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Using Agricultural and Forest Land Values to Estimate the Budgetary Resources Needed to Triple Maryland's Preserved Acres

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Land preservation has long been a goal of Maryland. To slow the disappearance of agricultural, forest, and other natural lands, Maryland has developed a variety of land preservation programs. Maryland has been consistently a leader among states in these efforts. As a further demonstration of its commitment to agricultural and forest land preservation, on April 7, 2002, the Maryland General Assembly approved Senate Joint Resolution 10. This resolution set a goal of preserving triple the amount of land currently in preservation status, or approximately 686,000 acres, by the year 2022. This is approximately 34,300 acres per year.

In the 25 years that agricultural and other preservation programs have existed in Maryland, the state and county programs have preserved approximately 343,000 acres. Thus, achieving the goal of preserving twice that amount or 686,000 more acres in just 20 years may prove difficult unless sufficient resources are allocated to achieve the target. In addition, if the programs have managed to purchase easements on the "easiest" to enroll parcels, then policymakers will need to re-examine eligibility criteria and determine what further steps must be taken in order to attract the remaining eligible lands.

Maryland has lost a large percent of its farmland since 1950, 47% loss of Maryland farmland (USDA 1999) and its population has increased 119% respectively (U.S. Census Bureau 1999). And the threat of continued loss remains high. The American Farmland Trust ranked the Northern Piedmont region (southeastern Pennsylvania, Maryland, and northeastern Virginia) as the second most threatened agricultural area in the United States; and the Mid-Atlantic Coastal Plain/Delmarva Peninsula (Delaware and Marylou de marche and's Eastern Shore) as the ninth most threatened based on each area's market value of agricultural production, development pressure, land quality, and high rates of farmland conversion (American Farmland Trust, 1997).

The Maryland Department of Planning predicts that 500,000 more acres of farms, forests, and other open spaces will be converted to development over the next 25 years under current trends. Both Maryland and Delaware's populations are projected to increase by 2020. Maryland's population is projected to grow 11.5% to 6 million people by 2020. Therefore, the on-going concerns about the conversion of agricultural land to housing and commercial development are well founded. However preservation is becoming more costly as the value of land continues to increase. Between 2005 and 2006, there was an increase of 13% in Maryland to $8,900 per acre. And as more land is preserved and the supply of developable land decreases, one may see the price of land continue to escalate. Therefore, one important element of reaching the goal is how much money needs to be allocated to finance the endeavor. This report addresses both questions of eligibility and expected budgetary outlays.

Predicting the cost of preserving additional lands requires us to know the value of agricultural land. To generate an estimated value of land and location attributes in the land market, hedonic models for per-acre prices were estimated using actual sales transactions for agricultural and forest land in Maryland from 1997 to 2003. Separate models were estimated for 6 groups of counties across the state: Urban Central, Rural Central, Southern, Upper Eastern Shore, Lower Eastern Shore and Western. Within a group, separate models were estimated for parcels with residential structures and those without structures. The models were tested for spatial correlation.

Given the predominance of spatial correlation in the models, spatial correlation models were run for all the models. Most land characteristics performed much as we expected in explaining the prices. Predicted prices per acre were within 5% of the actual market price in the out-of-sample group. Predicted prices were less accurate for high-valued parcels than for low-valued parcels; however, for the purposes of this study this error is less of a concern than having poor predictions for the low-valued parcels.

In general, the results suggest that per-acre prices will decrease as acreage on a parcel increases; larger parcels receive lower per-acre prices. This was true for parcels with and without residential structures. While, in general, models show that being closer to a city increased the value of the property, in the localized multi-county models distance was less important. Some of the nearest cities (Hagerstown, Cumberland, and Salisbury) seem to have less impact on the price per acre than cities such as Baltimore and Washington, D.C.

Another common result across the models was that parcels with a higher percentage of cropland had higher prices per acre than those with higher percentage of forest for parcels without structures. However, having forested acreage rather than cropland did not impact the price per acre for parcels with residential structures in four of the six regions Prime soils were not as influential in determining prices as was expected a priori. The price per acre of a parcel with waterfront was higher. While parcel price per acre for those with residential housing has been increasing since 1999 in most regions, those without housing structures exhibited more variance in prices overtime – with some regions increasing then decreasing and others having a price increase only at the very end of the study period.

Using eligibility criteria based on Maryland Agricultural Land Preservation Foundation's (MALPF) minimum standards (50 or more acres and 50 percent prime soils), we find Maryland has a great deal of high quality farmland and forestland available to be preserved. In addition, more acreage will become eligible as more parcels are preserved and other parcels become contiguous with newly preserved parcels. The resulting number of eligible parcels statewide was 7,227, with a total of 850,490 acres. Average predicted per-acre land price for the eligible parcels was $4,512, and average size was 118 acres. Average percentage of prime soils was 84%. In addition, some of this agricultural land continues to be relatively inexpensive, especially if one assumes that landowners will continue to accept easement payments of less than the full easement value (discounting). Therefore, adjustments in eligibility criteria do not appear necessary to reach the preservation target.

The estimated coefficients from the hedonic regressions mentioned above allow us to predict prices for all agricultural parcels in the state greater than 10 acres. Using these predicted prices, we then could determine the market value of the least expensive 686,000 acres to preserve. The budgetary resources needed to compensate these landowners for lost development rights and preserve 686,000 acres of land were computed to be $2.29 billion.[1] The average price per acre for these least expensive parcels was $3,367. There were 5,137 parcels identified from all over

[1] As mentioned above, one can see these estimates as the maximum value needed, assuming that some number can be deleted for the agricultural value. For example, if we assume that the agricultural value of land in Maryland is $400 per acre, the cost of preserving the 686,000 acres would be $274.4 million less than the cost to purchase the acres outright. If the agricultural value was $300 per acre, the cost would be $205.8 million less.

the state that would meet this goal in the least expensive manner possible. These parcels had high average soil quality (82%), were primarily cropland (64%), and averaged 134 acres each. The needed monetary resources might be less given that the agricultural value of the land, the ongoing stream of income the landowner can generate, has not been subtracted. Landowner discounting such as under MALPF is possible (landowners accepting approximately 25% less than the easement value). With a 25% discount, the budgetary resources could be closer to $1.72 billion for the least expensive parcels. Given that one cannot guarantee that this level of discounting will continue or that all preservation will be conducted by MALPF or another program that also uses discounting, we have reported the estimated full land value amount. Preserving land with higher levels of prime soils or with higher averages of cropland would require the state to expend over $400 million more than the "least-cost" targeting strategy. Other types of characteristic-targeting were also investigated.

Current escalations in land value suggest that the total resources needed may be higher. For example, based on USDA's land value estimates, the average per-acre farm value has more than doubled since 2002, from $3,900 per acre to $8,900 per acre. Rental rates have also increased 12% suggesting increased agricultural profitability. While this survey is farmers' opinions of the value of their land and buildings rather than based on actual market transactions, it provides some sense of the magnitude of the price increases. Thus, we estimate the total resources needed to preserve the 686,000 eligible acres given an increase in land values from 12 to 100 percent would be $2.56 billion on the low end and $4.58 billion on the high end.

INTRODUCTION

Resource land preservation has long been a goal of Maryland. To slow the disappearance of agricultural, forest, and other natural lands, Maryland has developed land preservation programs as well as programs to direct housing development to targeted areas called priority funding areas. In fact, Maryland is consistently a leader in these efforts beginning one of the first programs to preserve open space through conservation easement donations, the Maryland Environmental Trust (MET) in 1967.[2] MET had preserved almost 111,600 acres. Soon thereafter, the State's Department of Natural Resources (DNR) created Program Open Space. Through this program, the State has amassed more than 250,000 acres for state and local parks throughout Maryland. And in part due to this program's efforts, Maryland ranks thirteenth in all the states in terms of acres of parks (U.S. Census Bureau, 2002) although much smaller than many other states. Maryland also pioneered statewide purchase of development rights in the late 1970's with the creation of the Maryland Agricultural Land Preservation Foundation (MALPF). MALPF was one of the first statewide farmland preservation programs in the country. As of 2004, MALPF has preserved almost 233,000 acres at a cost of $329 million (MALPF Task Force 2005). In addition to the statewide efforts, individual counties have introduced their own agricultural preservation programs using both transfer of development rights (TDR) and purchase of development rights formats. Calvert County and Montgomery County are considered leaders in the use of TDR programs. Howard County's use of installment purchase agreements is studied throughout the country. More recently in 1990, the Maryland Greenways Commission was established to preserve natural infrastructure through corridors such as streams and mountain ridges. The newest program, Greenprint, began in 2001 and builds on the preservation goal to specifically target large natural land areas. Similarly, the Rural Legacy program, begun in 1997 as part of the Smart Growth program, seeks to preserve large contiguous blocks of natural and working landscapes. Maryland continues to pass legislation and appropriate funds to these programs that protect rural areas and working lands. Federal and state tax benefits also provide incentives to landowners to enroll their property in preservation programs.

In short, Maryland has made a commitment to agricultural and forest land preservation. These programs began in part because the State lost almost 50 percent of its agricultural land, 1.9 million acres, between 1949 and 1997. The 1970's were the beginnings of this effort because by then Maryland had lost more than 1.4 million farmland acres of the 4 million acres it had in 1949. A recent report predicted that Maryland would lose 40,000 more acres by 2010 (Gardner et al. 2002). While the losses have been large, Maryland still contains a fair amount of natural and working lands. The State of Maryland encompasses 6.2 million acres. In December 2002, developed lands represented only 20 percent of Maryland's total land area, and protected lands[3] accounted for another 19 percent. Much of the remaining land, 61 percent, was privately owned, undeveloped land (3.8 million acres); one-half in agriculture and the other one-half in forest or natural cover.

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[2] A conservation easement limits the landowner's right to develop and subdivide the land, both now and in the future but the land remains in the private ownership. Landowners often receive cash payments and/or tax incentives for donating the conservation easement. Resale of the land does not erase the easement restrictions. Easement restrictions to date have been upheld by the courts (Danskin 2000) and thus these programs can be seen as permanently retaining farm and forest land.

[3] Protected lands include lands publicly owned at the federal, state, and local levels, as well as private preserves and privately owned lands with conservation easements.

While Maryland still retains a high level of undeveloped land, both the population growth and projected growth illuminate the concerns for continued conversion. In the 2000 Census, Maryland ranks eighth in the nation in percentage of population in metropolitan areas (93 percent) (U.S. Census Bureau, 2002). Maryland's population grew by 30 percent between 1973 and 1997, resulting in the conversion of nearly 400,000 acres to intensely developed uses during that period. This represents a 49 percent increase in the amount of intensely developed land in the State in a 24 year period (Maryland Environmental Trust, 2004). The State's population density rose 11 percent from 1990 to 2000, from 489 people per square mile to 542 people per square mile, with some regions growing more rapidly than others (Maryland Department of Planning, 2001). In addition, in the Washington, D.C., metropolitan area, the rate at which land is being consumed exceeds the population growth rate by almost 2.5 times. Maryland's population is expected to grow to 6.0 million, or by 13 percent, by 2020. This rate of growth is expected to consume more land over the next 20 years than all the land developed in the Chesapeake watershed over the last 200 years (Chesapeake Bay Foundation, 2000). Given these predictions, if the remaining agricultural and other resource lands are to be retained, drastic action is needed as soon as possible.

On April 7, 2002, the General Assembly approved Maryland Senate Joint Resolution 10. This resolution set a goal of preserving triple the amount of land currently in preservation status, or approximately 686,000 acres, by the year 2022. This is approximately 34,300 acres per year. In the 25 years that agricultural preservation programs have existed in Maryland, the state and county programs have preserved approximately 343,000 acres. Thus, achieving the goal of preserving 686,000 more acres in just 20 years may prove difficult unless sufficient resources are allocated to achieve the target. If the programs have managed to purchase easements on only the "easiest" parcels thus far—i.e., the "low-hanging fruit"—then policymakers will need to re-examine eligibility criteria and determine what further steps must be taken in order to attract the remaining eligible lands. One important aspect is how much money would be needed to fund this effort.

Citizens have stated through a variety of means that preserving agricultural land and open space is an important and worthwhile goal. Research studies and the passing of local and national bond initiatives indicate that taxpayers are willing to finance this type of endeavor. Agriculture continues to be a strong and viable part of the Maryland economy and vital to its continued economic health, particularly in certain counties. Yet, even with public support and the current funding mechanisms, the existing programs may not have sufficient resources to preserve enough parcels to meet the goal and/or may not be able to offer high enough easement payments to induce participation of the remaining agricultural landowners.

In addition, MALPF and some of the local preservation programs are funded at least in part by the continued conversion of farmland to other uses. The agricultural transfer tax is generated when farmland leaves an agricultural use for a residential, commercial, or industrial use. Through simple calculations, one can determine the cost of preserving one acre of land at the average 2002 MALPF easement price per county when the agricultural transfer tax is the sole funding mechanism. Carroll County would require the conversion of $60,051 worth of farmland, Baltimore County the conversion of $76,352, St. Mary's the conversion of $49,607, and Talbot

County the conversion of $40,722. In terms of acres, the preservation of just one acre of land in Carroll County would require the loss of 11.65 acres elsewhere in the county, in Baltimore County the loss of 9.6 acres, in St. Mary's the loss of 12.75 acres and in Talbot County the loss of 9 acres.

Thus, program administrators face a great challenge. They have limited resources to elicit participation from those landowners whose parcels offer a high level of social benefits. Policymakers must strive to ensure that each dollar is used most efficiently and contributes to achieving at least one of the myriad of goals set by the preservation programs. They must find new means of financing the preservation or less costly preservation techniques to ensure that they have sufficient resources to meet the ambitious goal. Preservation programs may need to be adjusted if policymakers are to preserve the kind of parcels they desire as well as the number of acres.

This report outlines the results for three research objectives:

1. Analyze the market value of the agricultural and forest properties using a hedonic price approach for recent transactions of agricultural and forest land (1997-2003) corrected for spatial correlation. Hedonic price functions use an econometric procedure to determine the market value of each land and location characteristics, holding all other variables constant. Estimated parameters define the market value for land and location characteristics such as distance to major cities and soil quality.

2. Assess the number of un-preserved agricultural and wooded acres available under current minimum MALPF criteria. These criteria include acreage, soils, and/or proximity to other preserved parcels. Currently, Maryland has preserved 343,000 acres (Maryland Department of Agriculture 2002). Are there 686,000 more acres that could be enrolled in agricultural land preservation programs given the existing eligibility criteria?

3. Use the estimated coefficients from objective (1) to predict the cost of preserving un-enrolled eligible farms identified in objective (2), given their characteristics.

OBJECTIVE 1: ANALYZE THE MARKET VALUE OF AGRICULTURAL PROPERTIES

To determine the market value of the agricultural parcels, we examined market transactions of agricultural properties in Maryland from 1997 to 2003. By looking at these market transactions, we can determine what value different land characteristics have. Once we know the values of the land and locational characteristics, we can use them to predict the prices of other agricultural parcels around the state that have not sold during the study period. Because each land parcel is unique, we estimate what are called hedonic models that allow for the fact that parcels have different combinations of characteristics. The estimated value for a characteristic is computed assuming everything else on the parcel stays the same. For example, how much would being a mile closer to Baltimore be worth given the same number of acres, the same percentage of prime soils, etc.? These estimations also take into account that the land has value for its agricultural, forest, and/or residential use that may be realized at some point in the future. Details of the hedonic model can be found in Appendix A.

We analyzed the price per acre for the 1997 to 2003 sales transactions for agricultural and forest parcels.[4] We found that land parcels with structures such as houses seem to be valued differently than land parcels without structures. Therefore, we estimate two different models: one for the per-acre land price of parcels with residential structures (per-acre improved) and one for the per-acre land price of parcels without residential structures (per-acre unimproved). We derive the price of land per acre by subtracting the appraised improvement value from the market sales price and dividing by the number of acres in the parcel.[5] We adjusted the land price per acre by taking the natural log of the per-acre price, and we used this as the dependent variable. We considered a variety of land and location characteristics that are consistent with those used in previous analyses of farmland values and with the goals of Maryland's agricultural preservation programs (Bell and Bockstael 2000; Nickerson and Lynch 2001; Shi, Phipps and Colyer 1997).

We assume that the price people will pay for a parcel is a function of its ability to produce income from agricultural or forest uses and from housing and aesthetic services. Potential buyers and sellers (and the professional appraisers) look at comparable sales to the parcels considered. These sales prices are then used to infer the value of different characteristics and thus how much a particular parcel would be worth. Therefore the included characteristics are those that reflect agricultural, forest and development values.

Characteristics Explaining Land Values

Distance to Nearest City. The distance to the nearest city on a road network is included to represent the potential development value, commuting time to an employment center, how far in the future one might expect the parcel to be converted to a more developed use, and transportation costs to a market or output processors (LDCITY). Farms that are closer to a city and its employment opportunities are expected to have higher values and are expected to be developed sooner than those farther away. We also allow for the fact that the distance to a city and the value of the parcel may vary by how far away the parcel is. For example, if the parcel is within 25 miles of Baltimore, the city may have a greater influence on the development potential than if the parcel is more than 25 miles away.[6]

Improvement Value. Improvements to a parcel may impact the overall worth to a potential buyer, even though they are not included in the per-acre land price variable; i.e., the land may be worth

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[4] Prices were adjusted using the Index of Prices Received by Farmers (USDA) to a base year of 2003 to account for any inflation/deflation of the dollar that had occurred during this time period.

[5] Maryland reassesses the value of improvements and land every 3 years. Therefore, while this may not be a perfect representation of the house's value, it does provide us with the best possible estimate.

[6] To incorporate this nonlinear relationship, the distance to the nearest city was transformed to the natural logarithm of distance to the nearest city.

more or less to someone if there is a house attached to it. Improvements (IMPS) include not only residential structures, but other structures and improvements such as roads, docks, barns, etc. In the dataset, the majority of improvements were residential structures.[7]

Waterfront access. People often will pay a premium to be next to a river, the Bay, or an ocean because proximity to water provides an amenity or aesthetic service to them. Farms with waterfront areas thus may have higher market values as potential purchasers or developers factor this attribute into the price they are willing to pay. Therefore, a variable was created (WATER) that equaled 1 if a waterfront area was part of or adjacent to the parcel.

Net agricultural returns. The number of acres, the soil quality, and the type of land use will influence the net agricultural returns and thus the price per acre of a farm or forest parcel. Therefore, variables for the farm size, the proportion of the farm in agricultural uses, and soil quality are included to represent agricultural returns:

- *Parcel Size.* The size of the parcel is included (LDACRES). While larger farms may have higher agricultural returns, 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 price.[8]

- *Land-use.* GIS-computed variables for the percentage of the parcel used in crops, pasture and forest (CROP, PASTURE, FOREST) were also included as proxies for agricultural returns. The estimated coefficients on pasture and forest land can be thought of as the value of these land uses relative to the excluded category, cropland. A parcel with a higher percentage of cropland is expected to have a higher agricultural return than pasture or forested land. Thus, the ongoing agricultural return and the price will be higher for parcels with a high percentage of cropland relative to those with a high percentage of forest or pasture. Also, the cost of removing trees to convert the land or complying with the Forest Conservation Act may make it less desirable to develop than land in other uses, which may decrease the market value for development purposes.

