Capitalization of Open Spaces into Housing Values and the Residential Property Tax Revenue Impacts of Agricultural Easement Programs

Jacqueline Geoghegan, Lori Lynch, and Shawn Bucholtz

Using a unique spatial database, a hedonic model is developed to estimate the value to nearby residents of open space purchased through agricultural preservation programs in three Maryland counties. After correcting for endogeneity and spatial autocorrelation, the estimated coefficients are used to calculate the potential changes in housing values for a given change in neighborhood open space following an agricultural easement purchase. Then, using the current residential property tax for each parcel, the expected increase in county tax revenue is computed and this revenue is compared to the cost of preserving the lands.

Key Words: agricultural preservation, hedonic models, open space, spatial econometrics

The preservation of open space has become an important policy issue in the United States as conversion of land in forestry and agricultural uses into residential and commercial uses continues. From 1982 to 1992, approximately 6.2 million acres of agricultural land and 5.1 million acres of forest land were converted to urban and other developed uses in the United States (Vesterby et al., 1997). In the Washington, DC, metropolitan area, the rate at which land is being consumed exceeds the population growth rate by a factor of almost 2.5. If current trends continue, 800,000 additional acres of resource lands will be developed by 2030 in the greater Washington, DC, region (Chesapeake Bay Foundation, 2002).

Open space provides many potential public goods with aesthetic, recreation, and biodiversity values. It also offers associated ecosystem services such as flood control and water purification. Farmland preservation programs can help maintain a land base for the agricultural economy, provide the amenities of open space and rural character, slow suburban sprawl, provide critical wildlife habitat, and reduce pollution in areas where suburban development is occurring (Bromley and Hodge, 1990; Fischel, 1985; Gardner, 1977; McConnell, 1989; Wolfram, 1981).

Because the private land market does not recognize these public goods (i.e., there is a market failure), private and governmental entities have introduced a variety of mechanisms to preserve open space or slow its conversion, including cluster and exclusive agricultural zoning, purchase of and transfer of development rights programs (PDRs and TDRs), use of agricultural easements, and the outright purchase of open spaces for parks using tax dollars or private donations. The general public

---

Jacqueline Geoghegan is assistant professor, Department of Economics, Clark University, Worcester, MA; Lori Lynch is associate professor and Shawn Bucholtz is graduate student, both in the Department of Agricultural and Resource Economics, University of Maryland.

The authors thank Michael Fragkias, Laura Schneider, and Suchandra Basu for their assistance with this research, as well as two anonymous reviewers and participants at the NAREA 2002 Land Use Policy Workshop for helpful comments and suggestions. This research was supported by U.S. EPA Grant No. R825309, NASA New Investigator Program in Earth Sciences Grant No. NAG5-8559, Center for Agricultural and Natural Resource Policy, and the National Center for Smart Growth Research and Education at the University of Maryland. The geographic data in the analysis are from a project coordinated by Professor Nancy Bockstael, Department of Agricultural and Resource Economics, the University of Maryland, with funding by EPA Cooperative Agreement No. CR-821925010, EPA STAR Grant No. R-82801201, and a Maryland Sea Grant.

This paper was presented at the Land Use Policy Workshop of the Northeastern Agricultural and Resource Economics Association annual meetings, Harrisburg (Camp Hill), PA, June 9–11, 2002.

demonstrated its support for open space preservation by passing over three-quarters of the ballot initiatives generating funds for this purpose: in 2000, $7.4 billion in conservation funding was authorized; in 1999, $1.8 billion; and in 1998, $8.3 billion (Land Trust Alliance).

Yet, even with this additional funding, there may still be insufficient funds to preserve enough open space. Thus, policy makers need further information on the potential benefits and costs of open space preservation. Also, while private purchases of open space do occur, as many environmental organizations and individual landowners purchase land, governments are likely to remain involved with the purchase of open space. Policy makers need to determine which tract to preserve and which financing mechanisms to use to purchase the land or its development rights. As previously noted, many of the ballot initiatives concerning open space have passed, providing funding for open space acquisition. However, alternative funding mechanisms may be needed if raising taxes through bond initiatives becomes more difficult.

The potential benefits of preserving open space accrue to the general public living throughout a region. However, the landowners near the preserved parcels might also receive direct benefits. These neighboring parcels could receive a positive externality from the open space, and some of this benefit may be capitalized into the price of the houses.[1] If this increase in housing value exists, some of it could be recaptured through property taxes and generate an additional source of financing for open space provision.

While this strategy may not provide all the open space society would be willing to pay for (i.e., it does not represent the full welfare improvement and will not necessarily lead to the optimal number of acres preserved), it does represent one source of benefits and funding. Previous research (Nickerson and Lynch, 2001) has shown there is little statistical evidence that the easement restrictions imposed by agricultural land preservation programs are capitalized into the price of the specific agricultural parcel. However, other studies have suggested preserved agricultural open spaces can increase residential values of parcels near these preserved farms (Geoghegan, 2002; Irwin and Bockstael, 2001).

This paper examines one portion of the benefits of preservation programs—those accruing to adjacent homeowners—to determine how much additional land agricultural preservation programs can finance through the increase in tax revenue generated from nearby residential properties. Specifically, if the open space provided by preservation programs increases nearby residential land values, and consequently generates higher property tax revenues, how many further acres of open space could this increase in tax revenue provide? Using a unique spatially explicit database for three counties in Maryland, this proposition is tested.

To estimate the benefit of an agricultural preservation program to nearby residential landowners, a hedonic model of market transactions is estimated that includes traditional hedonic explanatory variables as well as neighborhood land use variables. The land use variables were calculated using a geographic information system (GIS) to measure 10 different types of land use around each parcel. These land uses were then aggregated to "permanent" and "developable" open spaces. The former category includes agricultural and forest land enrolled in the agricultural land preservation programs, state and local parks, and golf courses. Agricultural and forest land which does not have an easement attached is also open space, but because this land could potentially be developed at some time in the future, it is designated as "developable" open space.

The hypotheses to be tested are (*a*) that open space increases neighboring residential values, and (*b*) that the "permanent" open space variable has a larger effect on housing price because residential buyers know it will never be converted to a residential subdivision. The estimated coefficient on the permanent open space variable is then used in a simulation. We increase the current level of permanently preserved agricultural open space by 1% to determine the increase in residential property values to adjacent landowners. This increase in property values is subsequently used to calculate the level of increased property tax revenue generated. Next, the number of acres of preserved agricultural land that could be financed with this additional revenue is calculated and compared to the number of acres associated with the 1% increase from the simulation to determine the potential for further purchases of agricultural land.

