Does Targeting a Designated Area

Crowd out the other Preservation Programs' Efforts?

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Abstract: Maryland has introduced a number of land preservation programs over the past 40 years to permanently preserve resource lands. Although new programs can increase the number of acres being preserved, they might have unintended impact on land preservation due to interaction with existing land preservation programs. The Maryland Rural Legacy program began in 1997 by designating large contiguous blocks of land and focusing its preservation efforts only in those areas. The program's could attract existing programs to shift their preservation effort into this designated rural legacy areas if there exist economy of scale or they subsidized existing programs' effort through matching funds. Alternatively, it could crowd out the others' preservation efforts in these areas if the RL program raises the cost of preserving there. Using parcel level data and a property score matching method, we find: 1) parcels in designated RL areas are more attractive to preservation programs, 2) the RL program crowds in the preservation effort of the other programs, and 3) RL program preserves more parcels and acres of land in these areas due to increased funding.

Key words: Crowding effects, Designated preservation areas, Land preservation.

JEL code: Q18, Q24, Q28, Q58

Introduction

Although Maryland has a plethora of land preservation programs, contiguity of preserved parcels has not been achieved (Lynch and Musser 2003). The programs have retained land in a scatter gun pattern rather than in targeted geographic regions. In particular, the Maryland Agricultural Land Preservation Foundation (MALPF) used a ranking scheme and minimum criteria under which contiguity received no value.

In an effort to address this limitation, Maryland highlighted contiguity when it introduced Rural Legacy (RL) program in 1997 through the designation of RL Areas. Local governments or private land trusts receive special funding to preserve farm, forest, and ecologically important resource lands within these areas. The state allocates funding to RL areas each year.

Using a propensity score matching method, Lynch and Liu (2007) found that the RL program has a positive impact on the preservation within these designated RL areas. They estimated the effect of RL program designation on land preservation by matching the agricultural parcels in RL areas with those parcels with most similar attributes outside RL areas. However, their estimated effect is not the net or direct impact of Rural Legacy program, itself. Rather, it is a combination of several impacts of the Rural Legacy program, including direct and indirect impacts.

The first is a predisposition effect: local governments and private land trusts select areas which contain the most desirable parcels to preserve. Therefore, the parcels in RL areas are more likely to be preserved all else the same. One might suppose other preservation programs find these areas desirable. If this is the case, other preservation programs are more likely to enroll the RL parcels even after the RL program is introduced. The difference in the preservation outcomes between RL parcels and their constructed counterfactuals includes both the effect of RL program and this predisposition effect.

The second issue is a crowding effect of RL program on existing conservation programs. The special funding should result in more acres being preserved in RL areas but the RL program's activities might interact with existing preservation programs. Several possible interactions may occur. The designation of RL area and the extra funding could increase the preservation effort. For example, if economies of scale or threshold impacts exist and contiguity increases the marginal benefits of each acres preserved, both RL and the other programs could receive higher benefits from each additional acre preserved in the RL areas relative to a non-RL parcel (refers to the parcels out of RL areas). This would be an example of crowding-in preservation. The larger marginal benefits makes preservation there higher valued. And the RL program has sent a signal to the others that it will focus its efforts in one location.

However, the RL program's efforts can also reduce other programs' preservation effort in the designated areas. If the programs compete for the same land, the cost of preservation per acre could increase within the RL areas, e.g. the landowners' asking price increases. The designation could also signal to housing consumers that this area's amenities are increasing providing another source of increased demand. Therefore, the other programs may shift their preservation effort to the parcels outside the RL areas. This would be an example of how RL area designation could crowd out preservation

Assuming the RL areas are well chosen, a crowding in effect will preserve more desirable parcels than a crowding out effect. If economies of scale exist regarding benefits, a crowding in effect is always the socially efficient result.

To the best of our knowledge, only Parker and Thurman (2008) have examined the crowding effect regarding land preservation. They analyze whether federal land conservation and preservation programs crowd out the efforts of private land trusts in terms of retaining open space. They construct a panel data at the county level from 1990 to 2000 and evaluate the crowding effects using a panel regression framework. They examine acreage data for the Conservation Reserve Program (CRP), Wetland Reserve Program (WRP), and the national parks and forest. The private land trust acreage data are from The Nature Conservancy (TNC) and Land Trust Alliance (LTA). LTA appears to have crowded in: LTA increases acres in areas with high enrollment in CRP, WRP and retained parkland. Both crowding in and crowding out effects are detected for TNC's activities.

We evaluate the effect of the RL program by isolating the crowding effects of RL program on existing land preservation programs. We use parcel level data for 3 Southern Maryland counties: Calvert, Charles, and St. Mary's. Two outcome variables are adopted to approximate the effect of the land preservation programs: 1) the probability that a parcel is preserved, and 2) the acres that are preserved. The realized probability of preservation is either 0 (a parcel is not preserved) or 1 (a parcel is preserved). The unobserved probabilities (constructed counterfactuals), however can take any value between 0 and 1. The "preserved acres" are the acres of a parcel weighted by the probability that the parcel is preserved. The treatment variable is whether a parcel is in a RL area or not: 1 indicates the parcel is in a RL area, and 0 otherwise.

Different from Parker and Thurman (2008), we study the crowding effects on preservation efforts from designated preservation areas measured by the likelihood and acres of preservation. We use a micro-level parcel data including characteristics that affect a parcel's predisposition to be preserved. We specify the conditions under which crowding in or out could occur and empirically test whether there is a crowding in or out effect.

The remainder of this paper is organized as follows. Section 2 provides the background information of the RL program, our study areas, and other preservation programs in Maryland. A description of data sources is in Section 3. Section 4 presents a theoretical framework for land preservation decisions, strategies and possible crowding effects. Section 5 describes our pre- and post-treatment outcomes. Section 6 discusses the crowding effects and our empirical strategies to isolate them, and the net effect of RL program. Empirical results are presented in Section 7, and a robustness check by studying the impact of RL program on market value of land is in section 8. We then conclude in Section 9.

Program Desriptions

Rural Legacy program

The Rural Legacy Program requires contiguous tracts of high benefit resource land to be identified and provides extra funding for preservation in these areas. Local governments and experienced land trusts/nonprofits may establish priority preservation areas and apply for money through a competitive process.

The program prioritized RL areas based on the agricultural, forestry, natural, and historical and cultural resources protected, the level of conversion pressure, and the economic value of the area's resource-based industries or services. Landowners in the designated RL program areas can sell or donate their development rights and retain ownership of their land or sell fee simple for public use. RL program does not specify minimum requirements for soil qualities, size or land use type. Instead, the program focuses on land with multiple conservation values. If a small parcel has extraordinary agricultural, environmental, or historic features on the property, the RL program could enroll it.

The program allows greater flexibility to use an Easement Valuation System (EVS) to set the value to be paid for a conservation easement. The EVS uses appraisals and a point system for natural resources. The point-based payments reward ecological and other attributes such as large parcels, wetlands, endangered species and other wildlife habitat, and swamps, which are often discounted in an appraisal approach.

Between 1998 and February 2007, 30 RL areas have been approved (Figure 1). The RL program has allocated $163 million to preserve 58,217 acres of farmland, forests, and natural areas in Maryland through April 2008.

