land." *Land Economics* 70(1): 53-62.

Lynch, L. and J. R. Horowitz. 1998. "Comparison of Farmland Programs in Maryland." In *The Performance of State Programs for Farmland Preservation.* Proceedings of a Conference in Columbus, Ohio, Sept. 10-11, Ohio State University.

Lynch, L., and S. J. Lovell, "Factors Influencing Participation in Agricultural Land Preservation Programs," Department of Agricultural and Resource Economics Working Paper #01-05, 2001 University of Maryland, College Park.

Lynch, L., and W. N. Musser, "A Relative Efficiency Analysis of Farmland Preservation Programs," *Land Economics*, 77(4)(November 2001):577-594.

Maryland Department of Agriculture. 2001. Maryland Agricultural Land Preservation Foundation Annual Report for FY 2001. Annapolis, MD.

Maryland Department of Agriculture. 1998. Maryland Agricultural Land Preservation Foundation Report. http://www.mda.state.md.us/agland/preserva.htm

Maryland Agricultural Land Preservation Foundation 2001. "Report of the Maryland Agricultural Land Preservation Task Force," (2001). http://www.mdp.state.md.us/planning/MALPP/FINAL2.pdf

Maryland Department of State Planning (MDSP). *Natural Soil Groups Technical Report*. HUD Project Number MD-P-1008-100, 1973.

McConnell, K. E. 1989. "The Optimal Quantity of Land in Agriculture." *Northeastern Journal of Agricultural and Resource Economics* 18(Oct.): 63-72.

Nickerson, C. J., and L. Lynch, "The Effect of Farmland Preservation Programs on Farmland Prices, " *American Journal of Agricultural Economics*, 83(2):341-351, 2001.

Plantinga, A. and D. Miller, "Agricultural Land Values and Future Development," *Land Economics*, 77(1)(February 2001):56-67.

Pruckner, G. J. 1995. "Agricultural Landscape Cultivation in Austria: An Application of the CVM." *European Review of Agricultural Economics* 22(2): 173-90.

Shi, Y.J., T.T. Phipps, and D. Colyer. 1997. "Agricultural Land Values Under Urbanizing Influences." *Land Econ.* 73(February 1997):90-100.

The Rural Legacy Program Grants Manual December 2001 Revision, 2001. Maryland Department of Natural Resources, Annapolis, MD

United States Department of Agriculture. National Agricultural Statistic Service, *Agricultural Statistics* 1997.

Weibe, K., A. Tegene, and B. Kuhn. 1996. "Partial Interests in Land: Policy Tools for Resource Use and Conservation." U.S. Department of Agriculture, Economic Research Service, Agricultural Economic Report No. 744.

Whittle, P., 1954. "On Stationary Processes in the Plane," *Biometrica* 41:434-449.

Wichelns, D. and J. D. Kline. 1993. "The Impact of Parcel Characteristics on the Cost of Development Rights to Farmland," *Agricultural and Resource Economics Review* 150-158.

Wolfram, G. 1981. "The Sale of Development Rights and Zoning in the Preservation of Open Space: Lindahl Equilibrium and a Case Study." *Land Economics* 57(3): 398-413.

Table 1. Number of Acres Preserved by County and Program (2000)

	County		
Program	Calvert	Carroll	Howard
MALPF	3,844	31,284	3,937
County PDR	0[a]	0	12,801
County TDR	10,960	0	1,350
Total	14,804	31,284	18,088

Source: Bowers (2000) and Bowen (2000)

[a]Some of the TDR acres reported above were sold as part of the County PDR program. Greg Bowen of Calvert Office of Planning and Zoning estimates that 2,500 acres of the TDR total have been preserved under the Calvert PAR program.