Review of Literature

Questions concerning the economic value of open spaces have been addressed using both stated preference and revealed preference (usually hedonic)

[1] Alternatively, the open space could be a negative externality if it is unsightly, odorous, or insect ridden.

methodologies. Halstead (1984), and Kline and Wichelns (1994, 1996a, b, 1998) have estimated the value of preserving agricultural land uses via stated preference models. Kline and Wichelns found a larger population and higher property values lead to greater support for agricultural land use preservation programs. Stated preference models have also been used to estimate the value of preserving open space in an urban setting (Breffle, Morey, and Lodder, 1998). Comparing stated preference models to hedonic models for measuring the amenity benefits from farmland, Ready, Berger, and Blomquist (1997) observed that the two methodologies generate estimates within 20% of each other.

Based on findings from the early hedonic literature, proximity to urban parks and greenbelts increased residential values, or, as distance from a greenbelt or park increased, residential values decreased significantly, controlling for all other attributes (Kitchen and Hendon, 1967; Weicher and Zerbst, 1973; Hammer, Coughlin, and Horn, 1974; McMillan, 1974; Correll, Lillydahl, and Singell, 1978; Peiser and Schwann, 1993).

Later research analyzed how forest land affected residential prices (Garrod and Willis, 1992a, b, c; Tyrvainen and Meittinen, 2000) and how a golf course affected residential land values (Do and Grudnitski, 1995). The effects of different types and sizes of open space at different spatial scales have been the focus of a large number of studies (for example, Cheshire and Sheppard, 1995; Bell and Bockstael, 2000; Geoghegan, Wainger, and Bockstael, 1997; Leggett and Bockstael, 2000; Acharya and Bennett, 2001; Shultz and King, 2001; Irwin, 2002; and Geoghegan, 2002).

In an analysis most closely related to this study, Geoghegan (2002) reported that permanent open space increases nearby residential land values over three times as much as an equivalent amount of developable open space in Howard County, Maryland. The current study extends Geoghegan's hedonic model by including two additional Maryland counties, as well as testing for endogeneity (Irwin and Bockstael, 2001) and possible spatial correlation and dependence involved with using spatial data (Anselin, 1988).

Maryland Farmland Preservation Programs[2]

Three Maryland counties—Howard, Carroll, and Calvert—are among the top 13 counties in the United States for number of preserved farmland acres (Bowers, 2000). In 1997, Howard County had preserved 18,088 acres, Calvert 14,804 acres, and Carroll 31,284 acres, with preserved acreage representing 45%, 33%, and 18% of total farmland in the respective counties (U.S. Department of Agriculture, 1997; Bowers, 2000). Table 1 summarizes the acres preserved under each program in each of the three counties as of 2000.

Maryland Agricultural Land Preservation Program

In 1977, the State of Maryland established the Maryland Agricultural Land Preservation Foundation (MALPF), a PDR program through which permanent easements on farmland are purchased. These easements prohibit nonfarm uses for current and all future owners. Appraisals and an "auction" are used to set the easement value. MALPF uses the lower of (*a*) a calculated easement value equal to an appraisal value minus the agricultural value, or (*b*) a bid made by the landowner. Farms are accepted in order of highest value per dollar bid until the budget is expended. Minimum eligibility criteria for participating farms were recently changed to include 50 contiguous acres or contiguity to another preserved farm, and having at least 50% of its soil classified as USDA Class I, II, or III, or as Woodland Group I or II.

MALPF's funding comes from a real estate transfer tax and an agricultural transfer tax. MALPF expended $23.1 million in fiscal year 1999, which counties matched with $6.7 million additional dollars (Chesapeake Bay Commission, 2001). The State program had purchased easements on more than 185,871 acres statewide by June 2000 (Chesapeake Bay Commission, 2001).

Landowners in the three counties studied here can participate in MALPF. Carroll County farms are primarily preserved through the MALPF program. The average price per acre for development rights under the MALPF program is $1,961 for Calvert County, $1,165 for Carroll County, and $1,603 for Howard County (Lynch and Lovell, 2002).

County Programs

Calvert County began a TDR program in 1978. Landowners receive approximately one transfer of development right (TDR) for every five acres of land in the parcel. Once a TDR has been sold, a conservation easement is attached to the parcel,

[2] The description in this section is drawn from Lynch and Lovell (2002).

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

	Maryland County		
Preservation Program	Calvert	Carroll	Howard
Maryland Agricultural Land Preservation Foundation	3,844	31,284	3,937
County Purchase of Development Rights (PDR)	0 [a]	0	12,801
County Transfer of Development Rights (TDR)	10,960	0	1,350
Total	14,804	31,284	18,088

Sources: Bowers (2000); personal communication with Greg Bowen, Calvert County Office of Planning and Zoning (2000).

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

restricting all current and future landowners from additional residential, commercial, or industrial uses. Landowners sell the TDRs directly to the development firms; thus the financing of the land preservation is primarily provided by the development firms rather than through tax dollars. These developers can then use the TDRs to increase the housing density above the current zoning in a growth area. The developers' demand for increased density and landowners' reservation prices determine the number and price of TDRs sold. The developers' demand is affected by the area's development pressure (demand for new housing) and the availability of designated growth areas where TDRs may be used.

Calvert County has also instituted a PDR program [called the Purchase and Retirement (PAR) Fund] to purchase TDRs. Thus, if developers' demand is low, landowners may sell TDRs to the county government until PAR program funds are exhausted. Development rights purchased by the PAR are retired. The prices paid in the PAR program are based on the average TDR market price. The average TDR price per acre is $2,517 (Lynch and Lovell, 2002). The funds to finance the PAR program come from three-quarters of the 5% agricultural transfer tax on the purchase price of all Calvert County farmland converted to another use.

Started in 1978, Howard County's Purchase of Development Rights (PDR) program initially used two market-based appraisals to determine the easement price per acre. However, in 1989, the program switched to a point system based on parcel characteristics to determine the easement value. Having certain characteristics, such as road frontage, increases the amount the county will offer the landowner for the rights to develop from the parcel. Once the landowner has sold the development rights, a conservation easement is attached to the parcel, restricting all current and future landowners from converting the parcel to residential, commercial, or industrial use.