The Rural Legacy areas in Southern Maryland

Charles, Calvert, and St. Mary's counties comprise Southern Maryland. The area is within 2 hours of both Washington, D.C. and Baltimore, MD. It has experienced high population growth that outpaced both Maryland's growth rate and the country's growth rate in late 1990s due to job opportunities from the U.S. Navy's installations and affiliated high-tech defense contractors.

All three counties designated Rural Legacy areas (Table 1). Southern Maryland has five approved RL areas for a total of 84,102 acres: Calvert Creeks and North Calvert in Calvert County, Huntersville and Mattapany in St. Mary's County, and Zekiah Watershed in Charles County. North Calvert area was approved in 2004, Mattapany in 2006, and the other three in 1998. We use the RL areas designated in 1998 as the data are available for them.

The Calvert Creeks RL area (20,527 acres) seeks to protect water quality and wetland habitat as well as cultural resources. The Huntersville RL area (8,357 acres) includes shoreline with significant agricultural, forestry, and environmental values including endangered species habitat, wetlands, historic structures and archeological sites. The Smithsonian Center for Natural Areas has designated part of this RL area as critical wildlife habitat in need of protection. The Zekiah Watershed RL area (31,000 acres) protects farms, forests, Special State wetlands, historic and archeological sites, and deposits rich in mineral aggregates. The Smithsonian Institute considers its natural hardwood swamp to be one of the most important ecological areas on the East Coast. The boundaries of the Zekiah Watershed RL area follow, for the most part, the boundaries of the watershed itself and major road feature. The Zekiah Watershed RL sponsors decided to concentrate on the area with the most development pressure first.

Three of the five RL areas are used in this analysis: Calvert Creeks, Huntersville, and Zekiah areas. By 2006, the RL program has protected 1,660 acres at a cost of $6.8 million with an average price of $4,003 per acre in Calvert Creeks RL area. In the Huntersville RL area, the RL program has preserved 2,720 acres at a cost of $8.8 million, with an average cost of $2, 693 per acre. The Zekiah Watershed RL area has preserved 2,328 acres at a cost of $9.4 million and at an average cost of $3,866 per acre.

Other permanent preservation programs in Maryland

Since 1977, the MALPF program aims to preserve productive farmland and woodland and curb the expansion of random urban development. By 2007, MALPF has protected over 265,691 acres at a cost of $490 million (Table 2). By 2005, the program has protected 4,263 acres in Calvert, 5,872 in St. Mary's, and 3,474 in Charles. Payments were $5,291 per acre in Calvert in 2004, $2,937 in St. Mary's, and $3,474 in Charles in 2005.

The maximum price that MALPF will pay is the lower of a landowner's asking price or the calculated easement value. A property's easement value is determined by subtracting its computed agricultural value from its fair market value (determined by an appraiser). The agricultural value of a parcel is determined by a formula that calculates land rent based on the soil productivity or the five-year average cash rent in the county.

MALPF co-holds some easement with the RL program to reduce on-going monitor expenses but has not shared the easement acquisition costs. No co-held easements were identified, our study areas.

Transfer of development rights (TDR) programs are also available in all three counties. A TDR program allows landowners in one area to sell the development rights associated with their property to developers who use them to develop land in another area more intensively than permitted by baseline zoning. Development rights are transferred from an agricultural area and farmland is preserved, development occurs in the designated growth zones. By 2004, Calvert has protected almost 13,000 acres through its TDR program; St. Mary's has 221 acres, and Charles has 1,554 acres. Calvert County also bought TDRs from landowners and retired them in its Leveraging and Retirement Fund (LAR) and Purchase and Retirement Fund (PAR).

Maryland Environmental Trust (MET) aims to protect land from development through donated conservation easements. By 2006, MET has preserved 106,007 acres state-wide. By 2003, MET had preserved 2089 acres in Calvert, 4,934 acres in Charles, and 3,248 in St. Mary's.

Figure 2 geographically delineates the RL areas and the level of preservation under the different programs. Almost 30 percent of the RL areas have been preserved compared to only 5.6% of the non-RL areas - suggesting that these areas are predisposed to be preserved (or a predisposition of the RL sponsors to pick high preservation areas). Since 1997, significant preservation activity has occurred from all the preservation programs. Rural Legacy program has preserved almost 6,500 acres in these 3 counties since 1997. The MALPF program has preserved almost half of its acreage since 1997. The TDR programs in Calvert and Charles have preserved 40% of their acres since 1997. At first glance, the raw data suggest a crowding out phenomena: the TDR programs had preserved 42% of its acreage within the RL areas pre-1997; but after 1997, the TDR program preserved only 30%. Similarly, MALPF preserved 28% of its acreage in RL areas before designation but only 4.5% after 1997.

Data sources and parcel attributes

Data was collected on parcels greater than 3 acres in the three counties. We collected information on variables that affect RL areas designation and preservation outcomes, including parcel attributes, land use, soil characteristics, and distance to major cities, and land preservation status.

The primary data set, the MDPropertyView 2002 Database (MDPVD), provided parcel level information such as size in acres, zoning code, waterfront access, public sewer availability, housing construction, subdivision designation, sales price paid (arm's-length or non arm's-length), assessment value for the land and any structures, the most current market transaction date, and geographic coordinates. The MDPVD Database is created by the Maryland Department of Planning (MDP) as a series of county-level files updated through October 2003. The files are spatially referenced by the x and y coordinates in NAD83 meters Maryland State Plane Coordinate System, allowing us to link to other state and federal spatially referenced data sets. Each parcel is also identified by a unique account number that allows parcel-level links with other parcel-level data sets.

A wealth of data characterizing Maryland lands such as land use, soil, and other characteristics have been digitized by the State of Maryland. To extract this data, we created buffer parcels to serve as proxies for the true parcel boundaries.[1] These buffer parcels intersect with spatially referenced data to extract parcel characteristics for the MDPVD land parcels. This process is called buffer parcel extraction.

Land use information for 1997 was extracted and the percentage of each type of land use were computed for each parcel. Land uses are categorized into Urban Areas (residential, commercial, industrial, and institutional), Agriculture (cropland, pasture, orchards, vineyards, and agricultural buildings), Forest (deciduous, evergreen, and mixed forests), Water, Wetlands, and Barren Land (beaches, bare rock, and bare ground).

Soil data comes from the MDP's 1973 work to classify and map all Maryland soils, completed in conjunction with the U.S. Department of Agriculture Soil Conservation Service. 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 categories define soil slope, soil erodibility, and floodplain soils, which affect the potential development on the land and agricultural returns.

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[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.

Distance to Washington, D.C. in miles was computed using U.S. Census Bureau road networks.

To proxy for the ecological values, we computed the percent of Maryland's Sensitive Species Project Review Areas, which include rare, threatened, and endangered species and rare natural community types (Maryland DNR 2003), and Non-tidal Wetlands of Special State Concern (Department of the Environment and DNR 1998) for each parcel. The percent of the parcel in estuarine wetland status was also extracted from the Maryland Wetland Map (Maryland DNR 1998).