- *Soil Quality.* A GIS-computed variable for the percentage of prime soils (PRIME) was also included. Soil characteristics may affect both the agricultural returns and the returns to converting the land to a residential use. We follow the Maryland soil classification system, which defines prime soil as having high agricultural productivity, good drainage, and little or no slope. A higher percentage of prime soil should indicate the potential for higher

[7] A variable was created for whether or not a residential structure was present on the parcel. The variable equaled 1 if one or more dwellings were present, and 0 if no dwellings were present. Information from the Maryland Property View dataset indicated number of dwellings, but to double-check, we also used the information in that database for square footage of structure, year built, and improvement value to confirm the presence of a residential or other structure. This variable was used to separate the sample into parcels with structures and parcels without structures.

[8] To incorporate a possible nonlinear relationship, the number of acres was transformed to the natural logarithm of the parcel size.

agricultural returns. Therefore, a farm with a higher percentage of prime soils would sell for a higher price, all else the same. Additionally, prime soils may increase the development value of the farm since it is often less costly to build on land with prime soils, as such land is flat and has decent drainage.

Agricultural Easement Restrictions. Because some of the parcels sold in the market had an easement attached which prohibits residential, commercial and industrial development, we also include a variable to indicate whether or not a farm has an easement (AGEASE), 1 equaling yes, and 0 equaling no. Farms with easements may sell for a lower price because of the development restrictions.

County Variables. Binary county variables for all the counties account for differences in the average returns landowners expect to receive - unrelated to the land and locational characteristics described above - due to county-level services (school quality, tax rates, parks and other amenities), permitted zoning densities,[9] and options to converting the land such as preservation programs. Each regression has a base county to which all other counties are compared.

Year of Sale. Binary variables were also created for all the years in the sample, 1997 through 2003 (Y98-Y03). Each year is compared to 1997 the first year of the market transactions.

Geographic Designation of Land Markets

The market value of the individual land and locational characteristics may vary from one region to another in the state depending on the boundaries of the real estate market. Land purchasers may have limited geographic ranges of parcels they would consider. A farmer with an operation in Wicomico County may be more likely to purchase the farm next to his or her current parcels than to purchase a farm in Cecil County, for example. Similarly, an individual working in Washington, D.C., is more likely to look at parcels in Montgomery, Howard, Prince George's or Calvert Counties. Most people looking for a house or land in these counties do not consider a parcel in Allegany or Queen Anne's as a perfect substitute. Geoghegan, Wainger, and Bockstael (1997) write that, if the market encompasses properties that are not really considered by individuals, the market is defined too large and the model results will be biased. On the other hand, if the definition of the market excludes properties that a purchaser would consider, the market is defined too small and the results will be less precise. Omitting relevant properties means the researcher has lost information. In the context of predicting parcel values from hedonic model results, it would be better to have less precise results than biased results. Therefore, an analysis of the land market as one market for the whole state is not desirable. However, determining the extent of the various land markets within the state is difficult to do in a systematic fashion. We therefore choose to designate markets based on crop reporting districts (CRD) as defined by USDA codes (Table 1: Counties by CRD Code). Figure 1 shows the map of the counties in Maryland and Figure 2 presents the outlines of the CRD areas.

[9] Zoning or a proxy for permitted density is often used in estimations of land value. However, in this analysis, we found that almost all the parcels within a county more than 10 acres had the same zoning classification. Because zoning was common amongst parcels, we were not able to use it in the analysis.

Table 1. Counties in Each Crop-Reporting District Code Group

CRD Code	Reference Name	Counties
2410	Western	Allegany, Garrett
2420 (1)	Rural Central	Carroll, Harford, Washington
2420 (2)	Urban Central	Baltimore, Frederick, Howard, Montgomery
2430	Upper Shore	Caroline, Cecil, Kent, Queen Anne's, Talbot
2480	Southern	Anne Arundel, Calvert, Charles, Prince Georges, St. Mary's
2490	Lower Shore	Dorchester, Somerset, Wicomico, Worcester

Counties within each CRD are similar in terms of agricultural land characteristics and based on the geographic supply of farmland. This implicitly assumes that counties in close proximity to each other share similar geographic, location, and other characteristics. Market segmentation is also determined by demand for land either for housing and/or agricultural purpose. Land within a certain distance from the major employment centers and having similar road networks would fall within the same market. Major rivers, the Chesapeake Bay and/or mountain ranges impact the size and extent of markets because of accessibility. The Maryland Division by CRD reflects both these supply and demand considerations.

Because of its size, an additional split was made for CRD code 2420 (Central Maryland), so that Carroll, Harford and Washington Counties made up one group (Rural Central), and Montgomery, Frederick, Baltimore County, and Howard County (Urban Central) made up the other.[10]

We also dropped from the dataset those parcels that:

- had less than 10 acres, as they were likely to be primarily large residential lots
- had improvement values (houses or barns) of more than $1 million (34 observations), as these were seen as being unrepresentative of parcels that a land preservation program might target
- had per-acre land prices of less than $300 per acre (the minimum agricultural use-value assessment)
- had per-acre land prices greater than $30,000 (113 observations), as they were considered unrepresentative of agricultural parcels that preservation programs might target
- listed a residential structure as present but had a zero improvement value listed (50 observations)
- were coded as non arm's-length (transaction through an auction, gift, between parent/child, etc.), and/or
- were missing a sales price.

[10] All observations in Prince George's County were dropped because the information on the structures on each parcel was highly inconsistent and appeared prone to data coding errors. Baltimore City was not included in any of the models.

Figure 1. Geographic Location of Maryland Counties

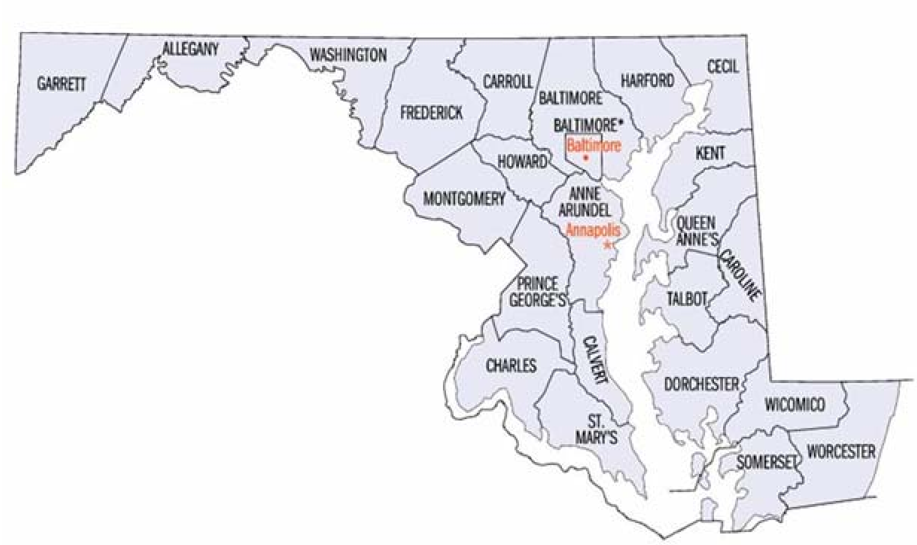


Figure 2. Maryland Counties by Crop Reporting District

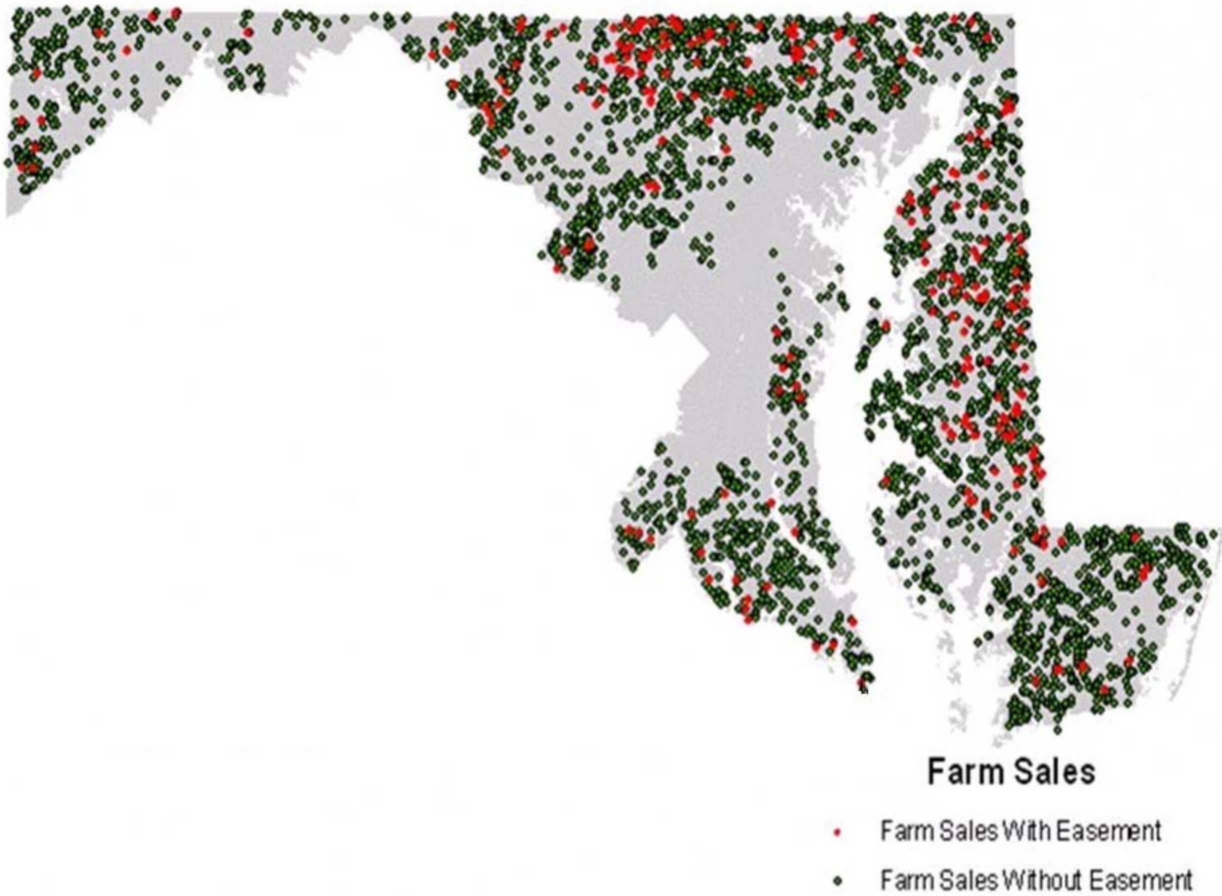
The total remaining number of observations was 3,449 arm's-length parcel sales. Table 2 presents the summary statistics. The geographic distribution of the sales can be seen in Figure 3. For the entire dataset, the average statewide per-acre price in 2003 dollars was $5,568. Average size of a farm was 68 acres and the average percentage of prime soils was 42%. More than half of each parcel was cropped with 5% in pasture and 36% in forest. Almost 5% of the parcels sold had waterfront access. The average distance from a city was 35 miles.

Sales were distributed pretty evenly between the years ranging from 15% in 1997 to 18% in 2000. Carroll County had the highest percentage of sales, at 9% of the total, and Howard had the fewest, at 1.4%. More detailed summary statistics are provided for each crop reporting district (CRD) for the samples with structures and without structures with the regression results reported below (Tables 8, 10, 12, 14, 16, 18, 20, 21, 24, 26, 28, 30).

Table 2. Descriptive Statistics for the Entire Sample (N=3449)

Variable	*Description*	*Average*	*Standard Deviation*
l_price	Sales price for parcel	$342,889.13	389,289.01
priceperacre	Sales price per acre	$5,567.90	5,231.02
imps	Improvement value per parcel	$84,153.47	124,391.50
acres	Number of acres in parcel	67.75	82.50
prime	Percent of Prime Soils on Parcel	41.57%	0.42
crop	Percent of Cropland on parcel	50.29%	0.35
pasture	Percent of Pasture on parcel	5.45%	0.16
forest	Percent of Forest on parcel	36.27%	0.33
waterfront	Waterfront access	4.61%	0.21
contig	Dist. to nearest preserved parcel (miles)	1.46	1.68
dcity	Distance to nearest city (miles)	35.35	17.24
agease	Enrolled in Preservation Program	7.25%	0.26
eligible	Eligible to enroll in MALPF program	40.39%	0.49
lacres	Logged Number of acres	3.76	0.91
ldcity	Logged Distance to City	3.42	0.59
y97	Sold in 1997	14.55%	0.35
y98	Sold in 1998	16.53%	0.37
y99	Sold in 1999	16.58%	0.37
y00	Sold in 2000	18.06%	0.38
y01	Sold in 2001	17.51%	0.38
y02	Sold in 2002	15.89%	0.37
HOWA	Howard County	1.36%	0.12
CARR	Carroll County	9.22%	0.29
CALV	Calvert County	1.54%	0.12
ALLE	Allegany County	1.97%	0.14
ANNE	Anne Arundel County	2.03%	0.14
BACO	Baltimore County	6.23%	0.24
CARO	Caroline County	5.74%	0.23
CECI	Cecil County	4.41%	0.21
CHAR	Charles County	4.38%	0.20
DORC	Dorchester County	4.96%	0.22
FRED	Frederick County	3.57%	0.19
GARR	Garrett County	6.23%	0.24
HARF	Harford County	4.61%	0.21
KENT	Kent County	3.77%	0.19
QUEE	Queen Anne County	5.10%	0.22
SOME	Somerset County	5.02%	0.22
STMA	St. Mary's County	4.87%	0.22
TALB	Talbot County	3.91%	0.19
WASH	Washington County	5.60%	0.23
WICO	Wicomico County	6.09%	0.24
WORC	Worcester County	4.64%	0.21

Figure 3. Maryland Agricultural Land Sales for Parcels of 10 or More Acres from 1997–2003



From this sample, 10 percent of the observations from each group were randomly selected and then withheld from the model estimations so that they could be used to evaluate the predictions. Table 3 contains the descriptive statistics for these observations.

Table 3. Descriptive Statistics for the Out of Sample Subset Predicted Prices (N=344)

Variable		*Average*	*Standard Deviation*	*Median*
vland	Land Sales Price for Full Parcel	$244,418.91	283753.08	$162,199.55
landprice	Per acre Land Sales Price	$5,979.33	5577.87	$4,128.42
pland	Predicted Per acre Land Price	$3,643.66	2583.10	$3,176.71
pdiff	Difference between Actual and Predicted	0.05	1.39	
acres	Average Acres in Parcel	57.94	64.31	
prime	% Prime Soil	0.40	0.42	
contig	Distance to Nearest Preserved Parcel	1.54	1.72	
dcity	Distance to Nearest City	36.03	17.46	
crop	% Cropland	0.49	0.36	
pasture	% Pasture	0.06	0.17	
forest	% Forest	0.37	0.34	

DATA SOURCES

The model variables include land parcels' structural, land, and community characteristics. This section describes the process used to compile the data for this study. The compiled data is used first for the hedonic model estimations, and then for the land value predictions. The data set creation relies on the ArcView 3.2 and ArcGIS 8.2 Geographic Information Systems (GIS) software programs to extract and combine data for geographically referenced parcels. The compiled data set contains one record for each parcel in the State of Maryland at least 10 acres in area, with geocoded parcel-level attribute data for each parcel.

The primary data set containing the parcel location and size data for the analysis is MDPropertyView 2002. The MDPropertyView 2002 Database (MDPVD) is created by the Maryland Department of Planning (MDP) as a series of county-level files. The files include data updated through October 2003 from the State's Department of Assessments and Taxation. The files are spatially referenced for use in GIS, allowing the data to be utilized in conjunction with other state and federal spatially referenced data sets. The centroid of each land parcel is geocoded, which allowed us to access other geographic data. For each parcel, data were collected from MdProperty View on the most current transfer date, price paid for the entire parcel at last transfer date, how the parcel was conveyed (arm's-length or non arm's-length), whether it was part of a multi-parcel sale, number of acres in the parcel, waterfront area for those counties near the Atlantic Ocean, Chesapeake Bay or major tributaries, the assessed value of the land, the assessed value of all improvements, and the total assessed value. The parcels are spatially referenced by the x and y coordinates in NAD83 meters Maryland State Plane Coordinate System. Each parcel is also identified by a unique account number that allows parcel-level links between the various MdPropertyView 2002 data files and parcel-level data sets created by other State agencies.

A wealth of data characterizing Maryland lands is linked to the MDPVD land parcels spatially through GIS techniques. For the most part, the land characteristics data are stored in maps that have been digitized by the State of Maryland. To extract these data for the specific land parcels in the MDPVD, buffer parcels are created as proxies for the true parcel boundaries.[11] A buffer parcel is a circular area whose center is at the land parcel centroid and whose total area is equal to the land parcel's acreage. The MDPVD contains the exact location of each parcel centroid as spatially referenced x and y coordinates. ArcView 3.2 GIS software uses these x and y coordinates to map the parcel centroids across Maryland. Each land parcel's size in acres, as measured in MDPVD, is used to calculate the parcel's radius in meters according to the formula: $radius = [(acres * 4046.87)/3.1416]^{1/2}$. With the radius and the parcel centroid for each land parcel, the Buffer Selected Feature command in ArcView creates noncontiguous circular buffer parcels. These buffer parcels intersect with spatially referenced data to extract land characteristics for the MDPVD land parcels. This process is called buffer parcel extraction.

[11] Exact land parcel boundaries are preferred to buffer parcels, but are currently available only for Montgomery and Howard County, Maryland.

Several data sets obtained from State agencies provide spatially referenced, detailed data on the characteristics of Maryland's land. The Maryland Department of Planning compiles detailed land use data from satellite and aerial photography taken as recently as 2002. Land uses are categorized into Urban Areas, Agriculture, Forest, Water, Wetlands, and Barren Land. Urban Areas include the sub-categories low-density residential, medium-density residential, high-density residential, commercial, industrial, institutional, extractive, and open urban land uses. Agriculture includes cropland, pasture, orchards, vineyards, and agricultural buildings and storage. Forest includes deciduous, evergreen, and mixed forests as well as brush. Water and Wetlands refer to open water and intermittently wet areas, respectively. Finally, Barren Land includes beaches, bare rock, and bare ground. ArcView is used to extract the land use data for each buffer parcel as the percentage of the parcel in each land use category. These land uses sum to 100 percent.

Soil data come from the Maryland Department of State Planning's 1973 work to classify and map all Maryland soils, completed in conjunction with the U.S. Department of Agriculture Soil Conservation Service. The two agencies developed the Natural Soil Groups classification system. Soils are grouped by productivity, erosion potential, permeability, stoniness and rockiness, depth to bedrock, depth to water table, slope, stability, and susceptibility to flooding. The MDP defines these factors as most significant for land use planning purposes. The Natural Soil Groups Technical Report (Maryland Department of State Planning, 1973) provides estimated chemical and physical properties for each soil group. Each soil group is classified according to categories for each of several soil properties. ArcView is used to extract the natural soil groups present on each parcel as the percentage of the parcel in each soil category. The categories define soil slope, soil erodibility, and floodplain soils, which affect the extent of potential development on the land and agricultural returns.

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). Circular buffers representing the parcels were again used and overlaid on county soil maps where different polygons represented different soil types. ARCVIEW was used to calculate the number of acres in those soil types corresponding to prime soils that were within the parcel buffer. The number of prime soil acres divided by the total parcel acres gave the percentage of prime soil on each parcel.

GIS techniques were also used to add distance to the nearest metropolitan area (Washington, D.C., Baltimore, Salisbury, Cumberland, and Hagerstown) using road networks from the U.S. Census Bureau.[12]

From the Maryland Department of Natural Resources (DNR), information was obtained on existing agricultural easements on a parcel. This data layer was created by DNR using information from the Maryland Agricultural Land Preservation Foundation (MALPF) through 2002.[13] Additional easements and preservation acquisitions made by state, local, and private

[12] ArcGis 8.2 was used to calculate the distance along each road network from parcel to the central business district of the metropolitan areas.