Howard County leverages the available funds using an installment plan, under which commitments of $55 million were made by 1997. Under the plan, the farmer 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 PDR program is funded with a quarter of the county's 1% real estate transfer tax levied against all Howard County real estate transactions, and with three-quarters of the 5% agricultural transfer tax on all county farmland converted to another use. The average price per acre for the Howard County PDR program between 1978 and 1997 was $5,366. The average easement payment pre-1989 was $2,316 per acre, and from 1989 to 1997, the average price was $6,420 per acre (Lynch and Lovell, 2002).

The Hedonic Model

Hedonic models are reduced-form statistical models that seek to trace out, at a point in time, the locus of equilibrium transaction prices as a function of the characteristics of the heterogeneous real estate transacted. Hedonic pricing models assume a property is a heterogeneous good made up of a bundle of characteristics. Each characteristic of the parcel—including environmental attributes, such as the amount of open space in the neighborhood—contributes to the sales price of the property, so that housing prices are modeled as:

$$\mathbf{R} = \boldsymbol{\alpha} + \mathbf{S}\boldsymbol{\beta} + \mathbf{L}\boldsymbol{\gamma} + \mathbf{G}\boldsymbol{\tau} + \mathbf{g}, \quad (1)$$

where $\mathbf{R}$ is an $\{n \times 1\}$ vector of housing prices, with n = the number of observations; $\mathbf{S}$ is an $\{n \times k\}$ matrix of parcel/structure characteristics; $\mathbf{L}$ is an $\{n \times l\}$ matrix of neighborhood characteristics; $\mathbf{G}$ is an $\{n \times m\}$ matrix of spatial and location variables; $\boldsymbol{\alpha}$, $\boldsymbol{\beta}$, $\boldsymbol{\gamma}$, and $\boldsymbol{\tau}$ are vectors of associated parameters; $\mathbf{g}$ is an $\{n \times 1\}$ vector of random error terms; k is the number of parcel/structural characteristics; l is the number of neighborhood characteristics; and m is the number of land use and other location characteristics.

A specific version of this general hedonic pricing model was estimated to test the hypothesis that different types of open space around a residential parcel contribute positively to residential land values. The data are from the State of Maryland, Department of Planning's (2002) encoded database of land parcels and associated sales transactions that include descriptions of the property and residential structure. The data consist of 10,135 arm's-length transactions that occurred between July 1993 and June 1996: Calvert County = 1,676, Carroll County = 3,133, and Howard County = 5,326.

The dependent variable is the natural log of the sales price. In explaining the variation in the natural log of the transaction price of the parcel (*LN$PRICE*), three types of explanatory variables are used: parcel and house characteristics, locational and neighborhood characteristics, and land use characteristics. The first set, parcel and house characteristics, includes the lot size. As with many previous hedonic models, the price of a parcel is assumed to be nonlinearly related to its lot size. Thus the natural log of this variable is used (*LN$ACRE*). Variables related to the house characteristics include the natural log of the age of the house (*LN$AGE*), the natural log of the square footage of the house (*LN$SQFT*), and the number of stories (*NUSTORY*). Binary variables are included to control for the assessor's perceived quality of the house (*AVERAGE*, *GOOD$VGOOD*, with the omitted category of *FAIR*), to indicate if the house has a basement (*BASEMENT*), and to control for the construction type (*FRAME*, *ALUM*, with the excluded category of all other types).

The second set of explanatory variables relates to the location and neighborhood attributes of the parcels. The natural log of the Euclidean distance from each parcel to the nearest of either Washington, DC, or Baltimore, Maryland, the two principal employment centers in the region, is included (*LN$CITYDIST*) as well as the natural log of the distance to the nearest town (*LN$TOWNDIST*). To account for neighborhood characteristics, variables were extracted from the *1990 U.S. Census of Population* at the block group level for each parcel (U.S. Department of Commerce, 1993). These include the natural log of population density (*LN$POPDEN*), percentage of population with a college education or higher (*%EDUCB*), and median household income (*MEDHSINC*).

Data for other neighborhood characteristics such as tax rates, public services, school quality, and crime rates were not available at the parcel level. However, these characteristics vary or are perceived to vary more between counties than within counties in Maryland, and because the agricultural preservation programs also differ by county, we estimate the hedonic models separately for each county.

Finally, indices were constructed to measure the amount of preserved and developable agricultural, forest, and recreational open space surrounding each parcel. Preserved open space consisted of the agricultural easement lands discussed above, as well as private conservation land, which includes Maryland Environmental Trust lands, golf courses and cemeteries, and county and federal park land. The other open space category consisted of agricultural and forested lands that do not have easements on them.

Two indices were calculated for each type of open space. The land use was extracted for a 100-meter buffer around each parcel and for a 1,600-meter buffer. The tax and assessment data include the centroid of each parcel rather than its boundaries; thus, these indices include the land use of the actual parcels as well as the neighboring lands. Heuristically, these two indices can be thought of as the "view" (100-meter radius buffer, represented by *SMPERMOPEN* and *SMAGFOREST*) or the "20-minute walk" (1,600-meter radius buffer, represented by *LGPERMOPEN* and *LGAGFOREST*) from the front door of each house. These variables were scaled to measure the percentage of total buffer area dedicated to the two types of open spaces. Summary statistics for Calvert, Carroll, and Howard counties are found in table 2.

The land use variables described above may be endogenous to the residential prices as these parcels are usually part of the same real estate market as the parcels used to estimate equation (1). Therefore, the same economic factors that affect the value of the *i*th parcel in a residential use will also affect the price of the *j*th parcel whose land use is being used to explain the *i*th parcel's value. The probability that the *j*th parcel is developed or is in an open space use may be in part a function of whether the *i*th parcel has been developed (Irwin and Bockstael, 2001). Therefore, if (1) is estimated using OLS, ignoring the possibility some of the variables in **G** are endogenous, the estimates of $\boldsymbol{\tau}$ would be biased.