Preservation data was collected for MALPF parcels through 2005, for the Maryland Environmental Trust through 2004, for the Calvert Transfer of Development Rights program through 2004, and for private conservation groups (Nature conservancy, private land trusts) through 2005. Maryland DNR provided information on RL areas designation and enrolled landowners. The number of preserved acres within a 1 mile radius was also extracted for each parcel.

Theoretical framework

This section provides a conceptual framework of land preservation programs' strategies, landowners' decisions on preserving land, and the potential crowding effects of the RL program on non-RL programs.[2] We assume in this model that a community has two areas: a RL area and a non-RL area. A non-RL program has been operating in the community to preserve farmland that otherwise would be developed in both areas. RL program enters later and only focuses on the parcels in the RL area.

Crowding effects are evaluated by comparing non-RL program's preservation efforts in two cases: only the non-RL program exists, and both programs exist. If the non-RL program shifts its preservation efforts from a non-RL area into a RL area after the RL program is introduced, one finds a crowding in effect; or if it shifts its preservation effort from a RL area to a non-RL area, one would find a crowding out effect.

[2] In addition to the RL program, both county and state preservation programs can operate in RL areas and we treat all those programs as one non Rural Legacy program to simplify the problem.

The RL program can influence non-RL program's preservation efforts within the RL area in three ways. First, the RL program can let the non-RL program move first to preserve the most affordable parcels such that the non-RL program's actions are not influenced by the RL program's activities. Second, the RL program could pay a higher or lower easement payment to the same parcels that are desirable to non-RL program. Third, the RL program can provide matching funds for the parcels preserved by the non-RL program, therefore reduces the cost of preserving parcels in the RL area for the non-RL program.

Say, there are M units of undeveloped land in RL area and N units in non-RL area that would be developed in the future if not preserved. Each landowner i is endowed with one unit of agricultural land. WTA_i is a landowner i's willingness-to-accept for giving up a parcel's development right permanently.[3] To induce the landowner to preserve his land, the non-RL program offers landowner i an easement payment EV_i and RL program offers an $\overline{EV_i}$. Both EV_i and $\overline{EV_i}$ are determined by land characteristics and the programs' evaluation criterions. Neither EV_i nor $\overline{EV_i}$ is affected by the available budgets of the two programs. $\gamma_i \in [0,1]$ indicates which program pays the landowner of unit i for preserving his land. $\gamma_i = 1$ if unit i is enrolled only in the RL program, and $\gamma_i = 0$ if only in the non-RL program, and $\gamma_i \in (0,1)$ if the RL program provides matching funds to non-RL program and the parcel is enrolled in both programs.

The owners of the M units of land in the RL area can either participate in the RL or the non-RL program while the owners of the parcels in the non-RL area can only participate in the non-RL program. The total easement payment for land unit $i \in M$ if preserved is: $\gamma_i\overline{EV_i} + (1-\gamma_i)EV_i$ and EV_i for $i \in N$. Landowner i is willing to preserve his land only if the easement payment exceeds his willingness-to-accept: $WTA_i \leq EV_i$ for $i \in N$ and $WTA_i \leq \gamma_i\overline{EV_i} + (1-\gamma_i)EV_i$ for $i \in M$. Otherwise, landowner i will not preserve but develop his land in the future. A parcel is preserved if a willing landowner is paid the easement value ($\beta_i = 1$) and is not preserved otherwise ($\beta_i = 0$).

[3] WTA_i is determined by agricultural profits, benefits from developing land now, the option value for leaving land to be developed in the future, and the expectation for losing development rights due to future regulation.

We assume that the budget for the non-RL and RL programs are always binding.[4] This assumption implies that not all the landowners who are willing to preserve their land are able to enroll their land into a program. We also assume that land value, and thus, WTA_i is not affected by the land preservation for simplicity purpose, i.e., there is no positive or negative amenity spillover effect of neighboring preserved parcels.[5] Land preservation programs aim to preserve all the units possible given their available budgets.

Baseline: no RL program

The maximization problem for the non-RL program, if the RL program does not exist, is to preserve as many parcels as possible until its available budget, B, is exhausted: $\sum_{i \in M \cup N} \beta_i EV_i \leq B$.

To illustrate the solutions, we assume in the rest of the paper that all the owners are willing to preserve their land ($WTA_i \leq EV_i$) and then sort the easement payment EV_i in an ascending order. The non-RL program chooses an optimal cut-off value λ^* such that: $\beta_i = 1$ if $WTA_i \leq EVi \leq \lambda*$ and $\beta i=0$ if $EVi \geq \lambda*$. The value of $\lambda*$ is:

$$\lambda^* = \left\{ \lambda | \sum_{i:\{WTA_i \leq EV_i \leq \lambda^*\}} EV_i \leq B, \text{ and } \sum_{i:\{WTA_i \leq EV_i \leq \lambda^* + \varepsilon\}} EV_i < B \right\}$$

RL program interacts with non-RL program

The RL program is introduced to preserve parcels in the RL area. The RL program will preserve as many units as possible in RL area given its budget constraint $\bar{B}$: $\beta_i \gamma_i \overline{EV_i} \leq \bar{B}$. The non-RL program again maximizes total parcels preserved in and out of RL areas given its budget constraint:$\sum_{i \in M} \beta_i (1 - \gamma_i) EV_i + \sum_{i \in N} \beta_i EV_i \leq B$.

As discussed earlier, the RL program can interact with the non-RL program in three ways: let the non-RL program move first to preserve low-cost parcels (*scenario A*), offer a higher easement

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[4] This is a realistic assumption as most programs have a waiting list of interested landowners.

[5] Positive spatial amenity spillover effect implies that neighboring parcels become more desirable and require higher easement payments than similar parcels that do not have preserved neighboring parcels. Our static framework is not able to capture this effect.

payment (*scenario B*), and provide matching funds for parcels preserved by the non-RL program (*scenario C*).

The underlying assumption for the above three scenarios is that parcels in and out of RL area are of equal value to the non-RL program. The introduction of RL program may increase the social benefits of preserving RL land. Thus the marginal benefit:marginal cost may alter and the non-RL program may become willing to preserve RL parcels even if they become more expensive (*Scenario D*).

We discuss the solutions of the maximization problem and the possible crowding effects given these four scenarios.

Scenario A: When the RL program lets the non-RL program move first to preserve affordable parcels, the non-RL program will choose to preserve the same parcels as it did before the RL program entered. The RL program then preserves the best remaining parcels in RL area. In this scenario, more RL parcels will be preserved than pre-RL program but is not a crowding in phenomena since RL actions have no affect on non-RL program. However, the RL program may crowd out the preservation efforts of the non-RL program if it moves first to preserve for the same parcels. In this case, the RL program may preserve some or all of the parcels that the non-RL program would have preserved. Thus, the non-RL program is "crowded out" and will shift its resources to the now relatively less expensive non-RL parcels. Whether more or less RL parcels are preserved if there is a crowding out effect is an empirical question.

Scenario B: When the RL program sets a higher easement payment than the non-RL program ($EV_i \geq \overline{EV}_i$), it crowds out the preservation efforts of the non-RL program. The RL program preserves parcels in the RL area until its budget is exhausted. More non-RL parcels are preserved if there is a crowding out effect. If the RL program selects parcels such that it only pays a higher easement payment ($\overline{EV}_i \geq EV_i$) for the parcels with $EV_i \leq WTA_i$, it will not crowd out the non-RL program.[6]

[6] The case under which the RL program pays a lower easement payment is not incentive compatible.