[13] For Howard, Calvert, Carroll and Montgomery Counties, we also had information on easements acquired through the county programs that might not have been included in the state-level data. For other counties, we were

organizations are compiled in several data sets. Some of these data sets are spatially referenced, while others use the unique account number that can be matched to the MDPVD to obtain spatial references. Maryland Environmental Trust Easements are perpetual land agreements between landowners and the Trust that ensure the properties will not be developed beyond some agreed-upon limit. The Maryland Agricultural Land Preservation Foundation (MALPF) preserves agricultural lands through perpetual easements. Parcels with Environmental Trust Easements and MALPF easements are identified by a unique account number. Forest Legacy Easements are perpetual conservation easements from willing landowners on private forest land. These parcels are identified by ArcView via buffer parcel extraction, as are Rural Legacy Areas. Rural Legacy Areas have been deemed to be among Maryland's best remaining rural landscapes and natural areas by local communities. Some parcels in these Rural Legacy Areas have been protected from development through purchase of land or conservation easements. In addition to the government easement programs, private conservation groups and organizations hold ownership to land or development rights for some parcels in the state. The Private Conservation Properties database, maintained by the State, is a collection of such properties. These parcels are identified by buffer parcel extraction.[14] The farm parcels sold with easement restrictions are identified in Figure 3 by red dots. Area of the easement was converted from square meters as reported by DNR to acres. Distance in miles from each parcel with an easement to every other parcel in the dataset was calculated. The minimum distance between a parcel and the nearest easement was then retained for the dataset.[15]

Lands currently owned and maintained by public agencies are identified through the MDPVD and buffer parcel extraction. Natural Heritage Areas are 32 land areas owned by the State to protect endangered and threatened species. Greenways and Water Trails are natural corridors set aside to connect larger areas of open space and to provide for the conservation of natural resources and offer opportunities for recreation. Stream valley parks in urban areas are an example of greenways and water trails. Currently, Maryland has more than 1,500 miles of protected greenways (Maryland Greenways Commission, 2000). Maryland's Department of Natural Resources as well as individual counties own and maintain parks, state forests, wildlife management areas, natural resource management areas, natural environmental areas, and fish management areas. Finally, federal lands in Maryland include U.S. military lands, U.S. Park Service lands, U.S. Department of Agriculture lands, and U.S. Fish and Wildlife Service lands.

In some cases, multiple parcels were purchased by the same person on the same date and the recorded sales price was not separated between parcels. Instead, the total price for the entire transaction was recorded, making it necessary to aggregate these parcels into one transaction.

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unable to locate a source of this information. Therefore, if the county had not transmitted information on county-level easements to the State, the analysis would not include them. The absence of these data means that some parcels that we excluded as too far from another preserved property to be considered contiguous may in fact be contiguous. In this case, more acres would be eligible in those counties than our analysis indicated. As more land is placed in preservation programs, we would expect the number of eligible acres on small parcels to increase.

[14] Parcels with agricultural or conservation easements were included in the sample. However, parcels with certain types of easements were not included. Excluded parcels had easements labeled as "exclusion, inholding, and road," for example, or easements which did not have identifiable boundaries, tax identification numbers, or geocoded centroids.

[15] Easement distances were created in TRANSCAD and then minimum distances were calculated using SAS.

These parcels were aggregated to the "farm-level" where properties were adjacent, as defined as being within ¼ mile of each other, using the edges of the circular parcel buffer as the measurement points. The parcel-level data were aggregated to the farm level by weighting each parcel's characteristics by the number of acres in that parcel. This applied to the size of the parcel in acres, the number of acres in easements, the percentage of prime soil, and the percentage of the parcel in various land uses. The farm-level transaction price and the assessed values for land, improvements, and total value were obtained by summing over prices and assessed values per parcel in that farm. If more than one parcel was purchased on the same date by the same person, but those parcels were farther than ¼ mile from each other, they were considered separate observations. In this case, we divided the total sale price weighted by the number of acres in each parcel bought.

MODEL RESULTS

A separate hedonic regression model was estimated for each group of counties, based on the USDA CRD codes for Maryland (Table 1).[16] The market transactions of interest include both unimproved (no structure) and improved (with structure) agricultural, forest, and residential parcels in excess of ten acres with forests, pasture, and agriculture. Therefore, the hedonic model estimation included the parcel characteristics that affect the value of land of these parcels. However, improved and unimproved parcels likely have different markets with different buyers and sellers. For example, a buyer looking to relocate to a rural area may not consider unimproved land a substitute for land with a house on it. Therefore, the parcels within each group of counties were separated into those with and those without structures.[17]

Tests for functional form of the hedonic price function were also conducted using both a Box-Cox specification and a test of linearity versus log-linearity (Greene, 1995).[18] Test results indicate that the log-log model specification for the unimproved and improved parcels (i.e., both dependent variable logged and relevant independent variables logged) was preferred over either the linear model or the log-linear model specifications.[19]

Tests for spatial dependence using a spatial weight matrix were conducted. The spatial matrix contains the inverse distance between each pair of parcels if they were two miles apart or less.

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[16] In each model, one county serves as the excluded binary variable, so there is always one less county binary variable than counties in the model.

[17] A Chow test was conducted and determined that there were differences between the values of certain characteristics depending on whether the parcel contained a structure or not. Palm (2005) found that a similar difference existed.

[18] As referenced in Greene, 1995: Davidson, R and MacKinnon, J. 1981 "Several Tests for Model Specification in the Presence of Multiple Alternatives," Econometrica 39: 781-793.

[19] All of these tests were run early in the research process before the counties were separated into final groups. The Chow test was run on a limited number of counties; the F-statistic was 13.18 (11,657 df) and was statistically significant. For the Box-Cox test and the test as cited in Greene, all counties were included in one model. The Box-Cox parameter Lambda was 0.47 under the Log-Log specification, which indicates that this model is preferred over a log-linear or linear-log model (see Greene, 1995). In the test for linearity versus log-linearity, as cited in Greene, the value of the variable F0 was 14.6 and significant at the 0.01 level. The value of the variable F1 was 1.528, with a P-value of 0.13, and not statistically significant. Therefore, the log-log model is preferred.

The question of where to set the distance measure is an empirical one. The distance of two miles was chosen after considering distances of 1/3 mile, ½ mile, 1 mile, and 2 miles and the associated degree of spatial correlation. Two miles was determined to be the distance within which spatial autocorrelation appeared in most of the regressions. The matrix is row standardized. A spatial error model was estimated using the iterated Generalized Moments (GM) estimator for all the models. Due to the large sample size, the GM estimator provides statistically valid results (Bell and Bockstael, 2000).

Both models for each group of counties were estimated using *SpaceStat* Version 1.9 (Anselin, 1995, 1998) and *Matlab* Version 7.1.[20]

The most general models, which include all the parcels, give coefficient estimates much as we hypothesized (Tables 4-6). In the combined regression for the 3,452 observations in the dataset, we find that parcels farther from the nearest city and with more acreage receive lower prices per acre. Those with improvements have a marginally higher price per acre for the land. The higher the percentage of forested acres relative to cropland, the lower is the price per acre of the land. Pasture on the other hand receives a price per acre equivalent to cropland. Having a high percentage of prime soils on the parcel increases the per-acre price.

Parcels with agricultural easements attached received significantly lower prices – almost 15% less, all else the same.[21] Price per acre increased each year after 1998 for the state as a whole. Most counties had significantly lower prices than Montgomery County. The exceptions included Anne Arundel, Baltimore County, Calvert, Cecil, Howard and Talbot, which had similar prices per acre. The characteristics included in the model explained about 51.3% of the variation in the parcels' land sales price per acre.

We estimated two additional general models: one for the 1,502 unimproved parcels (without housing) and one for the 1,949 parcels (with residential housing). The regression results for the general model of the per-acre price for the 1,502 unimproved properties were similar but not identical for various characteristics (Table 5). Parcels farther from the nearest city were less expensive. Larger parcels received lower per-acre prices. In the case of unimproved land, the current land use had less influence on the sales price; those with a high percentage of forest and pasture received prices per acre similar to those with a high percentage of cropland. A parcel with a high percentage of prime soils did receive a higher per-acre price. We found those unimproved parcels with an easement attached to be 16.5% lower in price, all else the same. Per-acre prices after 1998 were higher than those in 1997, except for 2003. We found similar results in terms of relative prices, with most counties having significantly lower prices per acre relative to Montgomery County, except Anne Arundel, Howard, Baltimore, Calvert, Harford, Cecil, Kent, and Talbot, all of which had similar prices. In addition, the model explained 54.51% of the variation in the per acre sales price with the included characteristics.

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[20] The analysis relied on the SEM_GMM function from the Spatial Econometric toolbox. These GMM spatial estimation models provide a means of implementing the Harry Kelejian and Ingmar Prucha estimation methods. Kelejian, H. H. and Prucha, I. 1999. "A Generalized Moments Estimator for the Autoregressive Parameter in a Spatial Model." *International Economic Review* 40: 509-533.

[21] The point of these models was not to determine the impact of agricultural easements on land prices; therefore, selectivity and other issues related to determining the correct counter-factual were not addressed. Those interested in this specific question are referred to Lynch, Gray and Geoghegan (2007) and/or Nickerson and Lynch (2001).

Table 4. Regression Results Explaining Land Price Per Acre for All Parcels in the State of Maryland

Variable	*Parameter Estimate*		*Standard Error*
Intercept	10.48876	***	0.17266
lnimps	0.00854	***	0.00106
lacres	-0.37538	***	0.01319
ldcity	-0.14397	***	0.04327
forest	-0.35405	***	0.03852
pasture	0.02969		0.0753
prime	0.1386	***	0.03467
agease	-0.14835	***	0.04577
y98	0.15148	***	0.04058
y99	0.22859	***	0.04059
y00	0.35518	***	0.0399
y01	0.3824	***	0.04037
y02	0.56886	***	0.04157
y03	0.60403	***	0.12698
ALLE	-1.48357	***	0.10548
ANNE	-0.18605		0.09624
BACO	-0.09346		0.07304
CALV	-0.13079		0.10662
CARO	-0.92412	***	0.0722
CARR	-0.4213	***	0.06421
CECI	-0.14183		0.07939
CHAR	-0.60474	***	0.07667
DORC	-0.88133	***	0.07346
FRED	-0.43897	***	0.07978
GARR	-1.20379	***	0.07011
HARF	-0.23787	***	0.07554
HOWA	-0.00505		0.11153
KENT	-0.20348	***	0.08598
QUEE	-0.31938	***	0.07526
SOME	-1.35975	***	0.07667
STMA	-0.47639	***	0.07704
TALB	-0.05735		0.07951
WASH	-0.85868	***	0.08734
WICO	-1.1984	***	0.08817
WORC	-1.15872	***	0.07753
R-Square	0.5128		
N (Number of observations)	3452		

Table 5. Regression Results for Unimproved Parcels in the State of Maryland

Variable	*Parameter Estimate*		*Standard Error*
Intercept	10.72407	***	0.25154
lnimps	0.00351		0.0026
lacres	-0.2947	***	0.01959
ldcity	-0.28587	***	0.06326
forest	-0.46452		0.05429
pasture	0.05292		0.1349
prime	0.15581	***	0.05364
agease	-0.16528	***	0.07349
y98	0.19346	***	0.06056
y99	0.25423	***	0.06237
y00	0.33561	***	0.05883
y01	0.36116	***	0.06063
y02	0.50092	***	0.06325
y03	0.3929		0.20306
ALLE	-1.67545	***	0.15038
ANNE	-0.09545		0.14217
BACO	-0.15937		0.11543
CALV	-0.22352		0.1648
CARO	-0.84335	***	0.10583
CARR	-0.41781	***	0.10496
CECI	-0.07907		0.11589
CHAR	-0.68706	***	0.11073
DORC	-1.11736	***	0.10207
FRED	-0.26608	***	0.12573
GARR	-1.12442	***	0.10023
HARF	-0.20612		0.12367
HOWA	-0.35025		0.21829
KENT	-0.19976		0.12144
QUEE	-0.2596	***	0.10777
SOME	-1.59148	***	0.10452
STMA	-0.32474	***	0.11669
TALB	-0.1493		0.11661
WASH	-0.93299	***	0.13533
WICO	-1.44404	***	0.12552
WORC	-1.3267	***	0.10572
R-Square	0.5451		
N (Number of observations)	1,502		

Table 6. Regression Results for Improved Parcels in the State of Maryland

Variable	*Parameter Estimate*		*Standard Error*
Intercept	8.8586	***	0.3159
imps	0.1257	***	0.0171
lacres	-0.4239	***	0.0177
ldcity	-0.0519		0.0582
forest	-0.2152	***	0.0541
pasture	0.0214		0.0900
prime	0.1350	***	0.0447
agease	-0.1189	***	0.0579
y98	0.1175	***	0.0536
y99	0.2074	***	0.0525
y00	0.3468	***	0.0534
y01	0.4273	***	0.0533
y02	0.6331	***	0.0545
y03	0.7674	***	0.1595
ALLE	-1.2182	***	0.1445
ANNE	-0.2174		0.1271
BACO	-0.0450		0.0935
CALV	-0.0500		0.1368
CARO	-0.8934	***	0.0975
CARR	-0.3567	***	0.0821
CECI	-0.1737		0.1060
CHAR	-0.4766	***	0.1038
DORC	-0.5422	***	0.1050
FRED	-0.4342	***	0.1022
GARR	-1.1037	***	0.0990
HARF	-0.1878	***	0.0953
HOWA	0.1069		0.1309
KENT	-0.0930		0.1196
QUEE	-0.3591	***	0.1025
SOME	-0.9588	***	0.1137
STMA	-0.5090	***	0.1006
TALB	0.0363		0.1056
WASH	-0.7353	***	0.1136
WICO	-0.9073	***	0.1229
WORC	-0.8739	***	0.1155
R-Square	0.4875		
N (Number of observations)	1949		

For the improved parcels, the results are reported in Table 6. Surprisingly, we find that proximity to the nearest city has no effect on the per acre land value. We used cities of different sizes (Baltimore, Washington, D.C., Cumberland, Salisbury and Hagerstown), and it could be that the impact of proximity varied greatly between the cities. As before, larger parcels receive a lower per-acre price, all else the same. The higher the percentage of forested acres relative to cropland, the lower is the price per acre of the land. However, again, pasture receives a price equivalent to that for cropland. A high percentage of prime soils once again increased the per-acre price. Similar to the models above, improved parcels with agricultural easements attached also received significantly lower prices—almost 12% lower. As one will see below, this result does not carry over to the more specific geographic models. We also found again that per-acre prices increased each year after 1998 for the state as a whole. Most counties had a significantly lower price than Montgomery County. Calvert, Howard, Baltimore, Cecil, Kent, Talbot, and Anne Arundel had per-acre prices similar to Montgomery County's. This model explained about 48.8% of the variation in the per-acre sale prices based on the land and locational characteristics included.

Results from Dispersed Geographic Markets – Per-Acre Price Models for Parcels without Structures

We first report the econometric results and descriptive statistics for the parcels without structures for the per-acre price models (Tables 7-18). Given that the majority of these models exhibited statistically significant spatial autocorrelation in the error structure, we report the spatial error model for them all. These regressions do not reveal as much about the value of individual characteristics as the state-wide models reported above. In part this can be explained by the fact that there are fewer observations once the models are split by both geographic location and improved/unimproved parcels. In addition, in many cases, parcels in a region may have similar land use practices, similar soils, and/or similar proximity to employment centers.

However, even though they are less illustrative in terms of the individual characteristics, we believe geographic-specific non-improved-improved- models are better suited to making price predictions which is the underlying goal of the project.

The synopsis of the results for the six models is that in the markets for "bare" land (parcels without structures), we find that having additional acres in the parcel decreased the per acre price (for detailed results of each region, see Appendix B). However the impact of a one percent increase in the number of acres for these parcels varied much more by region than in the improved models reported below. The Western Maryland market exhibited the smallest impact; a 1 percent increase in number of acres decreased the price by 0.15%. The Lower Shore was similar at 0.19%. Urban Central and Upper Shore markets decreased the per-acre price by 0.27% and 0.30% respectively for a 1% increase in number of acres. The biggest impacts were found in the Rural Central region at 0.33% and Southern Maryland at 0.38%. Parcel size varied from 40 acres in the Rural Central to 79 acres in the Upper Shore. The impact on per-acre price of proximity to the nearest city was not uniform for these parcels. In several regions (Upper Eastern Shore, Western, and Southern), the distance had no or a very weak impact on the market price per acre. Unlike the parcels with structures however, we do find that distance impacted price for the Lower Shore. As distance to Salisbury increased by 1%, the price per acre decreased 0.20%.