To address the potential endogeneity of the land use measures, we follow Irwin and Bockstael (2001) and estimate instrumental variables for these open space variables. In identifying instruments, variables are selected that are correlated with these open space variables but uncorrelated with the error term in equation (1). Specifically, these variables: (*a*) are hypothesized to affect the relative costs and benefits of converting the land or maintaining it in an

Table 2. Descriptive Statistics and Variable Definitions by County

		Calvert Co.	Carroll Co.	Howard Co.
Variable Name	Variable Description	Mean (Std. Dev.)	Mean (Std. Dev.)	Mean (Std. Dev.)
LN$PRICE	Dependent variable: Natural logarithm of full transaction price (in dollars)	11.9423 (0.4143)	11.9098 (0.3471)	12.3072 (0.3457)
(*P$*)*LGPERMOPEN*[a]	Percent of permanent open space within large radius (1,600-meter radius buffer)	0.0502 (0.0404)	0.1214 (0.0777)	0.1245 (0.0549)
(*P$*)*SMPERMOPEN*[a]	Percent of permanent open space within small radius (100-meter radius buffer)	0.0110 (0.0797)	0.0419 (0.1650)	0.0269 (0.1130)
(*P$*)*LGAGFOREST*[a]	Percent of agricultural and forest land within large radius (1,600-meter radius buffer)	0.5054 (0.1653)	0.5303 (0.0838)	0.3594 (0.0932)
(*P$*)*SMAGFOREST*[a]	Percent of agricultural and forest land within small radius (100-meter radius buffer)	0.2017 (0.2724)	0.1993 (0.2727)	0.1375 (0.0780)
LN$ACRE	Natural logarithm of parcel size (in acres)	!0.3632 (1.0826)	!0.4869 (1.0801)	!0.8688 (0.9082)
LN$AGE	Natural logarithm of age of structure (in years)	1.6401 (1.5266)	2.2654 (1.5149)	1.7306 (1.3778)
LN$SQFT	Natural logarithm of size of structure (in square feet)	7.2793 (0.4341)	7.3892 (0.3869)	7.6759 (0.4302)
AVERAGE	Dummy variable for a structure of average quality	0.5752 (0.4945)	0.2831 (0.4506)	0.5807 (0.4935)
GOOD$VGOOD	Dummy variable for a structure of good or very good quality	0.0227 (0.1489)	0.0220 (0.1468)	0.3894 (0.4877)
NUSTORY	Number of stories of structure	1.4657 (0.4733)	1.6088 (0.4712)	1.8098 (0.3862)
BASEMENT	Dummy variable for presence of a basement in the structure	0.5931 (0.4914)	0.9524 (0.2129)	0.9326 (0.2507)
FRAME	Dummy variable for framed structures	0.4612 (0.4986)	0.0875 (0.2825)	0.6842 (0.4649)
ALUM	Dummy variable for aluminum structures	0.4755 (0.4996)	0.7038 (0.4567)	0.2186 (0.4133)
LN$POPDEN	Natural logarithm of population density for census tract (in households per square mile)	4.7608 (0.8077)	5.1915 (0.9585)	5.8756 (1.1733)
%EDUCB	Percent of bachelor's degree education attainment	0.0697 (0.0247)	0.0920 (0.0361)	0.1753 (0.0543)
MEDHSINC	Median household income of census tract (in dollars)	47,665 (9,533)	43,645 (7,256)	62,181 (13,623)
LN$CITYDIST	Natural logarithm of distance to Washington, DC, or Baltimore, MD (in 100 kilometers)	11.1133 (0.2367)	10.6711 (0.2233)	10.1559 (0.2362)
LN$TOWNDIST	Natural logarithm of distance to nearest town (in 100 kilometers)	7.6665 (0.7375)	7.8654 (0.7486)	8.4256 (0.8121)

[a] Either actual value or predicted value (see regression results, tables 3, 4, and 5).

agricultural or forest use, (*b*) are not factors that explain housing prices, and (*c*) are not highly correlated with the observed explanatory variables that influence housing prices.

In addition to the soil attribute and slope variables used in Irwin and Bockstael (2001), we also include the distance to nearest transportation node and whether the area is currently or is planned to be connected to a sewer system. The physical attributes measuring soil quality are clearly exogenous to land values and to the other variables, as they are predetermined and do not change with a change in land use. Transportation node and city distance variables were tested for correlation, which was found to be small (ρ ranged from 0.02 to 0.23).

Sewer service is expected to influence decisions in the future for these currently undeveloped land uses. Using the estimated coefficients from these regressions, instruments for *P$SMPERMOPEN*, *P$SMAGFOREST*, *P$LGPERMOPEN*, and *P$LGAGFOREST* were created. If a Haussman test indicated the presence of simultaneity in the price equation with the land use variables, the predicted value from the instrumental variable step, rather than the actual value for the land use buffers, was used in the final regression for each county.

In addition to the endogeneity issue involved with estimating the hedonic model, the use of spatial data leads to the potential for bias and inefficiency if spatial effects are not taken into account. One of the most relevant of these effects is spatial autocorrelation, which results in inefficient estimates and biased standard errors. Spatial autocorrelation is likely to occur when important variables common to all observations in a neighborhood are not observable by the researcher, and thus not included in the model. Spatial autocorrelation in the residuals was tested using Moran's I statistic, the likelihood-ratio test, and a Lagrange multiplier test. In each county, these tests were conducted to indicate if there was spatial autocorrelation in the residuals. If spatial autocorrelation existed, a spatial model was estimated to address this issue. Similar to serial correlation, corrections require specification of a pattern to the errors. In this analysis, spatial weight matrices based on the inverse distance are employed.

Specifically, assume **X** is a matrix of the explanatory variables **S**, **L**, and **G** of equation (1). Then the spatial model discussed above is specified as:

$$(2) \qquad \mathbf{R} = \mathbf{X}\boldsymbol{\beta} + \mathbf{u},$$

where $\mathbf{u} = \lambda\mathbf{W}\mathbf{u} + \mathbf{e}$, and $\mathbf{e} \sim N(0, \sigma^2\mathbf{I})$. The weight matrix **W** reflects the relationship between each i, j pair of observations. For the models reported below, a row-standardized inverse distance weight matrix **W** was used, which assumes the spatial effects decrease as the distance between observations increases. The elements of **W** are defined such that $w_{ij} = 1/d_{ij}$ if $d_{ij} < c$, and $w_{ij} = 0$ if $i = j$ or if $d_{ij} > c$, where d_{ij} is the distance between parcel i and parcel j, c is the distance after which no spatial correlation is expected, and c is set to 1,000 meters. That is, only those "neighbors" within 1,000 meters are assumed to have the potential for spatial effects.

Because hedonic models are reduced-form models of an equilibrium locus of offers and bids for parcels of land, economic theory cannot inform the empirical specification [see Cropper, Deck, and McConnell (1988) for further discussion]. Therefore, following previous research (Bockstael, 1996; Geoghegan, Wainger, and Bockstael, 1997), flexible function forms are used here, specifically a log-log specification.