Scenario C: The RL program can provide matching funds to the non-RL program to preserve RL parcels: i.e. subsidize their RL selections. There could be a crowding in or out effect depending on the distribution of the easement value and the magnitude of matching funds (the size of $1 - \gamma_i$) . For example, RL program provides matching fund to every parcel that non-RL program preserves. If the matching funds are not large enough so that the money saved from preserved parcels will not be enough to preserve the next available parcels in RL area, the non-RL program would still shift money out of RL area to preserve the relatively less expensive and affordable non-RL parcels. RL program therefore crowds out the preservation efforts of non-RL program and more non-RL parcels are preserved.

Alternatively, if the matching funds are large enough such that RL parcels become relatively less expensive than the non-RL parcels, the non-RL program will preserve exclusively in the RL area. This can happen if the easement values of the higher cost RL parcels are not prohibitively high or the matching funds ($\gamma\ closer\ to\ 1\ than\ 0$) are substantial. The non-RL program would shift its preservation effort from the non-RL area into the RL area in order to preserve more units of land. Fewer non-RL parcels and more RL parcels are preserved by the joint effort of the RL and non-RL programs.

Scenario D: In the above three scenarios, we assume that the non-RL program values RL parcels the same as non-RL parcels. However, preserving RL parcels can provide higher social benefits than preserving non-RL parcels due to concentrated preservation in the targeted area. This induces the change in non-RL program's evaluation of the marginal benefits from preserving RL parcels after the RL program was introduced. The non-RL program may be more willing to preserve the more expensive parcels in RL area than in the non-RL area. Hence, there may exist a crowding in effect due to a perceived change in societal benefits.

To summarize, if parcels in and out of RL areas are valued equally by the non-RL program, the RL program crowds out the non-RL program's preservation effort if it does not let the non-RL program select parcels first or it offers higher easement payment for a parcel. When the RL program provides matching funds to the parcels in RL areas preserved by the non-RL program, no crowding-out or crowding-in effects may occur. Whether there is a crowding in or a crowding out effect depends on the magnitude of the matching funds and the distribution of the easement value. If the introduction of the RL program cause preserving parcels in RL areas to be sufficiently more valuable than preserving parcels out of RL areas, there may be a crowding in effect even if the RL program compete with the non-RL programs.

Pre- and Post-treatment outcomes

Preservation programs enrolled parcels at different points of time. For example, a parcel that is protected after a RL area is designated can be preserved in any year after the year of designation. The same holds for a parcel being preserved before the RL areas were designated. In order to impose the same time frame for pre- and post-treatment groups, we limit our analysis to the parcels preserved in a 9-year period before and a 9-year period after the introduction of the RL areas.

Our data allows us to trace back the preservation status of the parcels before the RL program was introduced. We define the time period from 1989 to 1997 during which RL program was not introduced as pre-treatment period. The post-treatment period is 1997-2005. We assign the pre-treatment preservation status as 0 for the parcels that are preserved after 1997, and its post-treatment preservation status as 1. Table 3 reports the mean preservation rate and acres.

Overall, parcels are more likely to be preserved and more acres are preserved in post-treatment period in both RL and non-RL areas. However, more acres and a larger proportion of parcels are preserved within RL areas than outside RL areas in both pre- and post-treatment periods. Non-RL programs have preserved 2.48 more acres and 4.6 more percentage points in RL areas than outside RL areas in pre-treatment period. After RL program was introduced, the differences in preservation rate and preserved acres are even larger: the difference in acres increases to 13.5 and the rate of preservation to 18 percentage points. Even after excluding the parcels preserved by the RL program, parcels in RL areas still are 13.4 percentage points more likely to be preserved and to have 5.33 more acres being preserved.

Empirical specifications

The outcome variables of the RL program is Y_{it}. Besides a set of exogenous variables X_i, and a dummy variable representing treatment status RL_{it}, a crowding effect of RL program, C_{it}, affects the outcome. The impact of C_{it} on preservation in and out RL areas can go in opposite directions. $t = \{t_0, t_1\}$ indicates a pre- or post-treatment period. $RL^1_{it_0} = 0$ and $RL^1_{it_1} = 1$ for parcels in RL areas, while $RL^0_{it_0} = RL^0_{it_1} = 0$ for parcels in non-RL areas. $C_{it} = 0$ in period t_0 and $C_{it} = 1$ in period t_1. The outcome equations for a parcel in its two treatment status can be written as:

$$Y^0_{it} = g_t(X_i) + \beta_{it}(X_i) * C_{it} + U^0_{it} \quad (1)$$

$$Y^1_{it} = g_t(X_i) + \beta_{it}(X_i) * C_{it} + \alpha_{it}(X_i) * RL^1_{it} + U^1_{it} \quad (2)$$

$g_t(X_i)$ measures the likelihood of preservation given the exogenous variables X_i. U_{it} is an error term where $U_{it} = \phi_i + \theta_t + \epsilon_{it}$. U_{it} decomposes to an individual specific fixed effect ϕ_i, an impact from local economic growth θ_t, and a temporary individual-specific effect ϵ_{it}. The individual fixed effect, ϕ_i, affects the preservation effort of other programs and allows us to control their impact.

The different parameters of interest can be expressed as:

The Average treatment effect on the treated (ATT), or the direct effect of the RL program on the outcome:

$$E_{RL} = E(\alpha_{it} | X_i, RL^1_{it} = 1) \quad (3)$$

The crowding effect of the RL program on preservation effort of the non-RL program:

$$E_C = -E(\beta_{it} | X_i, RL^1_{it} = 1) = E(\beta_{it} | X_i, RL^0_{it} = 0) \quad (4)$$

The effect of time-invariant unobservables ϕ_i:

$$E_\phi = E(\phi_i | X_i, RL^1_{it} = 1) \quad (5)$$

The effect of exogenous parcel attributes:

$$E_X = E(g(X_i)) \quad (6)$$

The effect of local economic growth:

$$E_\theta = E(\theta_t | X_i, RL_{it}^1 = 1) \quad (7)$$

The following three equations (8)-(10) from restricting matching between different sub-samples can be used to identify different parameters:

$$E[(Y_{it_0}^1 - Y_{it_0}^0)|X_i] = E_\phi \quad (8)$$

$$E[(Y_{it_1}^1 - Y_{it_1}^0)|X_i] = -2E_C + E_{RL} + E_\phi \quad (9)$$

$$E[(Y_{it_0}^1 - Y_{it_1}^0)|X_i] = -E_C + E_\phi - E_\theta \quad (10)$$

Identification strategy one

It is obvious that the equations (8)-(10) are not enough to identify all the parameters of interest. However, if we can eliminate the time effect of E_θ by imposing the same time frame for pre- and post-treatment groups, the rest of the parameters can be identified. The time frames for the pre- and post-treatment groups are centered on the year when the RL program was introduced. We then rule out time-varying factors, e.g. dramatic change in the funding from other programs or economics situation occurred in the pre- and post-treatment periods, which is supported by the evidence in table 2.[7] By ruling out these factors, the parameter of E_θ disappears from equation (10) and (10) becomes

$$E[(Y_{it_0}^1 - Y_{it_1}^0)|X_i] = -E_C + E_\phi \quad (11)$$

The parametersE_{RL}, E_C, and E_ϕ can then be identify from equation (8), (9) and (11).