Table 2. Descriptive Statistics for Characteristics of Participants

	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 3: 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
Howard parcels that 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 4. Elasticities from Estimated Models by County

	Total (Corrected) **Elasticity**	**Calvert** (Uncorrected) **Elasticity**	**Carroll** (Corrected) **Elasticity**	**Howard** (Uncorrected) **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

Table 5. Descriptive Statistics and Simulation Results for Eligible Nonparticipants

	Carroll County		Howard County		Calvert County: MALPF		Calvert County: TDR	
	N=44		N=22		N=33		N=71	
Variable	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Acres	139.91	46.21	150.42	75.55	150.37	94.08	108.04	75.63
Percent Prime Soil	43%	0.4	86%	0.18	46%	0.29	43%	0.3
Percent of Cropland	79%	0.17	72%	0.14	27%	0.26	33%	0.28
Miles to nearest city	28.81	6.26	14.73	5.33	35.67	5.62	34.52	6.16
Miles to nearest town	4.12	1.38	3.78	1.21	3.81	1.65	3.78	1.79
Miles to waterfront					1.53	1.12	1.67	1.59
Miles to nearest preserved parcel	0.008	0.038	0.015	0.039	0.03	0.06	0.02	0.05
Within 1/4 mile to nearest preserved parcel	4.5%	0.21	18%	0.39	18%	0.39	11%	0.32
100 acres or larger (# of parcels)	43	0	19	0	29	0	29	0
50 acres or larger (# of parcels)					33	0	67	0
Price if MALPF	$1,302	$281	$5,143	$882	$1,888	$311	$1,986	$303
Price if TDR					$2,331	$385	$2,453	$374
Price if PDR			$7,327	$1,256				

Figure 1. Easement Value per Acre by Number of Acres on Farm for Carroll County Participants and Nonparticipants