Estimation Results

The results from estimating equation (1) (the OLS model) and equation (2) (the spatial model) for Calvert, Carroll, and Howard counties are reported in tables 3, 4, and 5, respectively. The test statistics results of the spatial autocorrelation in the residuals for all three counties are provided in table 6. While for each county the results from the tests on spatial autocorrelation in the residuals demonstrated the need to use the spatial model, we found no major differences when comparing the OLS results to the spatial model results. Estimated coefficients are generally of the same size, and the more efficient test statistics from the spatial model do not result in qualitative or statistical significance changes for the estimated coefficients. Therefore, the following discussion of the parameter estimates is based on the results from the spatial model estimations.[3]

As seen from tables 3, 4, and 5, the estimated coefficients on the lot size and structural characteristics all meet a priori expectations and are statistically significant for the three counties, except for insignificant coefficients on *NUSTORY* for Carroll County and *BASEMENT* for Calvert County. The estimated coefficients for other characteristics varied both qualitatively and quantitatively by county. For example, the coefficient on *LN$CITYDIST* is negative and statistically significant in the Calvert and Carroll county regressions; the closer a parcel in these counties is to either Washington or Baltimore, the higher the sales price, as would be predicted by urban economic theory. *LN$CITYDIST* is not statistically significant in Howard County. In explaining this lack of significance, we argue that because Howard County is situated between Washington and Baltimore, it is possible Howard residents value a location affording a dual-commute opportunity, rather than simply being closer to one city versus the other.

We originally hypothesized that the closer a parcel is to a town, the higher the price. However, our findings show the distance to the nearest town (*LN$TOWNDIST*) is not statistically significant in Carroll or Howard counties, but is positive and significant in Calvert County. Calvert residents pay more to be farther away from towns, possibly

[3] Semi-annual time dummy variables were included in the regressions reported below and were all statistically significant.

Table 3. Regression Results for Calvert County

Variable	OLS Coefficient	*t*-Statistic	Spatial Model Coefficient	Asymptotic *t*-Statistic
CONSTANT	10.8992*	22.04	10.7624*	15.78
P$LGPERMOPEN	0.6303*	3.59	0.7118*	2.83
SMPERMOPEN	!0.1134	!1.72	!0.1117	!1.67
P$LGAGFOREST	!0.3492*	!7.42	!0.3907*	!6.03
SMAGFOREST	!0.0482	!2.38	!0.0496	!2.42
LN$ACRE	0.0982*	13.83	0.1002*	12.87
LN$AGE	!0.0226*	!5.31	!0.0287*	!6.28
LN$SQFT	0.3894*	20.46	0.3765*	19.49
AVERAGE	0.2106*	13.88	0.2020*	12.94
GOOD$VGOOD	0.4859*	12.29	0.4699*	11.56
NUSTORY	0.0790*	5.99	0.0655*	5.14
BASEMENT	!0.0126	!1.12	!0.0008	!0.07
FRAME	!0.0052	!0.22	!0.0311	!1.36
ALUM	!0.0422	!1.82	!0.0464	!2.07
LN$POPDEN	!0.0396*	!3.67	!0.0393*	!2.85
%EDUCB	0.9934*	3.94	1.0015*	2.83
MEDHSINC	0.0000	!0.30	0.0000	!0.18
LN$CITYDIST	!0.1669*	!4.27	!0.1432*	!2.59
LN$TOWNDIST	0.0241*	2.67	0.0265	2.02
Lambda			0.4067*	12.15
Adjusted R^2	0.7549		0.7785	

* Denotes statistical significance at the 5% level.

Table 4. Regression Results for Carroll County

Variable	OLS Coefficient	*t*-Statistic	Spatial Model Coefficient	Asymptotic *t*-Statistic
CONSTANT	11.4720*	37.44	11.6311*	32.47
P$LGPERMOPEN	!0.1181	!1.86	!0.1171	!1.57
SMPERMOPEN	0.0443	2.01	0.0317	1.33
P$LGAGFOREST	!0.1932*	!3.39	!0.2074*	!3.26
SMAGFOREST	0.0027	0.20	0.0027	0.20
LN$ACRE	0.1334*	31.68	0.1338*	31.06
LN$AGE	!0.0641*	!21.80	!0.0610*	!20.15
LN$SQFT	0.2692*	24.29	0.2629*	24.00
AVERAGE	0.1546*	17.51	0.1551*	16.76
GOOD$VGOOD	0.4036*	17.17	0.3973*	16.69
NUSTORY	!0.0212	!2.52	!0.0155	!1.83
BASEMENT	0.1324*	8.74	0.1330*	8.87
FRAME	!0.0528*	!4.05	!0.0488*	!3.79
ALUM	!0.0015	!0.16	!0.0007	!0.08
LN$POPDEN	0.0286*	4.75	0.0274*	4.02
%EDUCB	0.0814	0.62	0.0083	0.06
MEDHSINC	0.0000*	6.82	0.0000*	23.02
LN$CITYDIST	!0.1581*	!6.45	!0.1687*	!5.80
LN$TOWNDIST	!0.0044	!0.76	!0.0048	!0.75
Lambda			0.2149*	21.15
Adjusted R^2	0.7394		0.7458	

* Denotes statistical significance at the 5% level.

Table 5. Regression Results for Howard County

Variable	OLS Coefficient	*t*-Statistic	Spatial Model Coefficient	Asymptotic *t*-Statistic
CONSTANT	9.8834*	59.98	10.1107*	1,661.01
P$LGPERMOPEN	0.4950*	6.40	0.5869*	3.91
SMPERMOPEN	0.0367	1.69	0.0489*	2.02
P$LGAGFOREST	!0.1612*	!2.89	!0.2035	!2.31
P$SMAGFOREST	0.2066*	3.18	0.1482	1.75
LN$ACRE	0.1045*	26.82	0.1114*	23.79
LN$AGE	!0.0559*	!20.79	!0.0566*	!18.56
LN$SQFT	0.2518	34.22	0.2031*	29.46
AVERAGE	0.2258*	14.67	0.2300*	14.07
GOOD$VGOOD	0.4152*	24.96	0.4120*	23.06
NUSTORY	0.0675*	8.04	0.0734*	8.97
BASEMENT	0.0847*	8.13	0.0731*	7.15
FRAME	!0.0736*	!7.85	!0.0538*	!6.00
ALUM	!0.0919*	!8.58	!0.0601*	!5.65
LN$POPDEN	0.0089*	2.62	0.0041	0.74
%EDUCB	0.2816*	4.86	0.1601	1.62
MEDHSINC	0.0000*	13.31	0.0021*	5.70
LN$CITYDIST	!0.0033	!0.24	0.0154	1.68
LN$TOWNDIST	!0.0059	!1.32	0.0004	0.05
Lambda			0.6339*	167.09
Adjusted R^2	0.7390		0.7741	

* Denotes statistical significance at the 5% level.

because not all of Calvert towns provide desirable amenities or employment opportunities. Towns between and within these counties vary enormously. For both Carroll and Howard, we find a high degree of correlation between distance to towns and distance to city (ρ ranges from !0.65 to !0.45), but dropping this variable from the estimation did not change any of the results appreciably.