For a treated and a control parcel that are observably identical, the following conditions hold. First, the pre-treatment outcome is not affected by RL program (as the program did not exist) and

[7] As shown in table 2, MALPF's budget increases over time. However, the easement value and acquisition cost of farmland also increases over time at a similar rate. The increments of the two are comparable for pre- and post-treatment periods.

the difference in pre-treatment outcome between the two parcels captures the effect of the non-RL program's predisposition to preserve in the RL area.

Second, post-treatment outcome of untreated parcels is indirectly affected by the RL program through the possible crowding effect. Therefore, the difference between the post-treatment outcome of untreated parcel and pre-treatment outcome of treated parcel captures the crowding effect in addition to the predisposition effect.

Third, the difference in post-treatment outcome captures the crowding effect and predisposition effect. The three unknown effects can then be identified by the three conditions.

This strategy, however, assumes that the impact of local economic growth on the available budget for the non-RL program is eliminated completely. The presence of E_θ can bias the estimation of the crowding effect. As a result, the estimation returns an upper bound of the crowding effect if the time effect and the crowding effect move in the same direction.

Identification strategy two

Our data records whether a parcel is preserved by the RL program or the non-RL program and it is clear that RL and non-RL programs do not provide matching funding in our study area. We then can eliminate the net impact of RL program by excluding the parcels that are preserved by RL program. Then equation (9) is now restricted to a sub-sample that excludes parcels preserved by RL program and becomes:

$$E\left[\left(Y_{it_1}^1 - Y_{it_1}^0\right)|X_i\right] = -2E_C + E_\phi \qquad (12)$$

The equation (8) together with (12) identifies E_C and E_ϕ. Plug E_C and E_ϕ into equation (9), we can solve for E_{RL}. This strategy does not need equation (10) so that we can avoid the possible bias due to time effect. This strategy assumes that the crowding effect is from RL program to the other conservation program. In another word, the RL program's preservation effort does not react to the operation or the available funding of non-RL programs.

Propensity score matching method

The violation of Stable Unit Treatment Value Assumption (SUTVA) and multiple causal effects

Matching method (also randomized experiment) implicitly uses the assumption of "no interference between units" (Cox, 1958, p19) or the Stable Unit Treatment Value Assumption named by Rubin (1986). This assumption says that the potential outcomes of an individual depend on the treatment assigned to this individual but not the treatment assigned to other individuals or the allocation of other individuals to the treatment. The validity of SUTVA is assumed for matching method. The validity is warranted if the policy under consideration is rather small in size, if market effects are unlikely, or if the counterfactual world against which the policy is evaluated is such that similar distortions through market and general equilibrium effects would persist (Frölich, 2003).

An estimated Average Treatment Effect on the Treated (ATT) from matching method is the net impact of a treatment only if this assumption holds. However, this assumption might be invalidated if individuals interact to each other, either directly or through market. When SUTVA is invalidated (or a general equilibrium effect exists), controls can no longer provide the desired counterfactual to treated individuals for the treatment of interest. As a result, the estimated ATT from matching is no longer the accurate measure of treatment effect. Rather, it is a combination of multiple causal effects. Those causal effects include the direct effect and indirect effect of the treatment of interest, e.g. the effect of the treatment assignment to an individual and the treatment assignment to other individuals. The question becomes: can one isolate different causal effects using a matching method?

SUTVA violation makes causal inference more difficult. It will be almost impossible to identify or isolate the causal effects if treatment assignment to any individual affects any other individual’s outcome. The reason is that there will be too many causal effects to be identified. However, if one can reduce the interference of treatment assignment to a limited number of groups of individuals, it is possible to identify the limited number of causal effects. For example, Hong and Raudenbush (2006) impose a structure over the interaction of individuals to reduce the number of potential outcomes in evaluating kindergarten retention policy in the US. They model the impact of treatment assignment to an individual as operating through the individual’s treatment assignment and a scalar function and all the others’ treatment assignment. The scalar function takes two values: 1 if a high proportion of kindergartners are retained and 0 if not. Therefore, the number of causal effects in their study is reduced to a manageable level.[8]

In the case of RL program, the violation of SUTVA in "conventional" way is that the possibility of inclusion or exclusion of any single parcel affects the outcomes (preservation status) of the other parcels. However, this is less of an issue than the shifting of non-RL program's preservation efforts in or out of RL areas. The crowding effect of RL program becomes one of the multiple causal effects induced by the violation of SUTVA. As long as the basic assumption, Conditional Independence Assumption (or its weak version: Conditional Mean Independence assumption) or ignorability of treatment assignment assumption holds, we can employ matching method and restrict matching between different sub-samples to isolate different effects.

Propensity score estimation and matching methods

Propensity scores are estimated with a Logit model. We include in the model all the key covariates that affect both a parcel's inclusion in RL areas and the pre-treatment outcomes. We specify the Logit model to provide the best prediction of a Rural Legacy area designation. These parcel-level variables include proxies for ecological, agricultural, and forestry values, and development pressure.

The parcels that are waterfront properties, have a high percent of estuarine areas and wetland, have a higher percent of a floodplain, have a high percentage of special habitat, and land-uses of cropland and pasture, are of high ecological and agricultural value and are more likely to be included in a RL area. The parcels that are on public sewer or with zoning densities permitting more houses per acres, however, are less likely to be included in RL areas. Soil quality indicators such as distance to bed rock, permeability, and erodeability are also included as the RL program

[8] There are also studies that discuss causal inference using other approaches and in different contexts. In a randomized experiment context, Sobel (2006) proposes an identification strategy and the parameters of interest in the housing mobility experiment sponsored by the US Department of Housing and Urban Development. Halloran and Struchiner (1995) study the effect of vaccine on infectious diseases by defining "conditional direct casual effects". Heckman, Lochner, and Taber (1998) use a general equilibrium approach to study the effect of national tuition subsidy on college enrollment and earnings. Their methods, as pointed out by Sobel (2006) "combine empirical information and mathematical modeling without using the potential outcomes notation that statisticians have used to clarify problems of causal inference".

values those attributes. Table 4 reports the estimated coefficients for predicting a parcel's inclusion in a RL area.

Figure 3 is the distribution of estimated propensity scores for treated and control parcels. The distributions are not very compatible, with the control parcels being more left-skewed. We therefore use a leave-one-out cross-validation criterion to choose matching methods. Two matching methods: Kernel matching with normal kernel and bandwidth 0.01, and local linear matching method with biweight kernel and bandwidth 0.1 perform better than the others.

Empirical estimation and results

We restrict the matching analysis to parcels greater than 10 acres since these are the ones most likely to be preserved. We construct two treated groups: pre-treatment RL group and post-treatment RL group and two control groups: pre-treatment non-RL group and post-treatment non-RL group. The pre-treatment and post-treatment treated (control) groups are overlapped with the parcels that are never protected by any programs. The parcels that are enrolled in any preservation programs after RL areas were designated are included in pre-treatment groups but those parcels appear as being unprotected. The post-treatment groups exclude the parcels that are enrolled in any preservation programs before the RL areas are designated.