Table 7. Estimated Regression Coefficients for Urban Central Maryland- Parcels with No Structures (CRD2420)

Variable name	Estimated Coefficient	Std. Dev.
CONSTANT	12.51794	14.95352
LNIMPS	0.002632	0.391075
LACRES	-0.2661	-4.36447
LDCITY	-0.87203	-3.85504
FOREST	-0.36164	-2.08675
PASTURE	0.127482	0.553833
PRIME	-0.18195	-1.18746
AGEASE	0.066063	0.183014
Y98	0.127692	0.636892
Y99	0.450568	2.113301
Y00	0.514157	2.652184
Y01	0.62013	3.169239
Y02	0.751049	3.914631
BACO	-0.08155	-0.45981
FRED	-0.39484	-2.66896
HOWA	-0.31898	-1.27157
lambda	0.100563	1.010636
R-bar squared	0.238002	
Sigma squared	0.347311	
N (Number of observations)	171	
Comparison base: Montgomery County, 1997, Cropland		

Table 8. Descriptive Statistics for Urban Central (no structure, n=171)

Variable	Average	Standard Deviation
Parcel Price	$560,536.68	1,311,970.75
Price per acre	$ 13,965.60	25,951.39
Parcel Improvement Value	$ 6,128.42	33,560.90
ACRES	56.43	67.83
PRIME	60%	0.45
Crop	48%	0.33
Pasture	13%	0.22
Forest	33%	0.29
Waterfront	0%	0.00
Contig	1.21	1.05
dcity	27.98	7.60
AgEase	2%	0.13
MalpFac	0.35	0.48
lAcres	3.66	0.80
ldcity	3.29	0.31
Y97	9%	0.29
Y98	14%	0.35
Y99	12%	0.33
Y00	22%	0.41
Y01	20%	0.40
Y02	23%	0.42
BACO	40%	0.49
FRED	19%	0.39
HOWA	5%	0.22

Table 9. Estimated Regression Coefficients for Upper Shore Maryland Parcels with No Structures (CRD2430

Variable name	Estimated Coefficient	Std. Dev.
CONSTANT	10.3749	12.3302
LNIMPS	0.0075	1.5503
LACRES	-0.2984	-8.0061
LDCITY	-0.2781	-1.3264
FOREST	-0.4905	-3.9437
PASTURE	-0.0959	-0.2136
PRIME	0.1993	1.9456
WATER	0.6428	5.4792
AGEASE	-0.1331	-1.1279
Y98	0.1342	1.1184
Y99	0.3531	2.9357
Y00	0.3523	3.1326
Y01	0.4557	3.7557
Y02	0.5944	4.7945
CAROLINE	-0.5205	-4.2099
CECIL	0.1850	1.3973
KENT	0.1027	0.6978
QUEEN ANNE	-0.0594	-0.5058
lambda	0.0965	1.5172
R-bar squared	0.4415	
Sigma squared	0.3559	
N (Number of observations)	336	
Comparison base: Talbot County, 1997, Cropland		

Table 10. Descriptive Statistics for Upper Shore (no structure, n=336)

Variable	Average	Std. Dev.
Parcel Price	$405,819.37	576,145.04
Price per acre	$ 9,248.66	15663.29
Parcel Improvement Value	$ 6,571.29	35,002.96
ACRES	79.17	84.54
PRIME	58%	0.37
Crop	67%	0.30
Pasture	1%	0.07
Forest	26%	0.29
Waterfront	12%	0.32
Contig	1.68	2.14
dcity	55.20	12.02
AgEase	9%	0.29
MalpFac	0.46	0.50
lAcres	3.89	0.97
ldcity	3.99	0.23
Y97	14%	0.35
Y98	17%	0.37
Y99	16%	0.37
Y00	20%	0.40
Y01	17%	0.37
Y02	16%	0.37
CARO	23%	0.42
CECI	18%	0.38
KENT	17%	0.38
QUEE	23%	0.42

Table 11 . Estimated Regression Coefficients for Lower Shore Parcels with No Structures (CRD2490)

Variable name	Estimated Coefficient	Std. Dev.
CONSTANT	8.6313	21.9699
LNIMPS	0.0138	1.7498
LACRES	-0.1932	-5.1764
LDCITY	-0.1983	-1.7935
FOREST	-0.6910	-7.2196
PASTURE	-0.0376	-0.0165
PRIME	0.2221	1.9804
WATER	0.6829	2.9213
AGEASE	0.1124	0.7728
Y98	0.2697	2.5933
Y99	0.1314	1.2221
Y00	0.4618	4.5017
Y01	0.5491	5.0683
Y02	0.3554	2.6973
Y03	0.4267	1.8264
DORC	0.2619	2.1939
WICO	0.1962	1.4671
WORC	0.3044	2.8688
lambda	0.1592	2.7815
R-bar squared	0.3439	
Sigma squared	0.3667	
N (Number of observations)	375	

Comparison base: Somerset County, 1997, Cropland

Table 12. Descriptive Statistics for Lower Shore (no structure, n=375)

Variable	Average	Std. Dev.
Parcel Price	$138,653.10	215,967.58
Price per acre	$ 2,530.00	4,790.76
Parcel Improvement Value	$ 6,423.49	39,868.05
ACRES	76.90	86.54
PRIME	22%	0.35
Crop	44%	0.36
Pasture	0%	0.01
Forest	47%	0.37
Waterfront	2%	0.13
Contig	1.82	1.78
dcity	21.77	9.80
AgEase	6%	0.23
MalpFac	0.50	0.50
lAcres	3.94	0.87
ldcity	2.96	0.53
Y97	19%	0.40
Y98	19%	0.39
Y99	16%	0.36
Y00	19%	0.39
Y01	17%	0.37
Y02	9%	0.28
DORC	25%	0.43
WICO	27%	0.44
WORC	23%	0.42

Table 13. Estimated Regression Coefficients for Western Maryland: Parcels with No Structures (CRD2410)

Variable name	Estimated Coefficient	Std. Dev.
CONSTANT	8.4537	17.0580
LNIMPS	0.0003	0.0481
LACRES	-0.1490	-3.2047
LDCITY	-0.2200	-1.3903
FOREST	-0.2028	-1.5088
PASTURE	0.4417	1.3049
PRIME	-0.9452	-2.2394
AGEASE	-0.2141	-0.9776
Y98	-0.1039	-0.7353
Y99	0.0299	0.2067
Y00	0.1399	1.0092
Y01	-0.0431	-0.2980
Y02	0.4032	1.8421
GARRETT	0.3896	2.0119
lambda	0.2109	2.4395
R-bar squared	0.1962	
Sigma squared	0.2221	
N (Number of observations)	130	

Comparison base: Allegany County, 1997, Cropland

Table 14. Descriptive Statistics for Western (no structure, n=130)

Variable	Average	Std. Dev.
Parcel Price	$111,139.80	169,677.28
Price per acre	$ 1,744.20	1,130.12
Parcel Improvement Value	$ 2,775.61	12,293.23
ACRES	78.90	137.80
PRIME	3%	0.11
Crop	26%	0.33
Pasture	5%	0.13
Forest	60%	0.36
Waterfront	0%	0.00
Contig	2.88	2.39
Dcity	35.22	13.87
AgEase	4%	0.19
MalpFac	40%	0.49
lAcres	3.79	0.95
Ldcity	3.45	0.52
Y97	18%	0.38
Y98	18%	0.38
Y99	18%	0.39
Y00	21%	0.41
Y01	21%	0.41
Y02	4%	0.21
GARRETT	77%	0.42

Table 15. Estimated Regression Coefficients for Rural Central Maryland: Parcels with No Structures (CRD2420)

Variable name	Estimated Coefficient	Std. Dev.
CONSTANT	11.0059	19.2622
LNIMPS	0.0041	0.6244
LACRES	-0.3298	-5.5527
LDCITY	-0.4796	-3.0615
FOREST	0.1247	0.8281
PASTURE	0.3629	1.6627
PRIME	0.1508	1.2767
AGEASE	-0.2361	-1.1876
Y98	0.3147	1.8021
Y99	0.2631	1.3775
Y00	0.2044	1.2148
Y01	0.3766	2.2535
Y02	0.6868	4.2189
YO3	0.7098	1.7346
CARROLL	-0.1740	-1.3528
WASHINGTON	-0.9529	-4.4955
lambda	0.1260	1.5265
R-bar squared	0.3447	
Sigma squared	0.2829	
N (Number of observations)	167	

Comparison base: Harford County, 1997, Cropland

Table 16. Descriptive Statistics for Rural Central (no structure, n=167)

Variable	Average	Std. Dev.
Parcel Price	$ 227,406.79	309,684.60
Price per acre	$ 7,193.74	10,602.00
Parcel Improvement Value	$ 5,193.15	30,105.82
ACRES	40.11	36.88
PRIME	57%	0.41
Crop	51%	0.36
Pasture	9%	0.20
Forest	33%	0.33
Waterfront	0%	0.00
Contig	0.74	0.52
dcity	25.04	11.37
AgEase	5%	0.22
MalpFac	0.26	0.44
lAcres	3.39	0.74
ldcity	3.06	0.65
Y97	9%	0.29
Y98	15%	0.35
Y99	12%	0.32
Y00	18%	0.39
Y01	20%	0.40
Y02	25%	0.43
CARR	43%	0.50
WASH	34%	0.47

Table 17. Estimated Regression Coefficients for Southern Maryland: Parcels with No Structures (CRD2480)

Variable name	Estimated Coefficient	Std. Dev.
CONSTANT	11.5885	10.0289
LNIMPS	-0.0024	-0.3791
LACRES	-0.3779	-6.4042
LDCITY	-0.4361	-1.4505
FOREST	-0.2921	-1.7643
PASTURE	0.1011	0.2174
PRIME	0.3565	1.9819
WATER	0.4022	1.9592
AGEASE	-0.0215	-0.0996
Y98	-0.1910	-0.8491
Y99	-0.3899	-1.8550
Y00	-0.3475	-1.6280
Y01	-0.3402	-1.6389
Y02	-0.1577	-0.7492
Y03	-0.2654	-0.4053
CHARLES	0.1346	0.5128
ST. MARY	-0.3074	-1.4961
ANNE ARUNDEL	0.0732	0.3235
lambda	0.0972	1.2327
R-bar squared	0.4568	
Sigma squared	0.3816	
N	172	

Comparison base: Calvert County, 1997, Cropland

Table 18. Descriptive Statistics for Southern (no structure, n=172)

Variable	Average	Std. Dev.
Parcel Price	$218,091.82	292,608.78
Price per acre	$ 5,743.39	6,082.02
Parcel Improvement Value	$ 2,974.68	10,131.46
ACRES	62.69	89.07
PRIME	28%	0.36
Crop	35%	0.34
Pasture	3%	0.13
Forest	57%	0.36
Waterfront	8%	0.27
Contig	1.36	1.47
dcity	46.48	15.32
AgEase	6%	0.24
MalpFac	0.37	0.48
lAcres	3.67	0.89
ldcity	3.78	0.35
Y97	7%	0.26
Y98	12%	0.33
Y99	18%	0.38
Y00	18%	0.39
Y01	22%	0.42
Y02	22%	0.41
ANNE	18%	0.39
CHARL	38%	0.49
STMA	35%	0.48

We find that in the Rural Central area, a one percent increase in distance from the nearest city decreased the price by 0.48% - a much larger impact than that for the parcels with structures of 0.17%. Similarly, in the Urban Central region, the impact was greater for these parcels; a 1% increase in distance resulted in a 0.87% decrease in the price per acre compared to 0.36%.

In five of the six markets for bare land, cropland was considered more valuable than forested land although of similar price per acre with pasture uses. Only in Rural Central do we find that the presence of a high percentage of forest does not impact the price. A high percent of prime soils increased the per-acre price in the Upper Shore, Lower Shore, and Southern Maryland but had no impact in Urban and Rural Central. Western Maryland had very little prime soils on the parcels sold – only 5 percent. The lack of impact of prime soils in the Rural Central market for unimproved parcels was a surprise given that it was the only region where a high level of prime soils was rewarded for parcels with structures. As expected, parcels with waterfront access received significantly higher prices. In two of the regions, unimproved parcels saw a smaller increase in price per acre for waterfront access than for parcels with houses attached: in Upper Eastern Shore (12% higher compared to 39%), and southern Maryland (40% compared to 84%). However, we find the reverse in the Lower Eastern Shore (68% compared to 37%). Prices for these parcels started increasing in 1998 in the Urban Central and Upper Shore. Rural Central began higher prices in 2001 and Western Maryland in 2002. In the Lower Eastern Shore and Southern Maryland, prices varied throughout the time period. Southern Maryland saw higher per-acre prices in 1999 through 2001 but then they dropped again to 1997 levels.

Results from Dispersed Geographic Markets – Price Per Acre for Parcels with Structures Models

The models explaining the sales price per acre for parcels with housing structures are reported in Tables 19-30. Again, many of the models exhibited spatial correlation. Therefore the analyses corrected for spatial correlation using the iterated Generalized Moments (GM) model.

The synopsis for these six regional markets for parcels with housing structures is very similar to that for parcels without housing structures with a few notable differences. Again we find that parcels having additional acres receive lower per acre prices. Interestingly, a one percent increase in the number of acres has a similar impact in most regions decreasing the price by 0.41 to 0.46 percent; this was not true in the markets for parcels without structures. The parcel sizes in these regions varied from 49 acres in the Rural Central to 81 acres in Western Maryland. The percent decrease in price for a 1% increase in acreage was only 0.32% in the Upper Eastern Shore (average of 74 acres) but much higher in the Southern region (average of 47 acres) at 0.52%. The impact on price of proximity to the nearest city was less uniform than for the impact for acres. In several regions (Upper and Lower Eastern Shore, Western, and Southern), the distance had no or a very weak impact on the market price per acre. It was only in the Central region of the state that proximity to the nearest city significantly impacted the price per acre for parcels with residential structures. In the Rural Central area, a one percent increase in distance from the nearest city decreased the price by 0.17%. The average distance was 27 miles. In the Urban Central region, the impact was greater; a 1% increase in distance from the nearest city (average distance was also 27 miles) resulted in a 0.36% decrease in the price per acre for parcels

Table 19. Estimated Regression Coefficients for Urban Central Maryland: Parcels with Structures (CRD2420)

Variable name	Estimated Coefficient	Std. Dev.
CONSTANT	10.5217	11.4834
LNIMPS	0.0641	1.4900
LACRES	-0.4080	-9.1826
LDCITY	-0.3632	-1.9216
FOREST	-0.1592	-1.1084
PASTURE	0.0876	0.5282
PRIME	0.0592	0.5095
AGEASE	-0.0586	-0.3910
Y98	0.1300	1.0148
Y99	0.3203	2.4060
Y00	0.2044	1.4437
Y01	0.7149	5.4824
Y02	0.7818	5.7043
BACO	-0.1361	-0.8834
FRED	-0.4845	-3.4326
HOWA	0.1590	0.8737
lambda	0.1697	2.2784
R-bar squared	0.3520	
Sigma squared	0.4422	
N (Number of observations)	319	

Comparison base: Montgomery County, 1997, Cropland

Table 20. Descriptive Statistics for Urban Central (structure, n=319)

Variable	Average	Standard Deviation
Parcel Price	$564,768.82	545,327.91
Price per acre	$ 16,914.77	17,638.13
Parcel Improvement Value	$264,431.75	198,654.43
ACRES	53.66	72.20
PRIME	62%	0.43
Crop	52%	0.35
Pasture	12%	0.24
Forest	30%	0.29
Waterfront	0%	0.00
Contig	1.18	1.16
dcity	26.81	7.17
AgEase	6%	0.23
MalpFac	0.31	0.46
lAcres	3.55	0.86
ldcity	3.25	0.29
Y97	16%	0.37
Y98	19%	0.39
Y99	18%	0.38
Y00	14%	0.35
Y01	19%	0.39
Y02	15%	0.35
BACO	42%	0.49
FRED	22%	0.41
HOWA	10%	0.30

Table 21. Estimated Regression Coefficients for Upper Shore Maryland: Parcels with Structures (CRD2430)

Variable name	Estimated Coefficient	Std. Dev.
CONSTANT	9.2812	10.4026
LNIMPS	0.1180	2.9538
LACRES	-0.3201	-8.7617
LDCITY	-0.2639	-1.3350
FOREST	-0.1630	-1.1860
PASTURE	-0.0075	-0.0219
PRIME	0.2031	1.9697
WATER	0.3871	3.3370
AGEASE	-0.0113	-0.0964
Y98	0.0059	0.0519
Y99	0.1000	0.8138
Y00	0.2762	2.3850
Y01	0.3512	2.8921
Y02	0.7208	5.4240
CAROLINE	-0.8275	-7.1928
CECIL	-0.1130	-0.8924
KENT	-0.0851	-0.5732
QUEEN ANNE	-0.2930	-2.5740
lambda	0.0130	0.2043
R-bar squared	0.4021	
Sigma squared	0.4141	
N (Number of observations)	374	

Comparison base: Talbot County, 1997, Cropland

Table 22. Descriptive Statistics for Upper Shore (structure, n=374)

Variable	Average	Standard Deviation
Parcel Price	$513,090.28	557,312.84
Price per acre	$ 13,509.01	19288.18
Parcel Improvement Value	$210,404.93	189,190.46
ACRES	73.98	92.21
PRIME	59%	0.38
Crop	64%	0.30
Pasture	2%	0.10
Forest	25%	0.27
Waterfront	15%	0.36
Contig	1.63	2.11
dcity	53.58	11.73
AgEase	9%	0.28
MalpFac	0.36	0.48
lAcres	3.76	0.99
ldcity	3.96	0.22
Y97	19%	0.39
Y98	20%	0.40
Y99	17%	0.38
Y00	18%	0.38
Y01	15%	0.36
Y02	10%	0.30
CARO	24%	0.43
CECI	20%	0.40
KENT	15%	0.35
QUEE	22%	0.41

Table 23. Estimated Regression Coefficients for Lower Shore: Parcels with Structures (CRD2490)

Variable name	Estimated Coefficient	Std. Dev.
CONSTANT	7.3157	11.0732
LNIMPS	0.1700	4.2858
LACRES	-0.4373	-9.5842
LDCITY	-0.0388	-0.2665
FOREST	-0.4030	-2.5575
PASTURE	3.8031	1.0217
PRIME	0.0861	0.5954
WATER	0.3728	1.9499
AGEASE	0.2445	1.1485
Y98	0.1724	1.2188
Y99	0.3150	2.2285
Y00	0.5620	4.1795
Y01	0.5490	3.7342
Y02	0.6148	4.1623
Y03	0.2414	0.5132
DORC	0.3139	1.7917
WICO	0.1332	0.8227
WORC	0.1937	1.2875
lambda	0.1918	3.1185
R-bar squared	0.4267	
Sigma squared	0.4166	
N (Number of observations)	268	

Comparison base: Somerset County, 1997, Cropland

Table 24. Descriptive Statistics for Lower Shore (structure, n=268)

Variable	Average	Standard Deviation
Parcel Price	$260,830.74	336,756.17
Price per acre	$ 6,687.83	6,928.29
Parcel Improvement Value	$112,404.88	109,381.24
ACRES	69.20	91.58
PRIME	19%	0.33
Crop	53%	0.32
Pasture	0%	0.02
Forest	31%	0.28
Waterfront	7%	0.26
Contig	1.85	1.73
dcity	21.81	12.00
AgEase	4%	0.20
MalpFac	0.39	0.49
lAcres	3.74	0.94
ldcity	2.92	0.60
Y97	17%	0.38
Y98	18%	0.38
Y99	18%	0.38
Y00	19%	0.39
Y01	15%	0.35
Y02	14%	0.34
DORC	24%	0.43
WICO	35%	0.48
WORC	21%	0.41

Table 25. Estimated Regression Coefficients for Western Maryland: Parcels with Structures (CRD2410)

Variable name	Estimated Coefficient	Std. Dev.
CONSTANT	7.5232	8.2132
LNIMPS	0.1339	2.0716
LACRES	-0.4352	-7.1166
LDCITY	0.0155	0.1146
FOREST	-0.2546	-1.4131
PASTURE	0.1982	0.6327
PRIME	0.0901	0.3022
AGEASE	0.0048	0.0218
Y98	0.1126	0.6679
Y99	0.1296	0.7929
Y00	0.1534	0.7917
Y01	0.4601	2.8046
Y02	0.5567	2.6222
GARRETT	0.0402	0.1982
lambda	0.2278	2.8344
R-bar squared	0.3471	
Sigma squared	0.2742	
N (Number of observations)	125	

Comparison base: Allegany County, 1997, Cropland

Table 26. Descriptive Statistics for Western (structure, n= 125)

Variable	Average	Standard Deviation
Parcel Price	$174,511.68	122,968.62
Price per acre	$ 3,259.60	3,104.27
Parcel Improvement Value	$ 73,976.66	98,368.49
ACRES	80.89	72.79
PRIME	6%	0.18
Crop	36%	0.34
Pasture	10%	0.17
Forest	49%	0.33
Waterfront	0%	0.00
Contig	2.66	2.25
dcity	32.33	15.07
AgEase	4%	0.20
MalpFac	54%	0.50
lAcres	4.05	0.86
ldcity	3.32	0.65
Y97	14%	0.35
Y98	22%	0.41
Y99	26%	0.44
Y00	11%	0.32
Y01	19%	0.39
Y02	8%	0.28
GARRETT	73%	0.44

Table 27. Estimated Regression Coefficients for Rural Central Maryland: Parcels with Structures (CRD2420)

Variable name	Estimated Coefficient	Std. Dev.
CONSTANT	10.3660	16.7464
LNIMPS	0.0317	0.8696
LACRES	-0.4586	-12.6694
LDCITY	-0.1715	-1.4971
FOREST	-0.1263	-1.2085
PASTURE	0.0047	0.0358
PRIME	0.1507	2.0428
AGEASE	-0.1720	-1.8697
Y98	0.0243	0.2291
Y99	0.0249	0.2489
Y00	0.2146	2.0923
Y01	0.2960	2.9441
Y02	0.4548	4.6536
YO3	0.9050	5.1766
CARROLL	-0.1210	-1.4464
WASHINGTON	-0.6284	-4.0722
lambda	0.0981	1.8706
R-bar squared	0.4219	
Sigma squared	0.3311	
N (Number of observations)	443	