Hypothesis tests on the estimated coefficients for the block-group census variables resulted in some unexpected outcomes. In Howard County, the estimated coefficient on *LN$POPDEN* is not statistically significant, in Carroll it is positive and statistically significant, and in Calvert it is negative and statistically significant. However, population density could have two opposite effects on housing prices. Our a priori hypothesis was that population density is a measure of congestion. Nevertheless, it is conceivable that population density acts as a proxy for the density of other goods and services which might attract people and bid up the housing prices—although we hope to have captured these locational amenities that are capitalized in the value of the home through inclusion of other right-hand-side variables. *MEDHSINC* has the expected positive coefficient in Carroll and Howard counties, but is not statistically significant in Calvert County. The coefficient on *%EDUCB* is positive and statistically significant only in Calvert County. These census variables are averages over the block group rather than for the micro-neighborhoods surrounding the transaction parcels comprising the data set. Unfortunately, these are the most disaggregated variables available for these neighborhood attributes.

The policy-relevant coefficients on the four open space land use variables in each of the counties also revealed mixed results. The Haussman test for endogeneity indicated the predicted values for the large buffer *P$LGPERMOPEN* and *P$LGAGFOREST* measures should be used for both Calvert and Carroll counties, while in Howard County, predicted values were used for these two variables as well as for the small buffer *P$SMAGFOREST* measure. Given the functional form used for the hedonic estimation, the estimated coefficients on these variables can be interpreted as elasticities. In Calvert County, the estimated coefficient on the large permanent open space (*P$LGPERMOPEN*) is positive and statistically significant, with an estimated elasticity of 0.71. In Howard County, the estimated coefficients for both the large (*P$LGPERMOPEN*) and small (*SMPERMOPEN*) open space variables are positive and statistically

Table 6. Error Term Spatial Dependence Test Statistics, by County

	County		
Test Statistic[a]	Calvert	Carroll	Howard
Likelihood Ratio	89.74 (0.0000)	58.34 (0.0000)	606.39 (0.0000)
Lagrange Multiplier	109.84 (0.0000)	77.54 (0.0000)	1,093.29 (0.0000)

[a] The Moran's I test statistic was positive and significant for Calvert and Carroll counties. It was not computationally feasible for Howard County due to the large number of observations.

significant with estimated coefficients of 0.59 and 0.05, respectively. In Carroll County, these two estimates are not statistically significant.

Carroll County residents could value open forest and agricultural land less because there is a greater amount of these lands in this county. However, in the large buffer, Carroll County had a mean of 12% permanently preserved open space and 53% unpreserved agricultural and forest land around the parcels examined. Howard County had a mean of 13% permanently preserved open space and 36% unpreserved agricultural and forest land. Calvert County had only 5% permanently preserved open space, but 51% unpreserved agricultural and forest land. Similarly, in the small buffer, Carroll had a mean of 4% permanently preserved open space and 20% agricultural and forest land, with corresponding values for Howard County of 3% and 14%, and for Calvert County, 1% and 20%. Thus, while Carroll has more open space around each parcel (65% compared to 56% in Calvert and 49% in Howard), it seems unlikely the differences in open space immediately surrounding the parcels alone explain the results.

If we consider open spaces beyond those surrounding individual houses, we find there is more agricultural land available in Carroll County. In 1997, Carroll had 178,000 acres of agricultural land compared to 40,000 acres in Howard and 45,000 acres in Calvert. In addition, while the rate of housing development is increasing in Carroll County, the county has not experienced the conversion rates seen in Howard and Calvert counties during the last 25 years. Thus, Carroll County residents may have a lower willingness to pay for open space due to a perception that there is a sufficient quantity of open space and they do not perceive it is disappearing quickly.

Another possibility is that Carroll County farmers employ different production practices than Howard or Calvert farmers. For example, they might start farming earlier in the morning, have a higher density of animals with the accompanying odors and insects, spray insecticides more frequently, or employ some other practice which neighboring residents find objectionable. Therefore, although residents receive some positive externalities from the presence of nearby open space, they also receive negative externalities as well—negating the positive effects.

Additionally, we hypothesized that open space is a luxury good and will have more value in counties where incomes are higher. While Howard County's median income is much higher on average than in either of the two other counties, Carroll's average median income of $44,000 is not much lower than Calvert's median income of $48,000. In conclusion, further analysis is needed to explain the lack of significance in Carroll. While the results for Howard County were robust, results for the Carroll and Calvert county models show the estimated coefficients were sensitive to changes in the variables and specification.

Interestingly, the agricultural and forest land measures (*AGFOREST*) were either negative and statistically significant or not statistically significant in the three counties, suggesting individuals either do not wish to live near these lands or are not willing to pay a premium to do so. We remain perplexed by this result. While permanent open space did have an impact in two counties, open space in agricultural or forest use that may be developed in the future was not important or decreased the value of the property. As mentioned above, perhaps these farms use production practices that generate negative externalities to the neighbors. Perhaps the insecurity of not knowing what changes might occur next to a parcel some time in the future fosters a lack of willingness to pay to be next to the open space.

In addition, the forests abutting these properties might be unsightly or people might prefer to have a view which the trees block. Deer have become an issue in these counties as they eat homeowners' landscape plants, cause car accidents, and increase the incidence of Lyme disease—all of which could make forest land less desirable. However, we still find it surprising that homeowners are not willing to pay more to be near agricultural and forest land.

The central policy focus relates to the effect of permanent open space on housing values. Based on the regression results, Carroll County will have no additional property taxes from increased preserved agricultural land, as this land use variable had no effect on the housing value. Consequently, we now focus exclusively on Calvert and Howard counties to conduct the simulations.

Simulations

How much additional land can agricultural easement programs finance? To answer this question, we used the estimated elasticities from the regression models for Howard and Calvert counties to simulate the increase in property taxes associated *only* with houses located near current agricultural easements for a 1% increase in the neighboring agricultural easements. As both the large and small permanent open space measures were statistically significant for Howard County, the larger measure is used for the simulations.[4]

We increase permanent open space by 1% and calculate the increase in tax revenue associated with the increase in housing values. Taking information on land use around preserved agricultural parcels in Howard and Calvert, the area of low density (0.4 units per acre) and medium/high density residential land (8 units per acre) for a one-mile (approximately 1,600 meters) radius buffer was calculated. This area was multiplied by the relevant housing density to compute the expected number of houses within this one-mile distance from each preserved parcel.