For strategy one, we conduct matching based on estimated propensity scores in three ways across the four sub-samples. First, we match pre-treatment RL group with pre-treatment non-RL group for equation (8). Second, we match post-treatment non-RL group with post-treatment RL group for equation (9). Thirdly, we match post-treatment non-RL group to the pre-treatment RL group for equation (11).

For strategy two, we first match pre-treatment RL group with pre-treatment non-RL group for equation (8). Second, we match post-treatment non-RL group with post-treatment RL group for equation (9). Third, we exclude the parcels being preserved by RL program in the post-treatment RL group and conduct matching between post-treatment RL and non-RL groups for equation (12).

Balancing tests are conducted using the standardized difference test, a t-test for equality of the variable means for the matched treated and control groups. Balancing test results are presented in Table 5. Most of the variables pass balance tests except for the permeability and erodeability variables for all matching protocols. Theoretically, parcels with higher permeability levels and lower erodeability would be more likely to be developed rather than preserved. The failure of balance test for the variables could induce a downward bias in the estimated ATT for all matching protocols and for the impact of non-RL programs.

Estimation results for crowding effect, E_C, predisposition effect, E_ϕ, and finally the effect of RL program, E_{RL}, are presented in Table 6 for identification strategy one and in Table 7 for strategy two.

For identification strategy one, the estimated ATTs for pre- and post-treatment matchings are significant at 5% level. For matching of post-treatment non-RL group vs. pre-treatment RL group, only the ATT for likelihood of preservation is significant at 5% level. For identification strategy two, the ATTs from all matching protocols are significant at 5% level. The estimated ATTs vary little across the two matching methods and identification strategies.

In terms of the likelihood of being preserved, the estimated predisposition effect, E_ϕ, is 2.6 percentage points, and of acres is 1.49-1.57 acres. This result indicates that there exist time-invariant unobserved attributes that differentiate parcels in and out of RL areas. Such a difference attracts more preservation efforts of non-RL programs within RL areas before the RL program was introduced. The identification strategy two finds a crowding in effect in terms of both likelihood of preservation and acres preserved. Strategy one finds both a crowding in effect in terms of likelihood of preservation and a crowding out effect in terms of acres preserved. This difference in estimation results for strategy one may be due to unintended time effect.

The crowding in preservation efforts increase preservation probability in RL areas by 0.7-1.0 percentage points, and increases the preserved acres by 0.2-0.23 per parcel. Even without a crowding in effect, the RL program has positive impact on preservation outcomes on two levels: a higher likelihood of preservation and more acres/larger preserved parcels. The results show that

RL designation increases the probability of preservation by 5.5-6 percentage points and preserved acres by 9-12.

Robustness check-the impact of RL designation on land value

As a robustness check, we also study the impact of RL designation on the market value of residential and undeveloped land. [9] This section can serve as a test on whether RL designation affects the market value of land and therefore, landowners' willingness-to-accept the given easement values to preserve their land.

The inflation adjusted market value of a parcel per acre is calculated by subtracting appraised improvement value from the arms' length market transaction value. The owners' equivalent rent of primary residence from the Consumer Price Index – All Urban Consumer for Washington-Baltimore, MD-DC-VA-WV (Bureau of Labor Statistics, 2007) was used to convert the actual transaction and appraised values into 2002 dollars.

The mean land value for RL and non-RL parcels sold before or after 1997 is presented in Table 8 and the matching result of RL designation on land value in Table 9. We conduct matching over parcels sold before and after 1997 respectively. There are 545 RL and 5866 non- RL parcels sold before 1997, and 288 RL and 3336 non-RL parcels after 1997. The mean sales price per acre are similar for RL and non-RL parcels before or after 1997 with RL parcels being sold at a price $538 higher than non-RL before 1997, and $2500 after 1997. The matching results show that RL designation may reduce land value slightly. However, none of estimated ATT are statistically significant. The results indicate that the RL parcels are equally valuable as the non-RL parcels both before and after 1997. The RL designation does not have a statistically significant impact on market value of land. It therefore implies that RL designation may not have much impact on WTA of landowners.

The lack of evidence that RL program have any impact of market value of land indicates that RL program may not be competing with the other programs by increasing the easement value.

[9] All publicly held lands are omitted from the sample, as are commercial, exempt, exempt commercial, and industrial land uses. These lands are fundamentally in a different land market than residential and agricultural lands. Commercial and industrial land, for example, may be more expensive than residential or agricultural land.

Therefore, our estimation of the crowding effect and the impact of RL program on land preservation appears robust.

Conclusion

In an attempt to encourage more contiguous preservation, Maryland introduced the Rural Legacy program to preserve large contiguous blocks of land with high social value. Local entities designate preservation areas and become eligible for special funding. The designation of the RL program interacts with and could crowd in or out the preservation efforts of the existing preservation programs.

The empirical analysis in this paper suggests a crowding in effect of the RL program, i.e. the RL area designation encouraged the other preservation programs to preserve land within it. Overall, the designation appears to have a positive impact on acres retained and on the probability of preservation of parcel within the areas. The program has enrolled more acres and larger parcels due to the extra funding and possibly the new payment schemes based less on market appraisals. Furthermore, the designated areas attract more preservation efforts from other conservation programs. Our empirical results indicate that RL program has no statistically significant impact of market value of developed land, and therefore has not changed the willingness-to-accept of landowners for preserving their land. We conclude that the crowding-in effect is due the economies of scale or complementing rather than competing with existing conservation programs.

Our study shows that the RL program crowds in the preservation efforts of existing conservation programs. However, it is unclear how the crowding in effect impacts land conversion, and overall whether the RL program with a crowding in effect reduces land conversion.

Empirical literature has found contradictory effects of land preservation programs on farmland conversion. On one hand, studies find that land preservation programs may impose higher development pressure to neighboring regions. For example, Irwin (2002) has found that preserving neighboring open space increases housing value by $1000 to $3300. Geoghegan, Lynch, and Bucholtz (2003) find that preserved open space increases property values on adjacent residential parcels in Calvert and Howard Counties in Maryland. On the other hand, empirical evidence suggests that the option to preserve farmland provided by farmland preservation programs may delay land development. Using a real option approach, Towe, Nickerson and Bockstael (2008) find that the parcels qualified for a preservation option have a 50% lower hazard rate of being developed than unqualified parcels in Howard County, Maryland.

To a certain extent, RL program may stem the increased development pressure as it provides continued funding until the whole contiguous block of land is permanently protected. As written in the Rural Legacy Program Grant Manual (2001), sponsors should seek to focus or target their continued funds to protect contiguous blocks of land, rather than scattered parcels that may be individually significant, but which could be surrounded or otherwise adversely affected in the future by development or unprotected lands. Thus, as a next step, we plan a study examining the impact of RL program on landowners' asking price for land preservation, market value of land, and land conversion. The crowding in effect could slow down land conversion in RL areas and strengthen the effect of RL program on land conversion.