Comparison base: Harford County, 1997, Cropland

Table 28. Descriptive Statistics for Rural Central (structure, n=443)

Variable	Average	Standard Deviation
Parcel Price	$349,037.82	286,678.33
Price per acre	$ 11,171.17	8,685.82
Parcel Improvement Value	$155,533.31	117,131.57
ACRES	48.91	50.38
PRIME	50%	0.42
Crop	51%	0.34
Pasture	12%	0.22
Forest	29%	0.30
Waterfront	0%	0.00
Contig	0.70	0.55
dcity	26.74	10.43
AgEase	12%	0.32
MalpFac	0.30	0.46
lAcres	3.50	0.85
ldcity	3.16	0.57
Y97	14%	0.35
Y98	15%	0.35
Y99	18%	0.38
Y00	16%	0.36
Y01	16%	0.37
Y02	19%	0.39
CARR	50%	0.50
WASH	27%	0.44

Table 29. Estimated Regression Coefficients for Southern Maryland: Parcels with Structures (CRD2480)

Variable name	Estimated Coefficient	Std. Dev.
CONSTANT	7.9384	6.4398
LNIMPS	0.1857	4.0472
LACRES	-0.5223	-10.8040
LDCITY	0.0359	0.1240
FOREST	-0.2441	-1.8367
PASTURE	-0.2985	-0.8074
PRIME	0.0842	0.6426
WATER	0.8404	4.9019
AGEASE	-0.0458	-0.2071
Y98	0.0706	0.4419
Y99	0.2837	2.1709
Y00	0.4906	3.4789
Y01	0.3849	2.8834
Y02	0.7192	5.3939
Y03	0.0042	0.0096
CHARLES	0.1101	0.4832
ST. MARY	-0.1921	-1.2255
ANNE ARUNDEL	-0.4162	-2.7960
lambda	0.0657	0.7459
R-bar squared	0.5020	
Sigma squared	0.3445	
N	228	

Comparison base: Calvert County, 1997, Cropland

Table 30. Descriptive Statistics for Southern (structure, n=228)

Variable	Average	Standard Deviation
Parcel Price	$344,866.88	312,077.72
Price per acre	$ 12,396.80	12,286.49
Parcel Improvement Value	$165,739.06	124,406.03
ACRES	47.21	58.05
PRIME	30%	0.39
Crop	39%	0.34
Pasture	2%	0.10
Forest	52%	0.34
Waterfront	9%	0.28
Contig	1.38	1.19
dcity	47.00	13.29
AgEase	4%	0.19
Eligible	0.27	0.44
lAcres	3.45	0.82
ldcity	3.81	0.31
Y97	18%	0.39
Y98	11%	0.32
Y99	21%	0.41
Y00	15%	0.35
Y01	18%	0.38
Y02	17%	0.37
ANNE	16%	0.37
CHARL	31%	0.46
STMA	40%	0.49

with houses. In part, the fact that distance to the city did not impact price per acre in four of the regions may be explained by the difference in the nearest cities – Washington, D.C. and Baltimore are much larger employment centers than Hagerstown, Cumberland and Salisbury and thus have a stronger influence on land values.

We also found that higher levels of cropland made parcels more valuable in several regions relative to higher levels of forest. This was true in the Lower Eastern Shore and Southern Maryland and weakly in Western Maryland. However forest, cropland, and pasture received similar prices per acre in the remaining areas: Urban Central, Rural Central, and the Upper Eastern Shore for parcels with houses. Interestingly, the quality of soils had a very minor impact in almost all the areas for these parcels unlike the results for parcels without structures. Only in the Rural Central area did we see a strong positive impact from higher soil quality. Soil quality impacts the desirability of a parcel for agricultural production and for housing construction. Given these parcels had a house located on them already, it could be that they were more likely to have high quality soil thus the variation between these parcels on this attribute was lower. Purchasers of these parcels may also be buying them as homesteads and do not care about their agricultural profitability potential nor do they need to build a residential structure. Parcels with waterfront access received significantly higher prices in Upper Eastern Shore (39% higher), Lower Eastern Shore (37%), and Southern Maryland (84%). Many of the markets saw an increase in the price per acre beginning in 1999: Urban Central, Lower Eastern Shore and Southern Maryland. The market in the other regions did not begin to experience higher per-acre prices until 2000 for the Upper Eastern Shore and Rural Central and until 2001 for Western Maryland. The only region which had a significantly lower price per acre for parcels with easements attached was in Rural Central Maryland – these preserved parcels with houses had per-acre prices that were 15% lower.

OUT OF SAMPLE PREDICTIONS

One method of validating a hedonic regression on sales value is to remove a subset of observations randomly and then use the estimated coefficients to predict their prices. Given that we know the actual price received, we can determine how close our predictions from the estimated regressions are to the actual market prices. In this way, we determine how well the model(s) performed. We removed a randomly selected 10% of the sample from each CRD. We then predicted the prices on these 344 observations. The descriptive statistics for this subsample are reported in Table 3.

We find that when compared to the actual per acre sales values, the predicted prices per acre are on average within 5% of the actual prices. Thus, the average performance is good. However, for individual parcels, the predicted prices could be quite different from the actual sale prices. The median values for these parcels (half the prices were above the median value and half the prices were below the median value) tended to be much lower than the average prices. For example, the average parcel price was more than $244,000 but the median parcel price was less than $163,000. Similarly, the actual average per acre land value was $5,979 while the median was $4,128. This is not abnormal in hedonic analysis – the high value observations have a large influence on the average values of the sample. We found that parcels with higher prices per acre (and per parcel) were most likely to have the model predict a lower per acre value. These parcels could potentially have some characteristics that were not observed and thus not included in the modeling effort. However, given the higher price per acre, they are also the least likely to be selected for preservation in a minimum cost targeting scheme and in programs with limited budgetary resources.

OBJECTIVE 2: HOW MANY ACRES ARE ELIGIBLE FOR LAND PRESERVATION UNDER THE CURRENT CRITERIA?

Eligibility of Land

We examined all agricultural lands in the state as identified by MdProperty View[22] greater than 10 acres.[23] This included 41,241 parcels and 2.9 million acres. These parcels averaged 71 acres – in some cases, people own their land in multiple parcels, especially if they purchased the land at different periods of time. Therefore, operational size of a farm or forest as reported by USDA, Maryland Department of Agriculture or Maryland Department of Natural Resources, for example, may be very different than the parcel size. As mentioned in the data section, if the land was sold in a multi-parcel sale, it was treated as one parcel, with the sum of the acres used for the analysis.

We retained those parcels that had not already been enrolled in a preservation program and that had no easement attached to the property. This resulted in 38,126 parcels that could be eligible for preservation, or a total of 2.6 million acres. These parcels averaged 67 acres. We applied the following eligibility criteria to these parcels: they had to be at least 50 acres and had to have at least 50% prime soils.[24] If parcels were less than 50 acres, we ascertained whether they were within ¼ of a mile from an already preserved parcel to mimic the requirement of contiguity needed by smaller parcels.

We found 7,227 eligible parcels, for a total of 850,490 acres. Table 31 presents the information on these eligible parcels by state and by CRD group. Average parcel size was 117.7 acres. Average percentage of prime soils was 84%. Average distance to the nearest preserved parcel was 1.14 miles. These parcels averaged 36 miles from the nearest city, although some of them were within 2 miles of a city. They averaged 64% cropland, 5% pasture and 24% forest cover. The average predicted price for the land sold in 2002 was $4,512 per acre.

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[22] Agricultural lands include anything that receives preferential taxation. Forest land can be included in this designation.

[23] A total of 444 parcels were dropped before we began the assessment of eligibility. These included agricultural parcels less than 10 acres and parcels with predicted prices less than $100. There were 356 parcels under 10 acres that were dropped. These had an average size of 6.9 acres. The total acreage for all of these 356 parcels was 2,449. Total land value for all of these parcels was $46 million. Predicted prices less than $100 were assumed to be due to data entry problems. There were also 144 parcels with a price per acre greater than $30,000. Of these only 7 were considered eligible. The ineligible parcels with high prices were all less than 50 acres.

[24] The Maryland soil classification system is followed in defining prime soil as having high agricultural productivity, good drainage, and little or no slope. This may be overly restrictive if one wants to preserve forest land.

There were 30,906 parcels that did not meet the eligibility requirements for one or more reasons even though they were identified as agricultural or forest land. The total number of non-eligible acres was 1.73 million. On average, these parcels were much smaller than those which were eligible, 55.7 acres as compared to almost 118 acres. They also had a smaller percentage of prime soils, 32% on average. In addition, they were farther from an already preserved parcel, 1.77 miles on average.[25] These parcels averaged 32 miles from the nearest city, although at least one was less than 1.5 miles away. They averaged 45% cropland, 6% pasture and 40% forest cover. The average price for the ineligible parcels was $5,594 per acre.

We used an approximation of the MALPF criteria to determine eligibility. MALPF stresses characteristics that contribute to agricultural productivity. Programs such as Greenprint and Rural Legacy use different criteria to determine eligibility. For example, the Greenprint program emphasizes the preservation of four types of ecological habitat: large blocks of interior forest; large wetland complexes; rare species and migratory bird habitat; and pristine stream and river segments. The program assesses a property based on the occurrences of rare, threatened and endangered plants and animals, area of upland and wetland interior forest, unmodified wetlands and stream lengths, soil and wetland types, area of highly erodible soils and proximity. Rural Legacy has different criteria some of which may be specific to the local preservation area. Determining eligibility based on these criteria may result in a different set of parcels to preserve. Because eligibility criteria vary by program and can be changed, we also examined what caused ineligibility. Table 32 presents the descriptive statistics for the ineligible parcels and parcels identified under sensitivity analysis. We relaxed certain eligibility requirements and examined how this would affect the eligibility of parcels. For example, when we eliminated the 50% prime soil requirement, we found that 8,982 of the parcels were not eligible solely because they did not meet the 50% prime soil criteria; i.e., they did meet the greater than 50 acre criterion. A program targeting forest land may find these parcels eligible under a different soil-ranking scheme. These almost 9,000 parcels averaged 131.5 acres, with an average of 10% prime soils. They tended to be farther away from other preserved parcels. They averaged 42% cropland, 5% pasture and 47% forest cover, i.e., more forest cover than both the average eligible parcel and the average ineligible parcel. These parcels are a similar distance to the nearest big city—32.5 miles. They have a lower average price, at $2,747.25 per acre, and thus may be desirable to target under a forest preservation goal.

MALPF recently changed its minimum acreage requirement from 100 to 50 acres, and this could possibly be altered again. In addition, given that being contiguous to another preserved parcel can render a parcel eligible, as more parcels are preserved, some of the smaller ineligible parcels may become eligible in the future. We looked at the 9,195 parcels that were ineligible because they are less than 50 acres and currently are not next to a preserved parcel. These parcels have an average of 24.3 acres – recall that we have already excluded all parcels of less than 10 acres.

[25] A total of 30 parcels were more than 1,000 acres. Of these, 7 were eligible for easements. These 7 had an average size of 1,300 acres and a maximum of 1,500 acres, and on average were 45 miles from a city. All were on the Eastern Shore and owned by individuals. Of the 23 non-eligible parcels, 7 were in western Maryland, 2 in southern Maryland, and the remainder on the Eastern Shore. Many were owned by companies or groups. The average size was 1,760 acres and the maximum was 4,266 acres.

Thus these parcels range from 10 to 49.99 acres. They have a high percentage of prime soils, with an average of 89%. The land cover average is 55% crops, 7% pasture and 27% forest cover. They tend to be about 1.5 miles from another preserved parcel and 32 miles from the nearest city. Their average price, however, is $8,312 per acre – 46% higher than the $4,512 average for all eligible parcels. As previously mentioned, smaller parcels tend to have a higher average per-acre price in most land markets; therefore, enrolling smaller parcels even with other desirable characteristics may be more costly

The other 12,729 parcels that were ineligible because they did not have 50% prime soil and were smaller than 50 acres had an average of 25 acres per parcel and 6% prime soils. These parcels also have a higher percentage of forest cover (44%). Cropland averaged 42% for these parcels and pasture averaged 5%. These parcels tended to be almost 2 miles away from other preserved parcels and averaged 31 miles from the nearest city. In addition, the $5,640 average price per acre was higher than the $4,512 average price of eligible parcels.

Using the MALPF criteria, though, we do find that there are more than 686,000 acres available to preserve—more than 850,000 acres in fact. Of course, we do not know if the owners of the parcels making up this acreage would be willing to enroll their parcels. The needed incentives to induce participation of these parcels and the resources available in the state and local programs will also play a role in how many acres will be enrolled in the near future.

Table 31. Results of the Simulations by State and by CRD Group

Region	No. of Parcels	Price for Land Per Acre	Acres	Nearest Preserved Parcel (miles)	Distance to Nearest City (miles)	Percent Prime Soil	Percent Cropland	Percent Pasture	Percent Forest
ELIGIBLE[a]									
Total	7227		850,490						
Average per parcel		$4,511.85	117.68	1.14	35.83	84%	64%	5%	24%
Western Maryland									
Total	58		6,638						
Average per parcel		$1,972.16	114.4495	2.42	20.87	73%	36%	9%	44%
Upper Shore									
Total	2379		3566612						
Average per parcel		$3,506.27	149.9	1.06	54.93	82%	73%	1%	20%
Southern Maryland									
Total	749		79883.7						
Average per parcel		$4,486.96	106.65	2.11	38.76	80%	27%	3%	42%
Lower Shore									
Total	896		118,539						
Average per parcel		$2,630.60	132.3	1.37	23.58	80%	66%	25%	0%
Rural Central									
Total	1459		131,015						
Average per parcel		$4,861.45	89.8	0.77	23.87	85%	63%	20%	9%
Urban Central									
Total	1686		157,501						
Average per parcel		$6,726.41	93.6	0.97	24.98	89%	59%	10%	25%
NON-ELIGIBLE[b]									
Total	30,906		1,722,718						
Average per parcel		$5,594	55.74	1.77	31.88	32%	45	6	40

[a] Total eligible in entire state, parcels greater than 10 acres, land price greater than $100.
[b] Total non-eligible statewide, parcels greater than 10 acres, land price greater than $100.

Table 32. Sensitivity of the Eligibility

	No. of Parcels	Price for Land Per Acre	Acres	Nearest Preserved Parcel (miles)	Distance to Nearest City (miles)	Percent Prime Soil	Percent Cropland	Percent Pasture	Percent Forest
Non-Eligible[b]									
Total	30,906		1,722,718						
Average per parcel		$5,594	55.74	1.77	31.88	32%	45%	6%	40%
Don't meet Soil Criteria									
Total	8982		1,180,921						
Average		$2,747	135.33	1.77	16.17	10%	42%	5%	47%
Don't meet Acre Criteria									
Total	9195		223,247						
Average		$8,311	24.28	1.46	32.04	89%	55%	7%	27%
Don't meet Soil or Acres Criteria									
Total	12,729		318,550						
Average		$5,640	25.03	1.88	31.31	7%	41%	5%	44%

[b] Total non-eligible statewide, parcels greater than 10 acres, land price greater than $100

OBJECTIVE 3: COMPUTING PREDICTED PRICE PER ACRE AND DETERMINING COST OF PURCHASING EASEMENTS ON ELIGIBLE PARCELS

We predicted the per-acre price for all agricultural lands not included in the dataset used for estimation or prediction. These included all parcels sold or transferred before 1997, parcels which retained the same ownership overtime, and parcels with transaction dates from 1997–2003 but that were left out of the model due to missing sale prices or because they were not arm's-length transactions. Prices were predicted based on the appropriate model as determined by county and by whether or not a structure was present.

All predicted prices are indexed to 2003 dollars. In order to predict total prices, a year between 1997 and 2003 had to be chosen in order to simulate all sales taking place in that one year for ease of comparison. The year 2003 could not be chosen because in some of the estimated models no transactions had been recorded for 2003. The year 2002 was chosen.

For those parcels with sale transaction dates from 1997–2003 that were missing key model variables, and that therefore had been left out of the estimation datasets due to missing variables, actual transaction prices at time of sale, rather than predicted price, were divided by the number of acres in the parcel to obtain the per-acre price. To obtain per-acre prices of land only, total assessed improvement value was subtracted out of total transaction price and the resulting number divided by total acres for these parcels.

We had hoped to adjust the land price by its agricultural value to obtain the "estimated easement value"; however, we found no obvious and straightforward method of conducting this calculation. Thus, one can see the estimated costs of preservation as the maximum value needed, assuming that some per-acre dollar amount can be deleted for the agricultural value. For example, if we assume that the agricultural value of land in Maryland is $400 per acre, the budgetary resources needed to preserve the 686,000 acres would be $274 million less than what it would cost to purchase the acres outright. If the agricultural value were $300 per acre, the resources would be $206 million less.

Parcels in the simulation dataset were then combined with the estimation and prediction dataset. Those eligible parcels without existing easements were used to estimate the expected easement value for new agricultural easements throughout the state. For parcels in the estimation dataset, the actual market prices per acre were used.

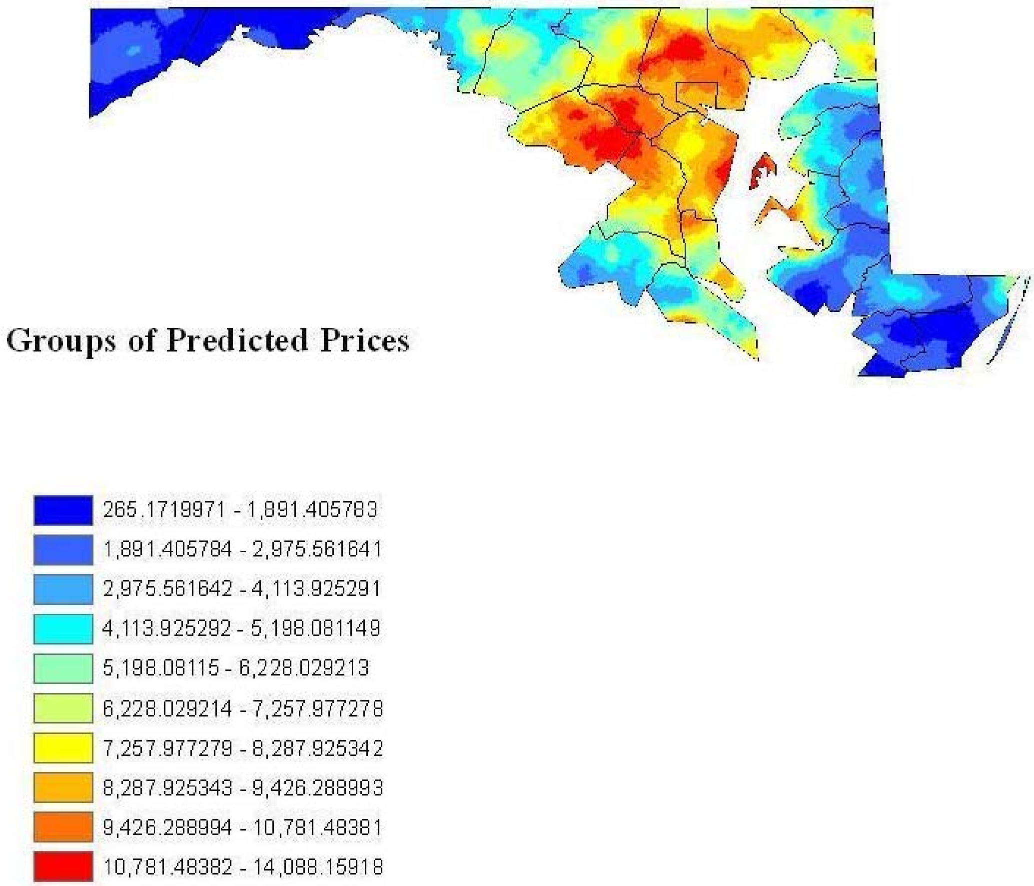
To determine the needed resources to preserve these eligible acres, the per-acre price of land only for these eligible parcels was used along with number of acres per parcel to develop a supply curve of easements. Also, parcels with land prices of less than $300 were dropped. The rationale was that if land prices were less than $300, it was most likely due to coding errors in the original assessment data and thus unlikely to be reflective of the real cost of preserving that parcel. A total number of 444 parcels were dropped.