Using the average value of houses in each of the counties ($134,245 for Calvert and $227,963 for Howard), the total value of the expected housing in each buffer was calculated. The increase in the property values was then calculated using the estimated elasticity assuming current preserved agricultural land has increased by 1%. Next, this increase in the parcel value was multiplied by the county property tax rate ($0.89 per $100 for Calvert and $1.04 per $100 for Howard) to determine how much tax revenue would be generated each year by the simulated increase in preserved agricultural land.[5]

Finally, using the average county easement payment over 1993–1997 ($2,855 for Calvert and $5,274 for Howard), the total number of new acres of agricultural easement that could be purchased with the increased tax revenue from just one year of property tax revenue was computed. Simulation results are presented in table 7.

Table 7. Simulation Results for One-Mile Buffer of Each Agricultural Easement: Howard and Calvert Counties

Description	Howard County	Calvert County
[1] Sum of total housing within 1 mile of each easement	41,631	29,526
[2] Average housing price	$227,963	$134,245
[3] Expected housing value (= [1] ([2])	$9,490,251,998	$3,963,690,359
[4] 1% increase in open space	181 acres	148 acres
[5] Estimated elasticity from spatial model	0.5869	0.7118
[6] Expected housing value increase for a 1% increase in open space (= [3] ([5])	$55,695,442	$28,214,618
[7] Additional property tax collected on increased value	$579,233	$251,674
[8] Average easement price per acre	$5,274	$2,855
[9] Additional acres of easement that could be acquired (= [7] ÷ [8])	110 acres	88 acres

For a 1% increase in preserved agricultural land (148 acres) in Calvert County, the increase in housing values within a one-mile radius of preserved parcels generated sufficient tax revenue to purchase an additional 88 acres in the first year. Assuming no real change in housing prices and no change in the property tax rate, the county could increase the number of acres preserved by 2,640 acres in 30 years. For a 1% increase in preserved agricultural land in Howard County (181 acres), the increase in housing values within a one-mile radius of these preserved parcels generated sufficient tax revenue to purchase an additional 110 acres in one year, or in 30 years increased the preserved acreage by 3,300 acres.

Conclusions

Many agricultural land preservation programs have inadequate resources to preserve all the parcels the general public may wish protected and that agricultural landowners would be willing to enroll. Programs are looking for innovative funding mechanisms or new sources of funds. Beyond the social benefits provided by permanently preserved agricultural land to the region's residents as a whole,

[4] The small open-space buffer is part of the large open-space buffer; thus, using both would be double-counting.

[5] The increased value will not be immediately evident in the assessed value of the property on which the property tax is based. However, in Maryland, these assessments are updated at least once every three years. The assessments are based on the fair market value using standard appraisal approaches. A recent transaction will be used in computing the fair market value of that property as well as the price of adjoining and comparable properties. Thus, we estimate the model using the most recent transaction price, knowing that within 0–3 years of the transaction, the property's assessment will be comparable. The property tax rate for Howard County is $1.044 for each $100 of assessed value, so we used a rate of 0.01044 for ease of exposition.

positive impacts may accrue directly to the owners of parcels neighboring the preserved parcels. These benefits usually are partially recaptured through increased property taxes, yet are not explicitly realized.

The increased tax revenue could be used to fund additional easement acquisitions rather than entering the county's general fund. This is especially important in some states where the agricultural land preservation programs are funded at least in part by the continued conversion of agricultural land to other uses. For example, in Maryland, the agricultural transfer tax is generated when farmland leaves an agricultural use for a residential, commercial, or industrial use, and this tax revenue is used to finance farmland preservation.

Lynch and Lovell (2002) determined that to preserve one acre of land at the average easement price per county using the agricultural transfer tax as the sole funding mechanism, $64,080 worth of farmland must be converted in Calvert County and $124,933 in Howard County. Using the 1997 value of land and buildings per acre of $3,584 in Calvert County and $5,518 in Howard County (U.S. Department of Agriculture, 1997), the conversion of almost 17.9 farmland acres in Calvert and 22.6 acres in Howard would be needed to finance the preservation of one acre.

Our findings show preserved open space does increase property values on adjacent residential parcels in two of the three examined counties in Maryland. Assuming the existing open space increases by 1%, using simulations based on the spatial econometric model, the increased property tax from these agricultural easements could generate enough revenue to purchase a significant portion of the 1% more open space acres, especially if one considers that the increases in tax revenue go on in perpetuity. In both Howard and Calvert counties, the revenue generated from an increase in permanent open space could purchase approximately 60% of the increase of the newly preserved lands in the first year alone. Conversely, in Carroll County, property values are not affected by proximity to open space.

As discussed above, Carroll County residents may value open forest and agricultural land less because, while they have similar percentages of open space immediately around them, the county as a whole has more of it. However, we do not demonstrate our first hypothesis that open space itself increases property values. In fact, unpreserved agricultural and forest land decreased the values in Carroll and Calvert counties. Thus, further research may be needed to determine the attributes of open space for which residents are willing to pay.

This research has the potential to contribute to the analysis of other government conservation and infrastructure programs, particularly economic-based policy programs and the spatial interaction between such programs. If the government intervenes and changes land use in ways that generate positive externalities—such as implementing dune and beach grass restoration programs designed to decrease beach erosion and thus improve the quality of the beach for nearby homeowners and other beach visitors—then the financing of these programs could be partially funded from some diversion of the increased housing values' impact on property tax (Parsons and Noailly, 2001).

References

Acharya, G., and L. L. Bennett. (2001). "Valuing Open Space and Land-Use Patterns in Urban Watersheds." *Journal of Real Estate Finance and Economics* 22(2/3), 221–238.

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

Bell, K. P., and N. E. Bockstael. (2000). "Applying the Generalized Method of Moments Estimation Approach to Spatial Problems Involving Micro-Level Data." *Review of Economics and Statistics* 82(1), 72–82.

Bockstael, N. E. (1996). "Modeling Economics and Ecology: The Importance of a Spatial Perspective." *American Journal of Agricultural Economics* 78(5), 1168–1180.

Bowers, D. (2000). "6th Annual Survey." *Farmland Preservation Report* 10(9), 1–7.