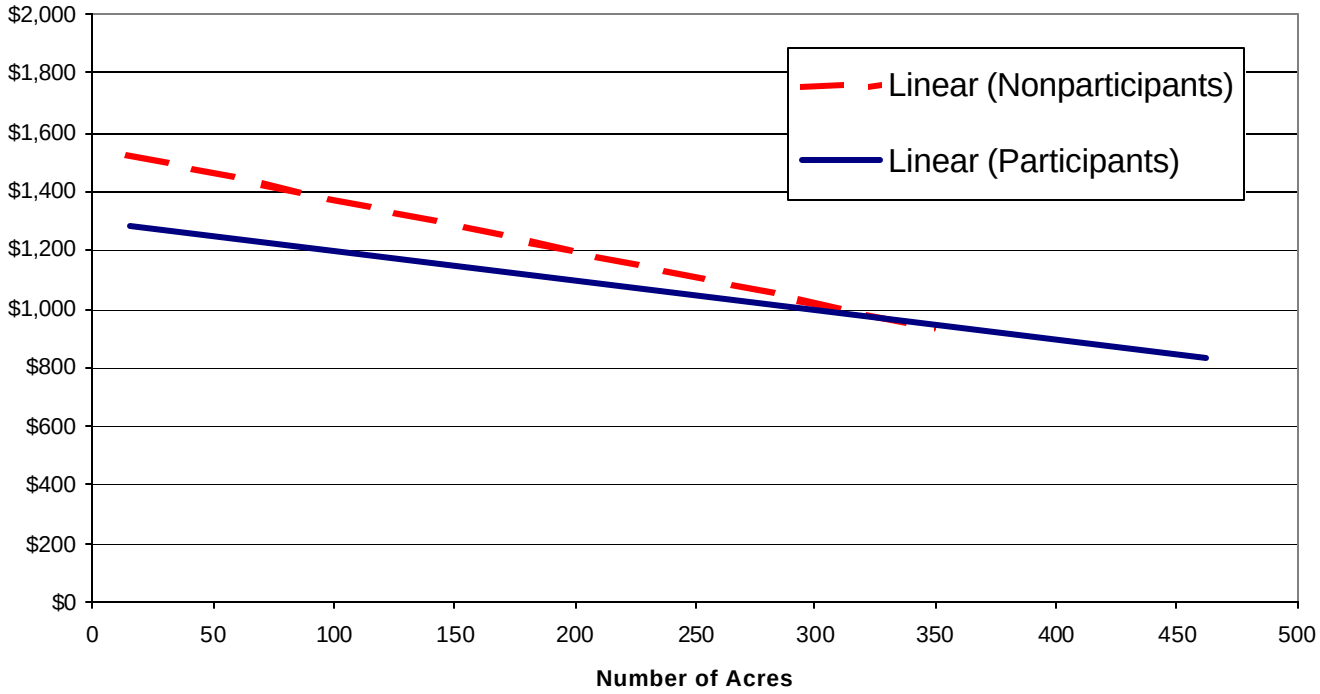


Figure 2. Easement Value per Acre as a Nonlinear Function of Distance to the Nearest City for Howard County Participants and Nonparticipants

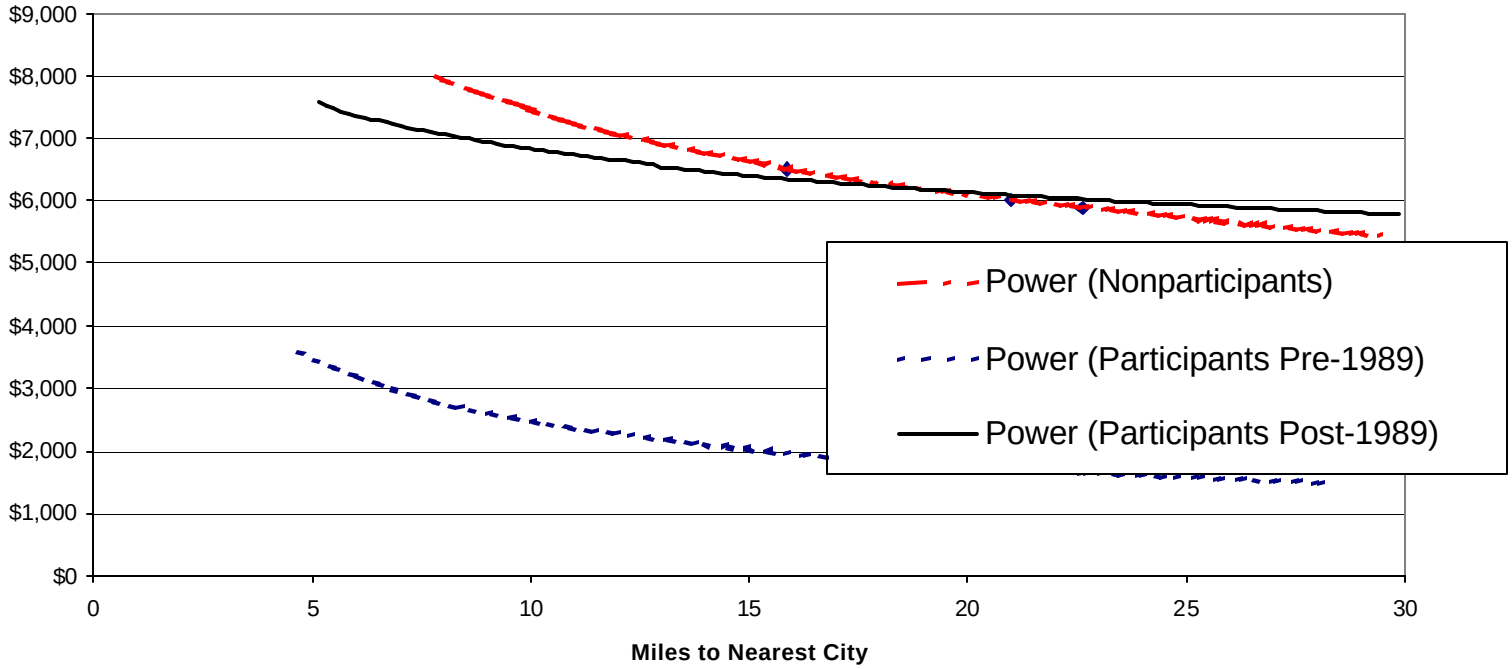
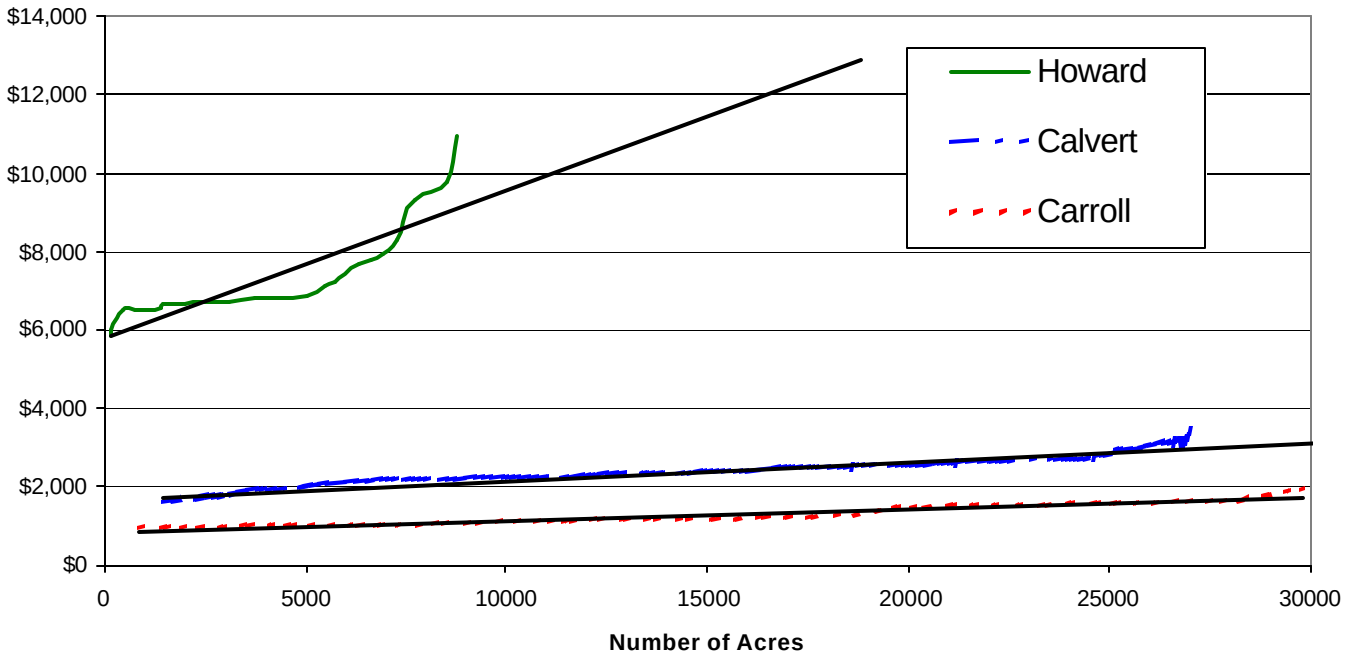


Figure 3. Easement Values per Acre to Enroll Additional Acres into the Programs by County



Footnotes

1. Although 50 TDR programs have been established, 22 of them have not protected any agricultural land.

2. When agricultural land is converted to another use, an agricultural 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 agricultural land preservation program receive three-quarters of the agricultural land transfer tax on county parcels. Other counties receive one-third.

3. 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 farther apart in order to obtain large blocks.

4. The fact that the county purchased some of the rights increased the demand and may have elevated the price in subsequent years. However, the county instituted the PAR program because an inadequate infrastructure ordinance passed and the market for TDRs disappeared. Without the PAR program, it is possible that no TDRs would have been sold in certain years.

5. 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.

6. 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.

7. Nonparticipant observations were obtained from a sample of agricultural landowners from a 1999 survey in these counties (Lynch and Lovell, 2001).