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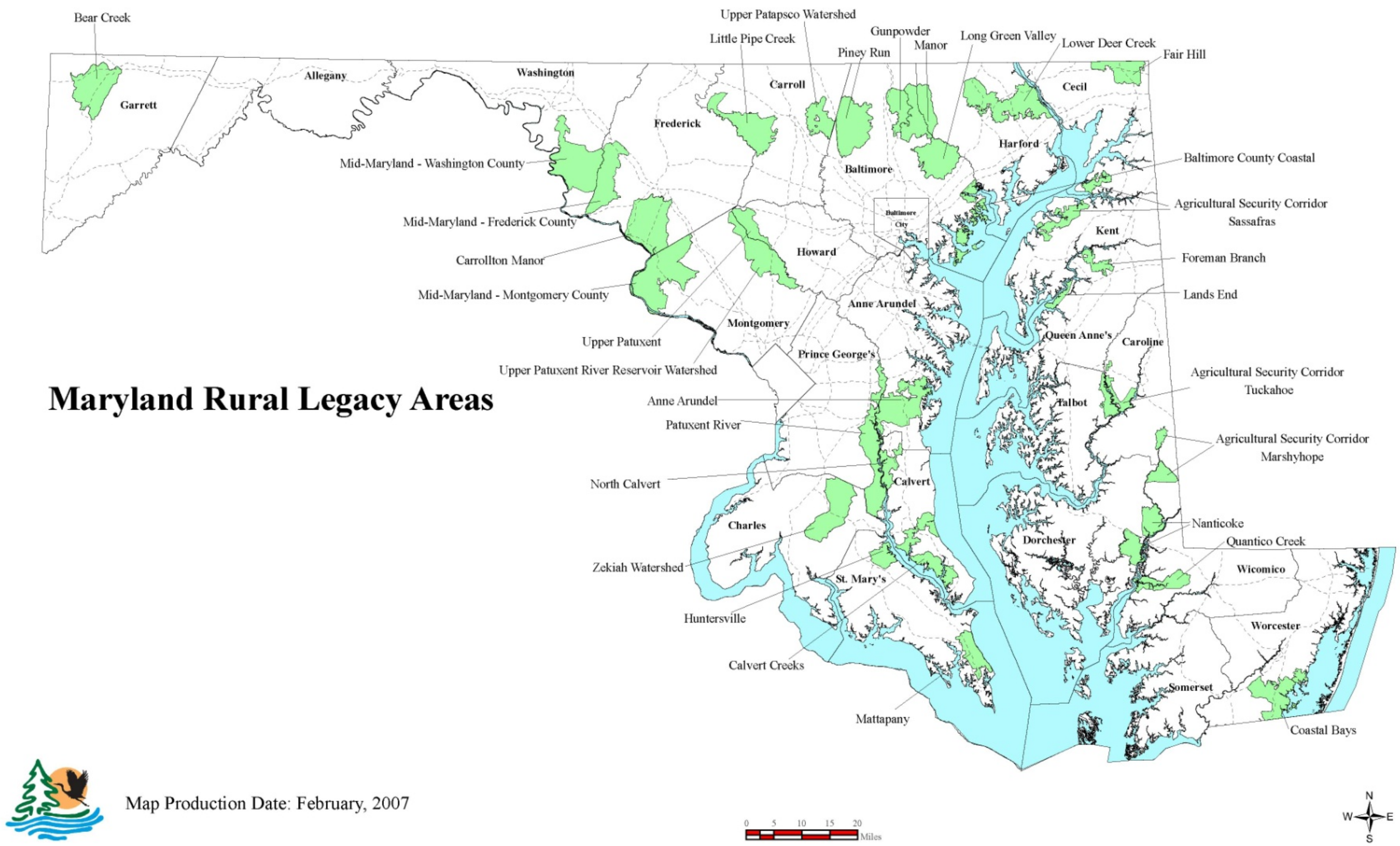

Figure 1: Rural Legacy Areas in Maryland

Table 1: Available grants for the Rural Legacy Areas in Calvert, Charles, and St. Mary's Counties

	Calvert County Calvert Creeks	Charles County Zekiah Watershed	St. Mary's County Huntersville
RL approved in	1998	1998	1998
RL expanded in		2001	2005
RL grants			
2008	750,000	500000	
2007		3000000	
2006			300,000
2005			
2004	600,000	202,218.56	
2003	1,500,000	1,000,000	
2002		1,000,000	
2001		1,500,000	3,700,000
2000	1,800,000	1,000,000	800,000
1999	2,000,000	500,000	1,500,000
1998		1,500,000	
Total to date	6,650,000	10,202,218.56	6,300,000

Note that the information on geographic distribution of RL grants in FY1998, and total available grants for FY2002 are not identified.
Source: Maryland Board of Public Work –after meeting agenda summary (1998-2008).

Table 2: The Maryland Agricultural Land Preservation Foundation (MALPF) available funds and preservation costs per acre statewide

Fiscal Year	Annual Net new MALPF acreage	Annual new funding for easement acquisitions ($)	Per acre acquisition costs($)	Per acre easement value($)	Per acre Fair Market Value (FMV) ($)	Per acre Agricultural Use Value (formula)($)	Per acre accepted asking price($)
1992	-29	0					
1993	8,341	11,472,760	1016*	1185*	2460*	1312*	1213*
1994	6,783	11,000,311	1617	2920	3639	718	1918
1995	7,851	11,120,874	1384	2235	3040	792	1633
1996	6,552	10,109,481	1537	2205	2977	773	1697
1997	11,797	16,324,722	1382	2193	2848	655	1470
1998	12,460	20,378,116	1634	2364	3027	666	1688
1999	14,241	23,109,183	1619	2345	3012	667	1650
2000	18,781	32,609,436	1683	2405	3129	724	1818
2001	12,966	25,246,645	1944	2511	3201	690	2223
2002	19,283	37,582,057	1958	2717	3,468	751	2676
2003	15,307	33,687,626	2199	3071	3,756	686	2400
2004	2,448	7,315,417	2982	4257	4,914	657	3779
2005	6,687	22,246,850	2802	4534	5,293	759	3189
2006	8,628	39,443,428	4492	7634	8,424	790	5475
2007	15,161	90,980,431	5952	9496	10,341	845	8010
Total	265,691	490,980,431					

* Value is for 1977-1993

Source: The Maryland Agricultural Land Preservation Foundation five year annual reports, Fiscal Year 2003-2007.