Again, the resulting number of eligible parcels statewide was 7,227, and the number of acres was 850,490. Average per-acre land price was $4,512 and average size was 118 acres. Average percentage of prime soils was 84% and average distance to the nearest preserved parcel was 1.14

miles. Table 31 shows the averages by CRD group for these variables for the number of eligible acres statewide, and also shows descriptive statistics about the 30,906 non-eligible acres statewide.

To achieve the goal of preserving 686,000 additional acres, the minimum cost of the land would be $2.29 billion.[26] We identified 5,137 parcels in the state that could be preserved to meet this goal in the least expensive manner possible. The average price per acre for the parcels with the lowest price up to 686,000 acres is $3,367 but ranges from $300 to $5,800. The parcel size averages 134 acres. These parcels average 82% prime soils. The average land use on these parcels is 64% cropland, 3% pasture and 25% forest. The average distance from one to another preserved parcel is 1.21 miles, and the distance of the parcels from the nearest city averages 36.14 miles.

Figure 4. Predicted Price Map for Maryland's Agricultural and Forest Lands



Prices are geographically dispersed throughout the state. Figure 4 demonstrates the spatial pattern of the prices we predicted using this analysis. Using the market values per acre, we utilized a kriging procedure to compute a price-based landscape across the state. We find higher

[26] As mentioned above, one can see these total costs as the maximum value needed, assuming that some number can be deleted for the agricultural value. After reporting the results of the analysis, we discuss how land values have changed in the state and how these numbers may need to be adjusted.

prices near cities and highways than in less populated and traveled areas. The blue areas are those with the lowest prices, centered in Western Maryland and the Lower Shore, with some blue in Charles County. The Upper Shore areas that are closer to Delaware and away from the waterfront also have lower-priced agricultural and forest land. The red areas represent the highest-priced land. Geographically, one can see that the red areas dominate in the Urban and Rural Central counties. Anne Arundel and Calvert also have some higher-priced pockets of land. Table 33 indicates the percent and number of inexpensive acres in each of the CRD locations as a complement to Figure 4.

Table 33. Location of Least Expensive Land to Preserve

Crop Reporting District	Percent of 686,000 acres	Number of Acres per region
Western	.01	6640
Rural Central	.22	118,000
Urban Central	.15	101,210
Upper Shore	.32	270,000
Lower Shore	.17	117,080
Southern	.12	73,000

Figure 5. Supply Curve of Eligible Forest and Farm Land for Preservation

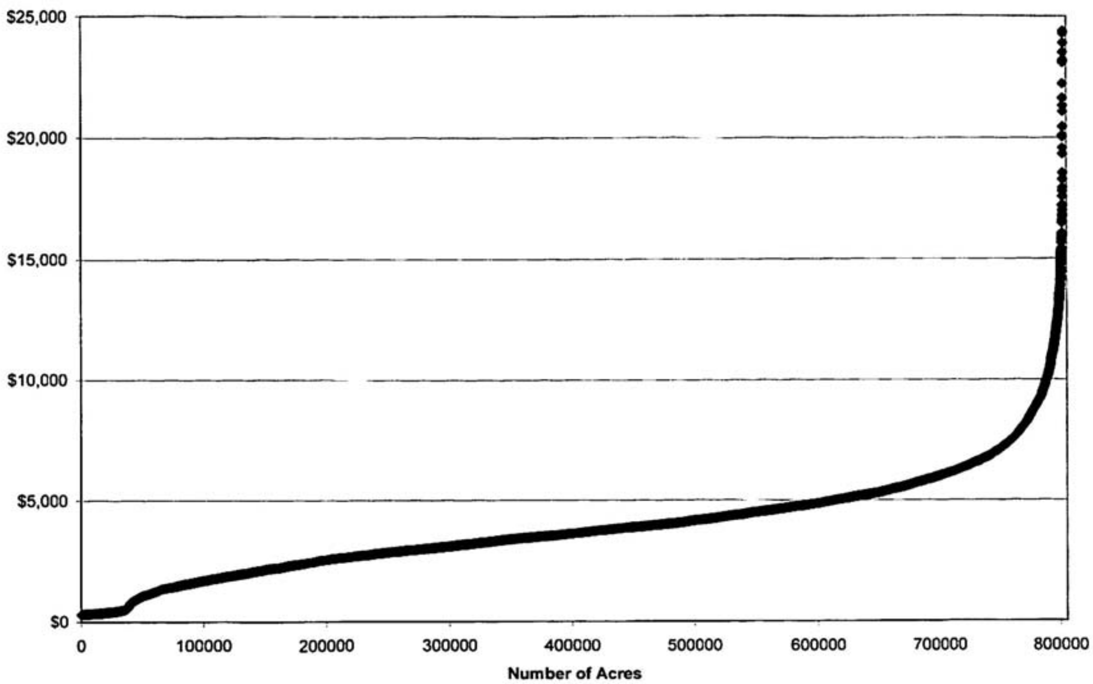


Figure 5 is the supply curve of the total eligible parcels identified across the state.[27] This supply curve does not include those 343,000 acres already preserved by the state. As one can see, one can preserve the least expensive acres first, at a cost of less than $6,000 per acre—many acres

[27] For the supply curve, we used all parcels greater than $300 per acre (301 parcels were deleted based on this criterion) and less than $25,000 per acre (10 parcels were deleted due to this restriction).

would be in the $2,000 to 4,000 range. However, this assumes that the owners of these parcels will accept what the State is offering them to enroll. If some of these parcels cannot be enrolled, then the expected value of easements climbs steeply. Considering acreage beyond the 686,000-acre goal, one finds that the needed monies climb to more than $6,000 per acre. And at the end of the supply curve, for acres after the 800,000 acre mark, we find that the cost to preserve these acres would be $10,000 or more per acre.

Table 34 presents the descriptive statistics of the eligible parcels by county. We also include the number of eligible parcels and the total acres within each county. The total acreage number includes those eligible agricultural and forest parcels identified in 2002. The reported average prices per acre are those predicted or actual for 2002. Figure 5 indicates the location within the counties where prices vary, but Table 34 gives a sense of the average cost of purchasing an easement in a particular county. Prices per acre range from $1,898 in Allegany County to $8,254 in Howard County. Allegany County ranked as having the fewest eligible acres (around 3,000 acres), and Kent County as having the most (91,689 acres). Average soil quality, size of parcels, and other attributes also varied by county.

We also examined how certain targeting scenarios would play out. For example, if one targeted those parcels with the best soils, one could preserve 686,000 acres (with on average 88% prime soils) for $2.74 billion. It would cost $400 million more to target those parcels with the best soils than to enroll the least expensive parcels ($2.29 billion). Parcels with prime soils average 113 acres, with a predicted average value of $4,801 per acre. Their land use is 64.7% cropland, 5% pasture and 23% forest. They are 1.13 miles from the nearest preserved parcel and 35 miles from the nearest city.

If the state decided to target those parcels nearest a city, believing them to be most threatened by conversion, the needed budget to preserve the slightly more than 686,000 acres would be $2.714 billion.[28] Thus, again, it would cost $420 million more to use a specific targeting strategy rather than the least-cost targeting approach which cost $2.29 billion. The average cost was $4,805 per acre. These parcels were slightly smaller than the least-cost parcels, with an average of 110 acres. Most were not "close" to the nearest city, distance ranged from 3 miles to 66 miles away, averaging 31. The parcels close to the city had 84% prime soils, 62% cropland, 6% pasture and 25% forest.

One could also target cropland for preservation. We found that to preserve the 686,000 acres with the highest percentage of cropland (73% on average) would cost $2.69 billion compared to the least-cost strategy of $2.29 billion. The average price was $4,623 per acre. Other land uses on these parcels included pasture (3 percent of land use) and forest (18 percent of land use). The cropland parcels averaged 119 acres each. Proximity to other preserved parcels was 1.07 miles, and they were 36 miles from the nearest city.

[28] This targeting strategy used proximity to the nearest city as an indicator of conversion pressure, whereas another measure may have captured this better. Because we have used five cities of varying sizes, we may not be capturing the conversion threat as strongly.

Table 34. Descriptive Statistics for Eligible Parcels by County in 2002

ALLEGANY COUNTY		
Variable	Label	Mean
PLand	Per Acre Land Price	1898.4400
ACRES	Aver. # of parcel acres	96.1397
PRIME	Percent Prime soil	0.7384
Contig	Miles to closest preserved parcel	3.0039
Crop	Percent Cropland	0.2115
Pasture	Percent Pasture	0.1140
Forest	Percent Forested	0.5267
dcity	Miles to Nearest City	9.7402
Total Acres identified (2002)		2980.33
number of parcels		31
ANNE ARUNDEL COUNTY		
Variable	Label	Mean
PLand	Per Acre Land Price	4528.6500
ACRES	Aver. # of parcel acres	93.5945
PRIME	Percent Prime soil	0.8884
Contig	Miles to closest preserved parcel	1.2480
Crop	Percent Cropland	0.6409
Pasture	Percent Pasture	0.0299
Forest	Percent Forested	0.2844
dcity	Miles to Nearest City	25.8031
Total Acres identified (2002)		14787.93
number of parcels		158
BALTIMORE COUNTY		
Variable	Label	Mean
PLand	Per Acre Land Price	7953.3200
Appraised market value	Value for MALPF eligible properties	5858.4800
ACRES	Aver. # of parcel acres	71.1199
PRIME	Percent Prime soil	0.9540
Contig	Miles to closest preserved parcel	0.5692
Crop	Percent Cropland	0.5257
Pasture	Percent Pasture	0.1102
Forest	Percent Forested	0.3153
dcity	Miles to Nearest City	23.8060
Total Acres identified (2002)		53624.42
number of parcels		754
number of parcels		281

Table 34. Descriptive Statistics for Eligible Parcels by County in 2002 (cont.)

CALVERT COUNTY		
Variable	Label	Mean
PLand	Per Acre Land Price	5377.3600
Appraised market value	Value for MALPF eligible properties	11623.1500
ACRES	Aver. # of parcel acres	91.0476
PRIME	Percent Prime soil	0.7327
Contig	Miles to closest preserved parcel	1.2343
Crop	Percent Cropland	0.4538
Pasture	Percent Pasture	0.0218
Forest	Percent Forested	0.4259
dcity	Miles to Nearest City	43.3831
Total Acres identified (2002)		13201.9
number of parcels		145
CAROLINE COUNTY		
Variable	Label	Mean
PLand	Per Acre Land Price	2081.4500
Appraised market value	Value for MALPF eligible properties	2195.0200
ACRES	Aver. # of parcel acres	114.2632
PRIME	Percent Prime soil	0.8500
Contig	Miles to closest preserved parcel	0.6015
Crop	Percent Cropland	0.7298
Pasture	Percent Pasture	0.0062
Forest	Percent Forested	0.2069
dcity	Miles to Nearest City	43.7212
Total Acres identified (2002)		64672.95
number of parcels		566
CARROLL COUNTY		
Variable	Label	Mean
PLand	Per Acre Land Price	5154.6200
Appraised market value	Value for MALPF eligible properties	4376.6700
ACRES	Aver. # of parcel acres	78.3597
PRIME	Percent Prime soil	0.8238
Contig	Miles to closest preserved parcel	0.7225
Crop	Percent Cropland	0.6002
Pasture	Percent Pasture	0.1160
Forest	Percent Forested	0.2012
dcity	Miles to Nearest City	31.2348
Total Acres identified (2002)		34164.81
number of parcels		436

Table 34. Descriptive Statistics for Eligible Parcels by County in 2002 (cont.)

CECIL COUNTY		
Variable	Label	Mean
PLand	Per Acre Land Price	4822.4600
Appraised market value	Value for MALPF eligible properties	3939.3700
ACRES	Aver. # of parcel acres	125.9563
PRIME	Percent Prime soil	0.8370
Contig	Miles to closest preserved parcel	1.1213
Crop	Percent Cropland	0.6706
Pasture	Percent Pasture	0.0156
Forest	Percent Forested	0.2492
dcity	Miles to Nearest City	54.6022
Total Acres identified (2002)		57436.05
number of parcels		456
CHARLES COUNTY		
Variable	Label	Mean
PLand	Per Acre Land Price	4213.8700
Appraised market value	Value for MALPF eligible properties	3575.8900
ACRES	Aver. # of parcel acres	132.1185
PRIME	Percent Prime soil	0.7205
Contig	Miles to closest preserved parcel	1.2770
Crop	Percent Cropland	0.3984
Pasture	Percent Pasture	0.0199
Forest	Percent Forested	0.4784
dcity	Miles to Nearest City	45.6871
Total Acres identified (2002)		6209.57
number of parcels		47
DORCHESTER COUNTY		
Variable	Label	Mean
PLand	Per Acre Land Price	2629.8100
Appraised market value	Value for MALPF eligible properties	2184.7700
ACRES	Aver. # of parcel acres	138.9822
PRIME	Percent Prime soil	0.8524
Contig	Miles to closest preserved parcel	0.9479
Crop	Percent Cropland	0.7663
Pasture	Percent Pasture	0.0015
Forest	Percent Forested	0.1677
dcity	Miles to Nearest City	27.3247
Total Acres identified (2002)		56843.74
number of parcels		409

Table 34. Descriptive Statistics for Eligible Parcels by County in 2002 (cont.)

FREDERICK COUNTY

Variable	Label	Mean
PLand	Per Acre Land Price	4513.5700
Appraised market value	Value for MALPF eligible properties	3397.8000
ACRES	Aver. # of parcel acres	111.9265
PRIME	Percent Prime soil	0.8194
Contig	Miles to closest preserved parcel	1.0464
Crop	Percent Cropland	0.6768
Pasture	Percent Pasture	0.0821
Forest	Percent Forested	0.1789
dcity	Miles to Nearest City	24.9060
Total Acres identified (2002)		60440.31
number of parcels		540

GARRETT COUNTY

Variable	Label	Mean
PLand	Per Acre Land Price	2056.8100
ACRES	Aver. # of parcel acres	135.4718
PRIME	Percent Prime soil	0.7241
Contig	Miles to closest preserved parcel	1.7463
Crop	Percent Cropland	0.5288
Pasture	Percent Pasture	0.0656
Forest	Percent Forested	0.3407
dcity	Miles to Nearest City	33.6450
Total Acres identified (2002)		3657.74
number of parcels		27

HARFORD COUNTY

Variable	Label	Mean
PLand	Per Acre Land Price	5837.3200
ACRES	Aver. # of parcel acres	87.8290
PRIME	Percent Prime soil	0.8908
Contig	Miles to closest preserved parcel	0.7656
Crop	Percent Cropland	0.6117
Pasture	Percent Pasture	0.0801
Forest	Percent Forested	0.2327
dcity	Miles to Nearest City	30.2507
Total Acres identified (2002)		46373.7
number of parcels		528

Table 34. Descriptive Statistics for Eligible Parcels by County in 2002 (cont.)

HOWARD COUNTY

Variable	Label	Mean
PLand	Per Acre Land Price	8253.9800
Appraised market value	Value for MALPF eligible properties	9000.0000
ACRES	Aver. # of parcel acres	101.1638
PRIME	Percent Prime soil	0.8965
Contig	Miles to closest preserved parcel	1.0858
Crop	Percent Cropland	0.6255
Pasture	Percent Pasture	0.0783
Forest	Percent Forested	0.2078
dcity	Miles to Nearest City	23.6860
Total Acres identified (2002)		20940.9
number of parcels		207

KENT COUNTY

Variable	Label	Mean
PLand	Per Acre Land Price	3501.4900
ACRES	Aver. # of parcel acres	177.3487
PRIME	Percent Prime soil	0.8137
Contig	Miles to closest preserved parcel	1.2450
Crop	Percent Cropland	0.7445
Pasture	Percent Pasture	0.0043
Forest	Percent Forested	0.1821
dcity	Miles to Nearest City	71.6068
Total Acres identified (2002)		91689.29
number of parcels		517

MONTGOMERY COUNTY

Variable	Label	Mean
PLand	Per Acre Land Price	6139.2800
Appraised market value	Value for MALPF eligible properties	5280.3700
ACRES	Aver. # of parcel acres	123.8307
PRIME	Percent Prime soil	0.8553
Contig	Miles to closest preserved parcel	2.2638
Crop	Percent Cropland	0.5244
Pasture	Percent Pasture	0.1421
Forest	Percent Forested	0.2703
dcity	Miles to Nearest City	31.5998
Total Acres identified (2002)		22661.01
number of parcels		183

Table 34. Descriptive Statistics for Eligible Parcels by County in 2002 (cont.)

PRINCE GEORGE COUNTY		
Variable	Label	Mean
PLand	Per Acre Land Price	4109.3300
ACRES	Aver. # of parcel acres	117.5999
PRIME	Percent Prime soil	0.8538
Contig	Miles to closest preserved parcel	4.1398
Crop	Percent Cropland	0.4036
Pasture	Percent Pasture	0.0395
Forest	Percent Forested	0.4907
dcity	Miles to Nearest City	24.4997
Total Acres identified (2002)		23990.3800
number of parcels		204.0000
QUEEN ANNE COUNTY		
Variable	Label	Mean
PLand	Per Acre Land Price	3150.5700
ACRES	Aver. # of parcel acres	175.2738
PRIME	Percent Prime soil	0.8273
Contig	Miles to closest preserved parcel	1.0148
Crop	Percent Cropland	0.7508
Pasture	Percent Pasture	0.0067
Forest	Percent Forested	0.1859
dcity	Miles to Nearest City	54.7399
Total Acres identified (2002)		88337.99
number of parcels		504
number of parcels		517
SOMERSET COUNTY		
Variable	Label	Mean
PLand	Per Acre Land Price	2099.9800
Appraised market value	Value for MALPF eligible properties	2424.3200
ACRES	Aver. # of parcel acres	101.3316
PRIME	Percent Prime soil	0.7306
Contig	Miles to closest preserved parcel	1.3989
Crop	Percent Cropland	0.5961
Pasture	Percent Pasture	0.0048
Forest	Percent Forested	0.2694
dcity	Miles to Nearest City	21.2475
Total Acres identified (2002)		11349.14
number of parcels		112

Table 34. Descriptive Statistics for Eligible Parcels by County in 2002 (cont.)