Breffle, W. S., E. R. Morey, and T. S. Lodder. (1998). "Using Contingent Valuation to Estimate a Neighborhood's Willingness to Pay to Preserve Undeveloped Urban Land." *Urban Studies* 35(4), 715–727.

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.

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

Chesapeake Bay Foundation. (2002). "Future Growth in the Washington, DC, Metropolitan Area." Annapolis, MD. Online. Available at http://www.savethebay.org/land/landuse/maps/future_growth.html

Cheshire, P., and S. Sheppard. (1995, May). "On the Prices of Land and the Value of Amenities." *Economica* 62, 247–267.

Correll, M. R., J. H. Lillydahl, and L. D. Singell. (1978, May). "The Effects of Greenbelts on Residential Property Values: Some Findings on the Political Economy of Open Space." *Land Economics* 54, 207–217.

Cropper, M. L., L. B. Deck, and K. E. McConnell. (1988). "On the Choice of Functional Form for Hedonic Price Functions." *Review of Economics and Statistics* 70(4), 668–675.

Do, A. Q., and G. Grudnitski. (1995). "Golf Courses and Residential House Prices: An Empirical Examination." *Journal of Real Estate Finance and Economics* 10(3), 261–270.

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

Gardner, B. D. (1977, December). "The Economics of Agricultural Land Preservation." *American Journal of Agricultural Economics* 59, 1027–1036.

Garrod, G., and K. Willis. (1992a). "The Amenity Value of Woodland in Great Britain: A Comparison of Economic Estimates." *Environmental and Resource Economics* 2, 415–434.

———. (1992b). "The Environmental Economic Impact of Woodland: A Two-Stage Hedonic Price Model of the Amenity Value of Forestry in Britain." *Applied Economics* 24(7), 715–728.

———. (1992c). "Valuing Goods' Characteristics: An Application of the Hedonic Price Method to Environmental Attributes." *Journal of Environmental Management* 34, 59–76.

Geoghegan, J. (2002). "The Value of Open Spaces in Residential Land Use." *Land Use Policy* 19(1), 91–98.

Geoghegan, J., L. Wainger, and N. E. Bockstael. (1997). "Spatial Landscape Indices in a Hedonic Framework: An Ecological Economics Analysis Using GIS." *Ecological Economics* 23(3), 251–264.

Halstead, J. M. (1984, April). "Measuring the Non-market Value of Massachusetts Agricultural Land: A Case Study." *Northeastern Journal of Agricultural Economics* 14, 12–19.

Hammer, T. R., R. E. Coughlin, and E. T. Horn, IV. (1974, July). "The Effect of a Large Urban Park on Real Estate Values." *American Institute of Planners Journal* 40(4), 274–277.

Irwin, E. G. (2002, November). "The Effects of Open Space on Residential Property Values." *Land Economics* 78(4), 465–480.

Irwin, E. G., and N. E. Bockstael. (2001). "The Problem of Identifying Land Use Spillovers: Measuring the Effects of Open Space on Residential Property Values." *American Journal of Agricultural Economics* 83(3), 698–704.

Kitchen, J. W., and W. S. Hendon. (1967, August). "Land Values Adjacent to an Urban Neighborhood Park." *Land Economics* 43, 357–361.

Kline, J., and D. Wichelns. (1994). "Using Referendum Data to Characterize Public Support for Purchasing Development Rights to Farmland Programs." *Land Economics* 70(2), 223–233.

———. (1996a). "Measuring Public Preferences for the Environmental Amenities Provided by Farmland." *European Review of Agricultural Economics* 23, 421–436.

———. (1996b). "Public Preferences and Farmland Preservation Programs." *Land Economics* 72(4), 538–549.

———. (1998). "Measuring Heterogeneous Preferences for Preserving Farmland and Open Space." *Ecological Economics* 26, 211–224.

Land Trust Alliance. (1999–2001). "Voters Invest in Parks and Open Space: Referenda Results." Annual referenda results for 1998, 1999, and 2000. Land Trust Alliance, Washington, DC. Online. Available at: www.lta.org.

Leggett, C. G., and N. E. Bockstael. (2000). "Evidence of the Effects of Water Quality on Residential Land Prices." *Journal of Environmental Economics and Management* 39(2), 121–144.

Lynch, L., and S. J. Lovell. (2002). "Hedonic Price Analysis of Easement Payments in Maryland Agricultural Land Preservation Programs." Working Paper No. 02-13, Department of Agricultural and Resource Economics, University of Maryland, College Park.

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

McMillan, M. (1974, November). "Open Space Preservation in Developing Areas: An Alternative Policy." *Land Economics* 50, 410–417.

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

Parsons, G. R., and J. Noailly. (2001). "A Value Capture Property Tax for Financing Beach Nourishment Projects: An Application to Delaware's Ocean Beaches." Unpublished manuscript, University of Delaware, Newark.

Peiser, R. B., and G. M. Schwann. (1993, Summer). "The Private Value of Public Open Space Within Subdivisions." *Journal of Architectural and Planning Research* 10, 91–104.

Ready, R. C., M. C. Berger, and G. Blomquist. (1997, Fall). "Measuring Benefits from Farmland: Hedonic Pricing vs. Contingent Valuation." *Growth and Change* 28, 438–458.

Shultz, S. D., and D. A. King. (2001). "The Use of Census Data for Hedonic Price Estimates of Open Space Amenities and Land Use." *Journal of Real Estate Finance and Economics* 22(2/3), 239–252.

State of Maryland, Department of Planning. *MdProperty View.* Statewide property map and parcel database. Baltimore, MD. Online. Available at http://www.mdp.state.md.us/data.mdview.htm.

Tyrvainen, L., and A. Meittinen. (2000). "Property Prices and Urban Forest Amenities." *Journal of Environmental Economics and Management* 39(2), 205–223.

U.S. Department of Agriculture, National Agricultural Statistics Service. (1993–1997). *Agricultural Statistics.* USDA/NASS, Washington, DC. Various annual issues.

U.S. Department of Commerce, Bureau of the Census. *1990 Census of the Population: General Population Characteristics, U.S. Summary.* Washington DC: Government Printing Office, 1993.

Vesterby, M., A. Daugherty, R. Heimlich, and R. Claassen. (1997, June). "Major Land Use Changes in the Contiguous 48 States." AREI Update No. 3. USDA/ERS/NRED, Washington, DC.

Weicher, J. C., and R. H. Zerbst. (1973, February). "The Externalities of Neighborhood Parks: An Empirical Investigation." *Land Economics* 49, 99–105.

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.