ST. MARY'S COUNTY		
Variable	Label	Mean
PLand	Per Acre Land Price	3890.7400
Appraised market value	Value for MALPF eligible properties	3166.4900
ACRES	Aver. # of parcel acres	111.8635
PRIME	Percent Prime soil	0.7343
Contig	Miles to closest preserved parcel	1.5209
Crop	Percent Cropland	0.4391
Pasture	Percent Pasture	0.0219
Forest	Percent Forested	0.4584
dcity	Miles to Nearest City	59.4038
Total Acres identified (2002)		21589.65
number of parcels		193
TALBOT COUNTY		
Variable	Label	Mean
PLand	Per Acre Land Price	4580.6600
Appraised market value	Value for MALPF eligible properties	3358.2000
ACRES	Aver. # of parcel acres	162.4094
PRIME	Percent Prime soil	0.7731
Contig	Miles to closest preserved parcel	1.5332
Crop	Percent Cropland	0.7361
Pasture	Percent Pasture	0.0102
Forest	Percent Forested	0.1796
dcity	Miles to Nearest City	48.8557
Total Acres identified (2002)		54407.16
number of parcels		335
WASHINGTON COUNTY		
Variable	Label	Mean
PLand	Per Acre Land Price	3494.2900
Appraised market value	Value for MALPF eligible properties	3040.0600
ACRES	Aver. # of parcel acres	102.0316
PRIME	Percent Prime soil	0.8432
Contig	Miles to closest preserved parcel	0.8206
Crop	Percent Cropland	0.6748
Pasture	Percent Pasture	0.0778
Forest	Percent Forested	0.1595
dcity	Miles to Nearest City	10.5456
Total Acres identified (2002)		50403.61
number of parcels		494

Table 34. Descriptive statistics for Eligible Parcels by County in 2002 (cont.)		
WICOMICO COUNTY		
Variable	Label	Mean
PLand	Per Acre Land Price	3242.2100
Appraised market value	Value for MALPF eligible properties	1700.0000
ACRES	Aver. # of parcel acres	107.3122
PRIME	Percent Prime soil	0.7398
Contig	Miles to closest preserved parcel	1.0924
Crop	Percent Cropland	0.6610
Pasture	Percent Pasture	0.0009
Forest	Percent Forested	0.2198
dcity	Miles to Nearest City	10.3780
Total Acres identified (2002)		9980.03
number of parcels		93
WORCESTER COUNTY		
Variable	Label	Mean
PLand	Per Acre Land Price	2542.1200
Appraised market value	Value for MALPF eligible properties	1663.3100
ACRES	Aver. # of parcel acres	143.4000
PRIME	Percent Prime soil	0.7766
Contig	Miles to closest preserved parcel	2.0715
Crop	Percent Cropland	0.5439
Pasture	Percent Pasture	0.0060
Forest	Percent Forested	0.3812
dcity	Miles to Nearest City	23.4894
Appraised market value	Value for MALPF eligible properties	1663.3100
Total Acres identified (2002)		40295.4
number of parcels		281

If large farms were considered the most profitable or most likely to survive, one could also target the largest parcels for preservation. The targeting strategy of the highest number of acres finds 4,545 parcels with an average of 157 acres to reach the goal. The cost to preserve the 686,000 acres would be $2.49 billion. Larger parcels tend to have lower per-acre prices—an average $3,871—which may explain the lower overall total cost compared to some of other targeting scenarios. These parcels had an average of 82% prime soils and were 66% cropland, 4% pasture and 24% forest. They were 37 miles from the city and 1.25 miles from the nearest preserved parcels.

If contiguity to other preserved parcels is the overriding goal, the state could seek to preserve large blocks of farm and forest land. In that case, the state could prioritize parcels close to other preserved parcels. This scenario targets 5,978 parcels for a total cost of $2.68 billion. The average cost for these parcels, which average 114.8 acres, would be $4,738 per acre. The average distance between one of these parcels and the next-closest preserved parcel is 0.76 miles, with the location of the latter ranging from next-door to 2 miles distant. The parcels average 0.76 miles from another preserved parcel ranging from next door to 2 miles away. They average 85% prime soils, 65.7% cropland, 5% pasture and 23% forest land use. They average 35.51 miles from the nearest city.

The programs and/or techniques used to preserve land will also impact the overall costs. For example, under MALPF, landowners can discount their bids, so the overall cost of acquiring easements may be lower. MALPF has determined that the savings due to discounting are $101.8 million out of the total easement value of $398.9 million for the 217,460 acres it had preserved through 2002. This computes to about a 25% discount in the easement values. If one assumes that such discounting would continue and/or that all parcels are preserved under such a system, then the budgetary resources would be closer to $1.72 billion for the least expensive parcels. In the last few years, the federal government has offered attractive tax incentives to encourage easement donations under the 1996 Pension Protection Act. For example, the Maryland Environmental Trust has protected 3,264 acres of private farmland, woodland and scenic open space in 2006 alone and now has more than 112,000 acres statewide. These could accelerate discounting and gifting if they are continued past 2007. But given that one cannot guarantee that landowners will continue to be willing to discount at this level or that all land preserved in Maryland will be conducted by MALPF and/or another program with similar discounting, or a program with gifting/charitable deduction, we do not report a discounted cost of preservation but rather the full land value amount in the budgetary resources needed. One can see these dollar amounts as the maximum value and the $1.72 billion with discounting as a lower bound.

RECENT CHANGES IN LAND PRICES

Since 2002, Maryland, like many other states, has seen a dramatic increase in farm values. This requires that we consider how these increases may impact the estimated cost of $2.29 billion to preserve the 686,000 acres. While estimates of farm real estate value increases are available, the translation of these for use in this study is not straightforward.

The USDA Agricultural Statistics Board estimates that farm real estate values have increased by an average of 12.7 percent between 2005 and 2006 from a base of $8,900. Cropland value has increased approximately 15.8 percent from 2005 to 2006, from a base of $8,800 per acre. Even more telling, however, is that the average per-acre farm value has more than doubled since 2002, from $3,900 per acre to $8,900 per acre. These estimates are based on a survey of landowners' perceptions of the value of both their land and buildings for the operators' entire farm operation. In addition to the survey of landowners' personal perceptions of value, experts from USDA's field offices reviewed the farm real estate values and submitted recommendations for values and estimated percentage change in value from the previous year.

Our study does not rely on estimates of value like the USDA numbers but is based on actual market sales – transactions where a seller was able to find a buyer willing to pay the agreed-upon price. The advantage of using the actual sales data is that one or two sales do not drive the estimates of farm real estate value but rather that all sales impact the final outcome. The average value (in 2003 dollars) for our sample was $5,567.90 higher than the USDA estimated value, but again the median was $4,128.42 (half the sales per acre were less than $4,128 and half the sales per acre were more than that). We also account for the fact that each parcel has a set of unique characteristics that may affect its sales price relative to other parcels. In addition, because the focus is on preserving the land, we tried to isolate the value of the land from the value of the buildings, whereas the USDA asks farmers about both land and buildings. The current study focuses on the market value a preservation program may have to consider when compensating the landowners for the lost development rights. In some cases, the value of the house and other improvements could be a large percentage of the market price, but the value of the house and improvements is not something the preservation program would incorporate in its payments to farmland owners.

Average cropland cash rent is listed as $62.00 per acre. Cash rent for cropland increased from $55.50 in 2002 to $62.00 per acre in 2006—a 12% jump—a very different number than the 128% jump in farm real estate values. In the results we therefore present two possibilities: one, that the land value increase of 12% reflects the change in agricultural value, and two, that the value of agricultural land has doubled—reflecting the increase of more than 100% since 2002.

Thus, we estimate the total cost of preserving the 686,000 eligible acres if the increase in land values were $2.56 billion on the low end and $4.58 billion on the high end.

The USDA's 2006 assessment also suggested that the farm real estate market was "cooling"—that the increase in value between 2005 and 2006 was not quite as large as in the previous three years. We cannot predict whether the market will accelerate once again, whether prices will remain stable, or whether prices will fall. Anything is possible. Agricultural land values in the United States peaked in 1982 and then crashed. Across the country, these values have been steadily rising since 1987, but it took almost 20 years for the inflation-adjusted (real) value of U.S. farm real estate to reach the 1982 peak. On the other hand, Maryland's agricultural land is heavily influenced by urban pressures and therefore has not had the volatility of some areas. The last five years have demonstrated how quickly the land market can change.

CONCLUSIONS

The values of land and location attributes in the market were estimated using hedonic models for per-acre prices based on market transactions for agricultural land in Maryland from 1997 to 2003. Separate models were estimated for 6 groups of counties across the state. Within a group, separate models were estimated for parcels with residential structures and those without structures. The models were tested for spatial correlation. Given the predominance of spatial correlation in the models, spatial correlation models were run for all the models. Most land characteristics performed much as we expected in explaining the prices. Predicted prices were within 5% of the actual market price in the out-of-sample group. Predicted prices were less accurate for high-valued parcels than for low-valued parcels; however, for the purposes of this study this error is less of a concern than having poor predictions for the low-valued parcels.

In general, the results mimic many previous studies and suggest that per-acre prices will decrease as parcel size increases. This was true for parcels with and without residential structures. While in the general models being closer to a city increased the value of the property, in the separate county models, distance was less important. Being farther from the nearest city decreased per-acre prices in the Upper Central and Rural Central districts for parcels with structures and in those two regions and the Lower Eastern Shore for parcels without structures. Some of the nearest cities (Hagerstown, Cumberland, and Salisbury) seem to have less impact on the price per acre than cities such as Baltimore and Washington, D.C. Another common result across the models was that parcels without structures with a higher percentage of cropland had higher prices per acre than those with land use characterized as forest. Having a higher percentage of pastureland rather than cropland did not have a significant effect on the price in any model. However, having forested acreage rather than cropland did not impact the price per acre for parcels with residential structures in four of the six regions – forest land use received a comparable per-acre price for these parcels except in the Lower Eastern Shore and Southern Maryland. Prime soils were not as influential in determining prices as was expected a priori. It had no impact on the price per acre for parcels with residential structures except in Rural Central Maryland. It had a positive impact on parcels without structures only in Upper Shore, Lower Shore and Southern Maryland.

The price per acre of a parcel with a waterfront area received a higher value per acre. In the Upper Eastern Shore and Southern Maryland, waterfront access commanded a premium for both parcels with and without residential structures but those parcels with residential structures received a higher premium. This could be a situation in which those parcels with attractive waterfront areas were those chosen to construct a home site. For Lower Eastern Shore parcels, both received a premium but those without structures were rewarded more. While parcel price per acre for those with residential housing have been increasing since1999 in most regions, those without housing structures exhibited more variance in prices overtime – with some regions increasing then decreasing and others having a price increase only at the very end of the study period.

Using eligibility criteria based on MALPF's minimum standards (50 or more acres and 50 percent prime soils), we find Maryland has a great deal of high quality farmland and forestland available to be preserved. In addition, more acreage will become eligible as more parcels are preserved and other parcels become contiguous with newly preserved parcels. The resulting number of eligible parcels statewide was 7,227, with a total of 850,490 acres. Average predicted per-acre land price for the eligible parcels was $4,512, and average size was 118 acres. Average percentage of prime soils was 84%. In addition, some of this agricultural land continues to be relatively inexpensive, especially if one assumes that landowners will continue to accept easement payments of less than the full easement value (discounting). Therefore, adjustments in eligibility criteria do not appear necessary to reach the preservation target. The estimated coefficients from the hedonic regressions allow us to predict prices for all agricultural parcels in the state greater than 10 acres. Using these predicted prices, we then could determine the needed budgetary resources of preserving 686,000 more acres. The minimum allocation of compensating the landowners for lost development rights and preserving the land was computed to be $2.29 billion.[29] The average price per acre for these least expensive parcels was $3,367. There were

[29] As mentioned above, one can see these total costs as the maximum value needed, assuming that some number

5,137 parcels identified from all over the state that would meet this goal in the least expensive manner possible. These parcels had high average soil quality (82%), were primarily cropland (64%), and averaged 134 acres each. If landowner discounting such as that which had occurred under MALPF is possible (landowners accepting approximately 25% less than the easement value), then the needed resources could be closer to $1.72 billion for the least expensive parcels. Given that one cannot guarantee that this level of discounting will continue or that all preservation will be conducted by a preservation program that uses discounting, one should view this estimate as a lower bound. It has been suggested that once landowners realize that the development restrictions imposed by having an easement applied to their property do not dramatically alter their land values (Nickerson and Lynch 2001, Lynch, Gray and Geoghegan 2007, Michael 2007, Anderson and Weinhold 2005), more will be willing to participate and may be willing to further discount. If that should occur, the budgetary resources needed decrease. Preserving land with higher levels of prime soils or with higher averages of cropland would require an outlay by the state more than $400 million greater than that to finance the "least-cost" targeting strategy. Other types of characteristic-targeting were also investigated.

Willingness to participate is also an important component of achieving the 1+ million-acre goal. Lynch and Lovell (2003) found that in general the likelihood of participation increases with farm size, growing crops, whether offspring plan to continue farming, eligibility, and the share of income from farming. Landowners closer to the nearest city were less likely to join. Thus, programs could use these factors to determine targeting approaches to facilitate attracting participants, even if some of these factors are not important goals in and of themselves.

Contiguity of preserved parcels has become an important goal for some preservation programs, and incentive structures need to be adjusted to ensure that new contiguous entrants are well-rewarded. The Oregon State Conservation Reserve Program sought to encourage enrollment of individuals who owned land along the same stream segment, as the cumulative total buffers of preserved land would have a larger impact if contiguous. Therefore, the program's incentive structure was designed in such a way that all landowners were rewarded when more than 50 percent of the land along a 5-mile stream segment was enrolled. Incentives to these producers included a one-time cumulative impact incentive payment of 4 times the annual rental rate. This type of incentive may motivate current participants to encourage their neighbors to consider joining a preservation program.

Another challenge for the State and for program administrators is to find alternative preservation techniques. The reader is referred to Duke and Lynch (2003), who outline a plethora of techniques in their report "Farmland Preservation Techniques: Identifying New Options." They also investigate how much support four of these innovative techniques would have (Duke and Lynch 2007, Duke and Lynch 2005).[30] Stakeholders and experts found that using a right of first refusal (ROFR) technique and/or developing some type of agricultural conservation pension (ACP) would be attractive and feasible. State or local programs would obtain a right of first

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can be deleted for the agricultural value. For example, if we assume that the agricultural value of land in Maryland is $400 per acre, the cost of preserving the 686,000 acres would be $274.4 million less than the cost to purchase the acres outright. If the agricultural value was $300 per acre, the cost would be $205.8 million less.

[30] These reports are also available at http://www.udel.edu/FREC/PUBS/.

refusal from landowners and decide to exercise it if and when a landowner has a bona fide offer from a developer. It was thought that an ROFR program would be the most cost-effective policy in the short run and would signal to farmers and developers that the state intended to preserve agriculture in the targeted area. Rights could be purchased for a low cost. Some were concerned that ROFR would not be cost effective in the long run if land values continued to escalate. If land appreciates rapidly, it may be more cost effective to preserve land in the present. Thus some experts suggested that ACP could potentially be more cost effective. ACP establishes the basis of the pension in the short term—i.e., at today's land prices—but pays out in the long term and takes advantage of the actuarial gains of risk pooling.

Another issue of concern is how the continuing preservation efforts affect the overall availability of land for housing and other purposes. As more land is restricted, the supply of developable land will diminish. As fewer acres are available for housing and commercial purposes (including the required infrastructure), one ponders what will happen to the cost of unrestricted land and thus the cost of purchasing development rights. Given there is still a relatively large supply of undeveloped land (3.8 million acres) in the state; one-half in agriculture and the other one-half in forest or natural cover, these impacts may be of more concern in the long-run than in the short-term.

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APPENDIX A: HEDONIC PRICE MODEL

A hedonic model relates the price of a heterogeneous good to the attributes that comprise the good. Hedonic models are widely used in the residential housing market literature to estimate housing market values because houses tend to vary on so many different dimensions. Hedonic models have also gained popularity as a means to value non-market environmental goods whose values may be capitalized into the housing market. Ridker and Henning (1967) estimate one of the first hedonic models in the residential housing market to support the claim that air quality affects property values. Researchers use hedonic models to measure benefits from environmental improvements or losses from environmental degradations. Examples include Geoghegan, Lynch, and Bucholtz (2003), Irwin and Bockstael (2001), and Geoghegan, Wainger, and Bockstael (1997) for estimating the value of open space; Leggett and Bockstael (2000) for estimating water quality value; Palmquist et al (1997) for estimating negative externality costs from polluting industry; and Smith and Huang's (1995) examination of the may studies (meta-analysis) of air quality valuation literature. Mahan et al (2000) use a hedonic model to measure the non-market value of wetlands in the Portland, Oregon housing market. They argue this method has advantage over other assessment techniques because the hedonic model uses observed market values to build the valuation estimates for non-market goods and services.

Hedonic models also have been used extensively to estimate land values in the agricultural land market. Xu et al (1993) employ a hedonic model to estimate the value of various site characteristics on farmland. They write that, in land market hedonic models, the land characteristics act as proxies for the expected net return to the land, the driving force behind land values. They use characteristics such as barn characteristics, house characteristics, and machinery characteristics, land, and location characteristics.

In a study of the effect of farmland preservation programs on agricultural land prices in of Maryland, Nickerson and Lynch (2001) employ a hedonic model on preserved and unpreserved agricultural land sales. The variable of interest is preservation status on the land parcel. The parameter in the hedonic model for preservation status indicates that preservation status does not significantly decrease land values. Nickerson and Lynch write that the hedonic approach is useful when one can observe parcel characteristics but not use values. Lynch, Gray and Geoghegan (2007) ask a similar question and compare two methods in answering it – hedonic approach and a propensity score matching analysis.

Lynch and Lovell (2003) study the private land market for both agricultural and residential use employing hedonic regressions. The study investigates whether values for parcel characteristics in the private land market are similar to the payment schemes developed by preservation programs. By subtracting assessed value of structures on the land from the total market value of the parcels, they estimate land characteristic values in the private land market through the hedonic model. The model included proxies for net agricultural returns to agricultural land and parcel characteristics that might affect the cost of and attractiveness of development on the land.

These studies from the literature demonstrate the wide applicability of hedonic methods to land market valuation. The volume of peer-reviewed published studies using hedonic methods sets precedence for hedonic techniques in valuing housing, land, and environmental characteristics. A primary advantage of hedonic models over other valuation methods such as contingent valuation is that hedonic models use actual, not hypothetical, market transactions.

Thus in this analysis, a hedonic approach is used to model the sales price of land. When deciding whether to place his or her land on the market, a landowner examines the relative returns to the parcel's characteristics in recent sales in the local land market. Similarly, the buyer will evaluate the relative cost of the parcel's characteristics before deciding to purchase the property. The price of the land in real estate transaction *i* is modeled as the net present value of the stream of agricultural rents, A_i, as a function of the parcel's characteristics, X_i, and time, *t*, until an optimal date to develop the land, t^*, and of the residential or other non-agricultural rents, R_i, as a function of the parcel's characteristics, X_i, and time, *s*, the time when *t* is greater than t^* such that

$$(1) \qquad P_i = \left[\int_{t=0}^{t^*} A_i\left(X_i, t\right) e^{-rt} dt + \int_{t^*}^{\infty} R_i\left(X_i, s\right) e^{-rs} dt \right].$$

Parcel characteristics include soil quality, land use, improvements, and geographic location, as well as other attributes. Parcels that are currently in agricultural use ($t<t^*$) are included in the analysis. A hedonic model is estimated to explain how these characteristics are rewarded for a locus of equilibrium land prices in recent private market transactions.

<u>*Model Functional Form*</u>

There is no theoretical foundation for the choice of functional form for the hedonic model beyond the assumption that the hedonic function is generally non-linear (Rosen, 1974). If the hedonic function is estimated linearly, as

$$P(a) = \alpha + \beta_1 a_1 + ... + \beta_J a_J + \varepsilon$$

then every land buyer in the market faces the same marginal implicit prices. This is an arbitrary constraint on buyer's preferences and one that most economists do not think is reasonable.

Because the hedonic theory does not explicitly identify a proper functional form, the researcher is faced with choosing among functional forms. Popular functional forms include the semi-log, inverse semi-log, log-log, and Box-Cox specifications. The semi-log model takes the form

$$\ln P(a) = \alpha + \beta_1 a_1 + ... + \beta_J a_J + \varepsilon$$

where the dependent variable is transformed by taking the natural log of price per acre. The inverse semi-log model specification is

$$P(a) = \alpha + \beta_1 \ln a_1 + ... + \beta_J \ln a_J + \varepsilon \, .$$

This is also often referred to as the linear-log specification. This form is justified by the authors in that it measures the decreasing, positive slopes of most marginal implicit price curves. The log-log, or double-log, form is specified as

$$\ln P(a) = \alpha + \beta_1 \ln a_1 + ... + \beta_J \ln a_J + \varepsilon .$$

The Box-Cox specification is often chosen for estimation because the data is used to choose the best functional form for the model. A classic Box-Cox model transforms only the dependent variable (Faux and Perry, 1999), though the Box-Cox specification may transform the dependent variable or the independent variables. Each variable can be transformed separately, but it is more common to use the same transformation for all of the variables. The Box-Cox specification can be used directly for the hedonic model estimation. Alternatively, the Box-Cox model can be used to test for and choose among various functional forms, including linear, semi-log, and log-linear forms.

Some researchers choose to report results from multiple functional forms. For example, Leggett and Bockstael (2000) report estimation results from linear, semi-log, log-log, and inverse semi-log forms. Palmquist and Danielson (1989) use Box-Cox techniques to select between the linear, semi-log, log-linear, and inverse semi-log specifications. They find the semi-log form is the best specification through minimization of the residual sum of squares for the transformed data.

The researcher can plot the distributions of the variables to assist in choosing a functional form for the hedonic model. If the variable distributions appear normal, then a linear functional form is likely most appropriate. If the variable distributions are right-skewed, then transformations such as logarithms and square roots may normalize the distributions for some or all variables.

Furthermore, as the purpose of the model in this study is to predict land parcel market values for use in the creation and analysis of targeting packages, it is important to choose the functional form that makes the best predictions. One method by which comparisons can be made across functional forms is the out-of-sample prediction. The out-of-sample prediction mimics the prediction process, as the parcel values being predicted by the model algorithm are not in the data set on which the model is being estimated. The out-of-sample prediction measures the error between the true parcel values and the predicted parcel values. The data set is randomly split into two groups – a training set with a large proportion of the observations and a validation set with the remaining observations. The model is estimated with the training set observations only. This ensures that the predictions are made for observations that are not included in the modeling sample. The parameters from the model estimation are then applied to the validation set to predict the parcel values. The differences between the predicted parcel values and the true parcel values are calculated to determine how well the model predicts the true parcel values.

Spatial Autocorrelation

Spatial autocorrelation originates from omission of spatially correlated variables from the model. The overall effect of omitted variables is captured in the model's error term. When the omitted variables are spatially correlated, the error term is spatially correlated. A spatially correlated error term violates the independence assumption in the standard assumption of an identically and independently distributed error term, $\varepsilon \sim N(0, \sigma^2 I)$. There is no longer zero covariance between the errors. Model results remain unbiased and consistent but are inefficient, leading to inaccurate t-statistics and significance levels (Anselin and Griffith, 1988). Parcel characteristics that affect the price may be spatially correlated. If some of these characteristics are not observable, then there may be spatial dependence across error terms. Many of the parcels are located near one another and would share these unobservable characteristics. If this is the case, the empirical problem becomes

$$P = X\beta + \varepsilon$$

$$\varepsilon = \rho W \varepsilon + \mu,$$

which can be estimated as

$$P = Xb + (I - \rho W)^{-1} \mu$$

(Whittle 1954; Cliff and Ord 1973), where W is a spatial weight matrix, ρ is a scalar parameter to be estimated, μ is a vector of random error terms assumed to have a mean of 0 and variance-covariance matrix $\sigma^2 I$, and ε is a vector of random error terms with mean 0 and with variance-covariance matrix $\sigma^2 (I-\rho W)^{-1} (I-\rho W')^{-1}$ (Bell and Bockstael 2000, Kelejian and Robinson 1993). As the distance between observations increases, the correlation between their errors is assumed to decrease. Thus, 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 farther 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). Numerous studies have found no qualitative or quantitative differences between spatially corrected and ordinary least squares models.[31]

[31] See, for example, Geoghegan, Lynch, and Bucholtz (2003), Lynch and Lovell (2003), and Leggett and Bockstael (2000).

APPENDIX B. DETAILED RESULTS FROM THE REGIONAL MODELS

Results from Dispersed Geographic Markets – Per-Acre Price Models for Parcels without Structures

The following paragraphs present the results by each area for the markets for parcels without residential structures. In the Urban Central model, 171 agricultural land parcels without housing structures sold in the time period 1997-2003 (Table 8). Table 9 presents the descriptive statistics for this region's sales transactions. The model explained only 23.8% of the variation in the per acre sale prices. Average price was $13,966 per acre. Average parcel size was 56.43 acres. Parcels averaged 28 miles to the nearest city. Larger parcel size received a lower per-acre price, which is consistent with most land market studies. Because of the log-log specification, the coefficients on the logged independent variables are equal to the elasticity of prices with respect to the variables. Elasticities tell us that a 1% increase in the value of the variable will increase (decrease) the price by a percentage equal to the estimated positive (negative) coefficient. For example, for acreage, if the acreage of the parcel increases by 1% (0.56 acres), the market price per acre of the parcel will decrease by 0.27% ($38). As distance from the city increased by 1% (1/4 mile), price fell by 0.87% ($122). As the percentage of woodland on the property increased relative to the percentage of cropland, the price per acre fell. An increase in forest land use from 33% to 34% decreased the price per acre by 0.36% ($50). A higher percentage of pasture (13% per parcel on average) did not significantly decrease the price of the parcel relative to cropland. Similarly, the percentage of high quality soils (60% on average) did not have an impact on the per-acre price. Surprisingly, parcels enrolled in preservation programs preventing conversion of the land (7% of the sample) did not have lower prices than those not enrolled. A greater appraised value of an improvement (non-residential), which averaged $6,128, did not have the per- acre prices. Frederick County had lower prices per acre than Montgomery County. Howard and Baltimore County prices were similar to Montgomery County's. Prices were significantly higher after 1998.

In the Upper Shore market for land with no structures, there were 336 agricultural land sales without housing structures (Table 10). Table 11 presents the descriptive statistics for these sales observations. The average sales price per acre was $9,248.66. The average acreage was 79.17. Distance to the nearest city averaged 55 miles. The model explained 44.15% of the variation in the per acre sale prices. As parcel size increased by 1% (3/4 acres), per-acre price decreased by 0.30% ($28). In this area, if the parcel was farther from the city, the price was not significantly lower. As the percentage of woodland on the property increased relative to the percentage of cropland, the price per acre fell. If forest use on the parcel climbed from 26% to 27%, the price decreased by 0.49% ($45). Again, a higher percentage of pasture did not significantly decrease the price of the parcel relative to cropland. The percentage of high quality soils did increase the per-acre price and was statistically significant. If the percentage of prime soils increased from 58% to 59%, the price increased by 0.20% ($18.50). Once again, we find that being enrolled in an agricultural preservation program (9% of the sample) and having an easement attached to the land had no impact on the price. In this area, parcels with waterfront area either on the Bay or a river had a 12% higher per-acre price ($1110). As the appraised improvement value increased by 1%, the per acre land value increased by 0.008%. The average improvement value for these parcels without structures was $6,571 per parcel. Prices were significantly higher after 1997 in all years except 1998. All else the same, Caroline County had per acre land value significantly less than Talbot County's, while Queen Anne's, Cecil, and Kent Counties' prices were not significantly different than Talbot's.

In the Lower Shore land market with no structures, there were 375 agricultural land sales of parcels without housing structures (Table 12). Table 13 presents the descriptive statistics for this region's sales transactions. The average price per acre was $2,530. The average size of the parcels was 76.9 acres. Average distance to the nearest city (Salisbury) was 22.8 miles. The model explained 34.39% of the variation in the per acre sale prices. Prices decreased by 0.19% (4.5) for each 1% increase in acres (3/4 acres). As the distance from the nearest city to the parcel decreased (1/4 miles), the per-acre price increased 0.20% ($4.5). As the percentage of woodland on the property increased relative to the percentage of cropland, the price per acre fell. Thus if the forest use increased from 47% to 48%, the price fell 0.69% ($16). Again, a higher percentage of pasture did not significantly decrease the price of the parcel relative to cropland. The percentage of high quality soils did have a positive impact on the per-acre price ($5). Increases in the percentage of prime soils from 22% to 23% resulted in a 0.22% increase in the per-acre price. Being enrolled in an agricultural preservation program (6% of the sample) and having an easement attached to the land did not affect the sales price. Parcels with waterfront area either on the Bay or a river (2% of the sample) had a significantly higher per-acre price – about 68% higher ($1,598). An increase in assessed improvement value of 1% increased prices by 0.014%. The average improvement value for these parcels without structures was $6,424 per parcel. Wicomico, Dorchester, and Worcester Counties were found to have significantly higher prices than Somerset. After 1997, prices were significantly higher in 1998, 2000, 2001, and 2002, but not in 1999 and 2003.

In the Western Maryland land market with no structures, there were 130 agricultural land sales of parcels without housing structures (Table 14). Table 15 presents the descriptive statistics for this region's sales transactions. The average price per acre was $1,744. The parcel size averaged 78.9 acres. Distance to the nearest city (Cumberland) averaged 35.22 miles. The model explained only 9.62% of the variation in the per acre sale prices. Prices decreased by 0.15% ($2.60) for each 1% increase in the number of acres per parcel (3/4 acres). Distance to the nearest city had no influence on the per-acre price. The percentage of woodland on the property negatively impacted the price per acre. As the percentage of forest on the property increased from 60 to 61%, per-acre price decreased 0.20% ($3.50). Pasture did not significantly decrease the price of the parcel relative to cropland. Surprisingly, as the percentage of high quality soils increased, per- acre price decreased. An increase from the average percentage of prime soils of 3% to 4% decreased the price by 0.945%, almost 1%. Being enrolled in an agricultural preservation program (4% of the sample) had no impact on the price. Garrett has slightly higher prices that Allegany County. Unlike some of the other regions, prices were not significantly higher after 1997, until 2002.

In the Rural Central land market with no structures, 167 agricultural land parcels without housing structures were sold (Table 16). Table 17 presents the descriptive statistics for this region's sales transactions. The average sales price was $7,194 per acre. Parcel size averaged 40 acres. Distance to nearest city averaged 25 miles. The model explained only 34.47% of the variation in the per acre sale prices. Prices decreased by 0.33% ($24) for each 1% increase in acres (0.4 acres). As the distance to the nearest city increased by 1% (1/4 miles), prices fell by

0.48% ($34.50). A parcel's land use had less impact on price in this area, with forest and pasture land use receiving similar per-acre prices to cropland. The parcels with an agricultural easement (5% of the sample) did not receive lower prices per acre even though their conversion is restricted. Carroll and Washington Counties had lower prices per acre than Harford County. Prices were significantly higher in this region after 2001. No other variables in this model had a statistically significant effect on price.

In the Southern Maryland market for parcels with no structures, there were 172 agricultural land sales of parcels without housing structures (Table 18). Table 19 presents the descriptive statistics for this region's sales transactions. Distance to nearest city averaged 46.5 miles. The average price was $5,743 per acre. The average parcel size was 62.7 acres. The model explained 45.7% of the variation in the per acre sale prices. Prices fell by 0.38% ($22) for each 1% increase in the number of acres (.47 acres). The distance to the city had only a weak impact on the price per acre. Increases in the percentage of forest on a parcel decreased the per acre sales price. For example, if the percentage of forest increased from 57% to 58%, the price per acre decreased 0.29% ($16.65). Pasture received an equivalent price to cropland but was only 3% on average of the represented parcels. Prime soils positively impact the per-acre price. If prime soil percentage increased from 28% to 29%, the price would increase by 0.357% ($20.50). Parcels enrolled in an agricultural preservation program did not receive a significantly lower price. Having a waterfront area on a river or on the Bay significantly increased the price per acre by about 40% ($2,297). Of the four counties, only St. Mary's had a per-acre price significantly lower than Calvert's. Prices in 1999 through 2001 were significantly different from 1997. After 2001, prices per acre were not significantly different from those in 1997.

Results from Dispersed Geographic Markets – Price Per Acre for Parcels with Structures Models

Details of the results for each region are now reported. The model for the Urban Central Maryland market for parcels with structures had 319 sales transactions between 1997 and 2003 (Table 20). Table 21 presents the descriptive statistics for this region's sales transactions. The average parcel price per acre was $16,915. The average parcel size was 54 acres. The distance to the nearest city averaged 26.8 miles. The included variables explained 35.20% of the variation in the sales. Parcels with higher improvement values received higher prices per acre for the land. The average improvement value was $264,432 per parcel. A 1% increase in the number of acres (1/2 acre) on the parcel decreased the per-acre price by 0.41% ($69). If the parcel is 1% closer to Washington, D.C., or Baltimore (1/4 mile), the price per acre increased 0.36% ($61). Forest land and pasture had values equivalent to that of cropland in this area. Prices after 1999 were higher than those in 1997. Frederick County had significantly lower prices compared to Montgomery but Baltimore and Howard prices per acre were not statistically different from those of Montgomery County.

There were 374 sales transactions in the Upper Eastern Shore market with the structures model (Table 22). Table 23 presents the descriptive statistics for this region's sales transactions. The average sales price was $13,509 per acre. The average size of the parcels was 74 acres. The distance to the city averaged 54 miles. Average improvement value was $210,405 per parcel. The regression explained 40.21% of the variation in the sales price per acre. Parcels with high value structures received a higher price per acre. As the value of the structure increased by 1%, the land value per acre of the accompanying land increased by 0.118%. Additional acres resulted in a lower sales price per acre—a 1% increase in the number of acres in the parcel (3/4 acres) resulted in a 0.32% decrease in the price per acre ($43). Surprisingly, distance to the nearest city only weakly impacted the sales price per acre. Parcels with forest and pasture cover received a price per acre similar to that for cropland. Average forest cover per parcel was 25% and average pasture cover was 2%. Those parcels with waterfront property sold for a higher price per acre—waterfront increases the price per acre by 38.7% ($5,228). Parcels enrolled in agricultural land preservation programs (9% of the sample) received per-acre prices similar to those for parcels without the easement restrictions. Sale prices beginning in 2000 were significantly higher than in 1997. Caroline's and Queen Anne's prices were significantly less than those of Talbot County. Price per acre in Kent and Cecil Counties, however, were not statistically different from that in Talbot.

The model for the Lower Eastern Shore market for parcels with structures had 268 sales transactions between 1997 and 2003 (Table 24). Table 25 presents the descriptive statistics for this region's sales transactions. The average price was $6,687.8 per acre. The average size of the parcels was 69.2 acres. Average distance to the nearest city was 22 miles. The appraised improvement value averaged $112,405 per parcel. The included variables explained 42.7% of the variation in the sales price per acre. Parcels with higher improvement values received higher per-acre land prices. An increase of 1% in the value of the structure on the property increased the land value per acre by 17%. Additional acres decreased the price per acre. As the number of acres grew by 1% (.69 acres), the price fell by 0.44% ($29). Being closer to the city had no impact on the price per acre a parcel received. The percentage of forest land decreased the value of the parcel per acre. As the percentage of forest increased from 31% to 32%, the price per acre fell 0.40% ($27). Prime soils did not impact the price – prime soils averaged 19% per parcel. Waterfront property increased the per acre sales value by approximately 37% ($2,475). Properties with agricultural easement (4% of the region's parcels) did not have significantly lower prices per acre, all else the same. Prices in and after 1999 were significantly higher than those in 1997. Dorchester was found to have significantly higher prices than Somerset. Wicomico and Worcester prices were similar to Somerset's.

There were 125 sales transactions used in the model for the Western Maryland market for parcels with structures (Table 26). Table 27 presents the descriptive statistics for the sales transactions for this region. The average price was $3,259.60 per acre. The average parcel size was 80.9 acres. Average distance to the nearest city was 32.33 miles. The regression explained 34.7% of the variation in the sales price per acre. Higher improvement values increased the land per-acre price. Appraised improvement values averaged $73,977 for these parcels with structures attached. A 1% increase in the value of the structure on the property increased the sales price per acre for the attached land by 0.134%. Additional acres decreased the price per acre. A 1% increase in acreage on the parcel (0.81 acres) decreased the per-acre price by 0.44% ($14). Increased forest cover had a weak impact on the price. Forest cover averaged 49% per parcel. Sale prices in 2001 and 2002 were significantly higher than those in 1997, but no increase in the sales price per acre is detected for years before 2001. No difference was found between Garrett and Allegany prices, although Garrett represented 73% of the sales transactions. The included variables for the 125 Western Maryland sales with structures model explained 34.7% of the variation in the sales price per acre, but only the number of acres and improvement value were statistically significant individually. This implies that many of the variables trend together and are highly correlated. For example, forest land could have fewer acres of prime soils or be correlated with distance from the city.

The model for Rural Central Maryland market for parcels with structures had 443 sales transactions between 1997 and 2003. The econometric results are presented in Table 28 and the descriptive statistics in Table 29. The average price was $11,171 per acre. The parcel size averaged 48.9 acres. The distance to the nearest city averaged 26.74 miles. The included variables explained 42.2% of the variation in the sales. Additional acres decreased the price per acre. A 1% increase in the number of acres (1/2 acre) decreased the price by 0.46% ($51). Being closer to the city increased the price per acre a parcel received – a 1% decrease in the distance (1/4 mile) increased the price by 0.171% ($19). Forest and pasture cover received equivalent prices to cropland in this market. Forest averaged 29% of the parcel land use, with pasture at 12% and cropland at 51%. As the percentage of prime soils increased, parcels had higher price per acre. An increase in the percentage of prime soils from 50% to 51% increased the per-acre price by 0.151% ($17). Parcels enrolled in agricultural preservation programs (12% of the sample) received lower prices per acre – about 17% less ($1,899). Prices after 2000 were higher than those in 1997. Carroll (weakly) and Washington Counties' prices were significantly lower than those of Harford County, all else the same.

There were 228 sales transactions in the Southern Maryland market for parcels with structures model (Table 30). Table 31 presents the descriptive statistics for this region's sales transactions. The average price was $12,397 per acre. The average parcel size was 47.2 acres. Distance to the nearest city averaged 47 miles. Appraised improvement values averaged $165,739 per parcel. The regression explained 50.2% of the variation in the sales price per acre. Parcels with higher valued structures received higher per-acre prices. As the value of the improvement increased 1%, the per-acre price increased by 0.19%. Additional acres resulted in a lower sales price per acre. As the number of acres increased by 1% (1/2 acre), the price fell by 0.52% ($64.5). Surprisingly, distance to the nearest city had no impact on the market price per acre. Parcels with a higher percentage of forest cover received lower per-acre prices. As forest cover increased from 52% to 53%, the price per acre fell by 0.24% ($30). Pasture land although a very small percent on average for parcels in this area at 2% had prices similar to cropland's. Prime soils had an average of 30% per parcel but had no impact on the price per acre. Those parcels with waterfront property sold for higher prices. Parcels with waterfront and structures received 84% higher per-acre prices ($10,413). Similar to the land market with no structures, the existence of an agricultural easement on the property (4% of the sample) had no impact on the per-acre price. Sale prices after 1999 were significantly higher than those in 1997. Anne Arundel parcels have lower prices per acre than Calvert parcels for parcels with structures, all else the same.