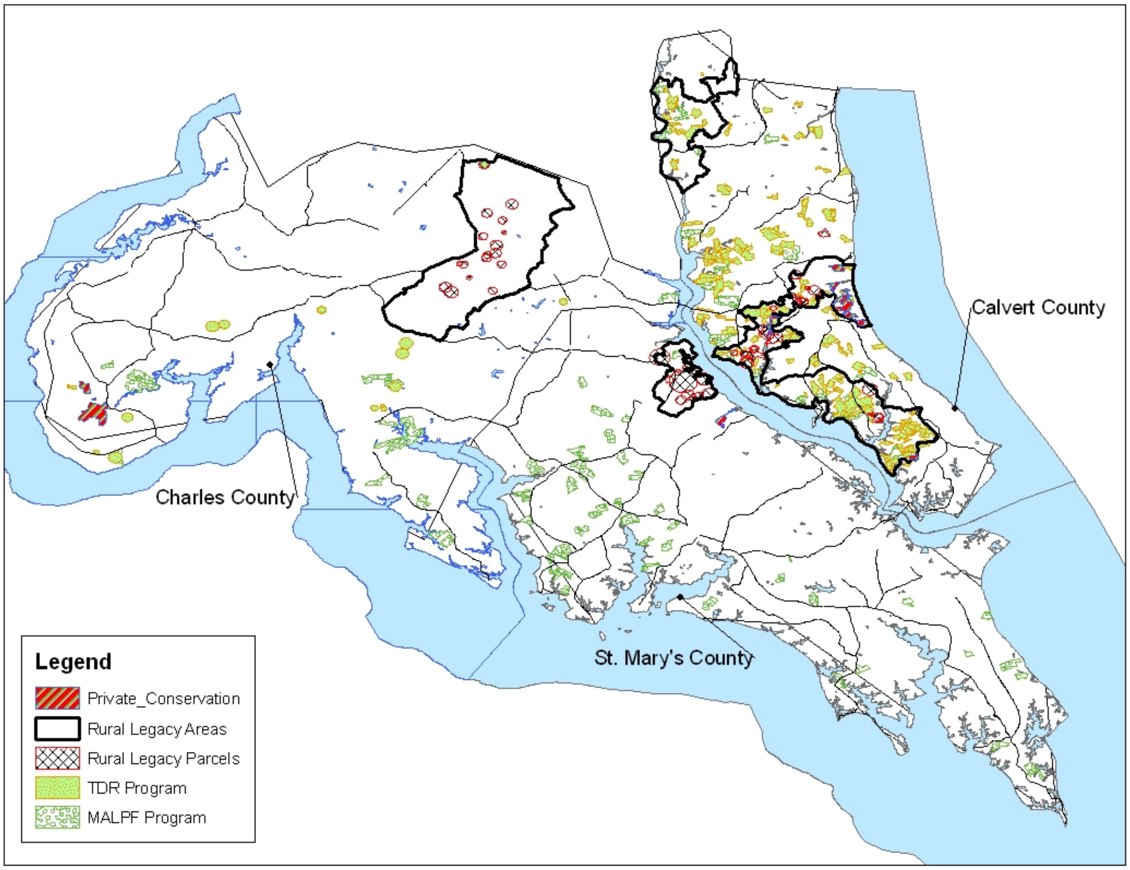

Figure 2: Rural Legacy areas and preserved parcels by program type

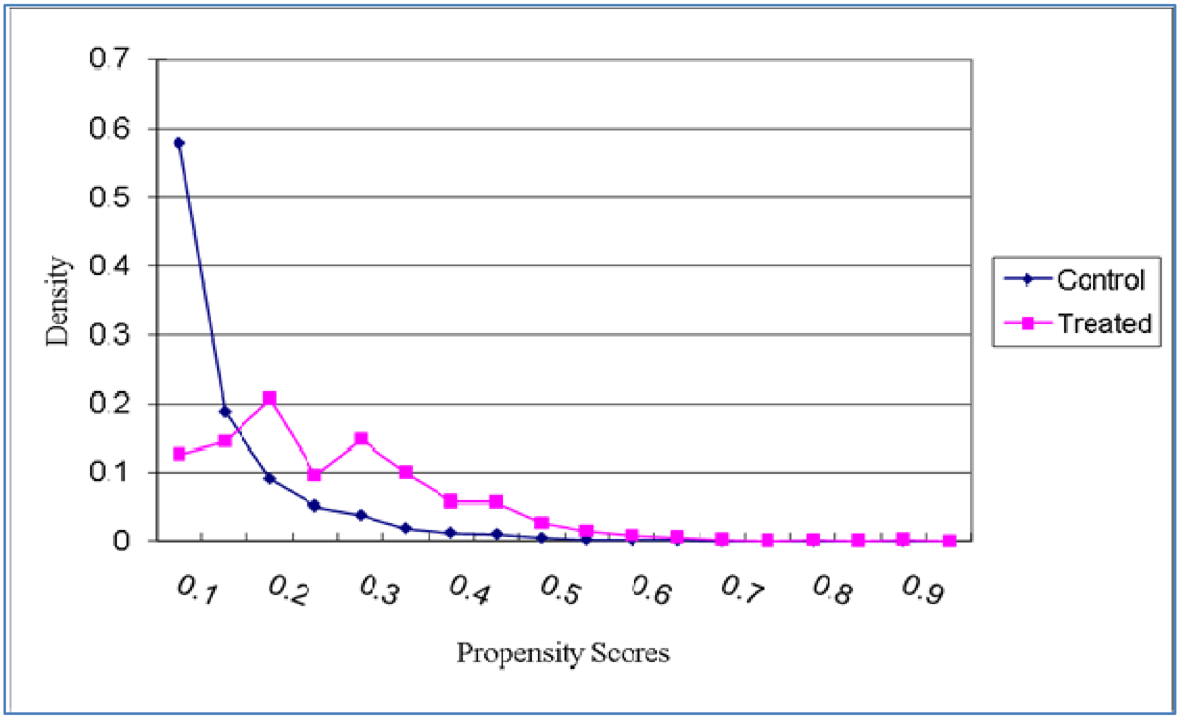

Figure 3: Distribution of estimated propensity scores

Table 3: Rate of preservation and acres preserved in RL and non-RL areas before and after 1997

		RL parcels	non-RL parcels
pre-treatment			
	preservation rate	0.067	0.021
		(0.25)	(0.143)
	preservation acres	3.195	0.714
		(18.47)	(10.89)
	# of parcels	720	6865
post-treatment include parcels preserved by RL program			
	preservation rate	0.19	0.041
		(0.39)	(0.2)
	preservation acres	16.07	2.53
		(61.2)	(19.48)
	# of parcels	720	6865
post-treatment exclude parcels preserved by RL program			
	preservation rate	0.138	0.041
		(0.35)	(0.2)
	preservation acres	7.86	2.53
		(30.9)	(19.5)
	# of parcels	676	6865

Note: The values are the proportion and acres preserved and standard deviation is in the parenthesis

Table 4. Estimated Coefficient for the Propensity Score Logistic Regression

Pseudo R2 = 0.1779	Log likelihood = -5927.4692	
Dependent Variable	In/out of Rural Legacy areas	
Independent Variables	Estimated Coef.	Std Err.
Acres	0.0083**	0.0024
Miles to Washington DC	-0.0300	0.0204
% cropland_1997	1.0040**	0.1670
% forest_1997	-0.0634	0.1377
% special habitat (in log format)	0.9904**	0.2097
On public sewer	-0.0251	0.5053
Zoning density per acre	-3.9806	3.7404
% estuarine (in log format)	2.4142**	0.7200
Waterfront property	0.8767**	0.1387
% acres with depth to bedrock>72 inch	-4.2090	4.6463
% acres with floodplain soil	1.4719**	0.4274
% acres with soil erodebability low and very low	3.6582**	0.4052
% acres with permeability medium or rapid	-2.0566**	0.3979
Acres squared	-3.08e-06**	1.02e-06
Miles to Washington DC squared	0.0000	0.0002
Acres*miles to Washington DC	-0.0001*	0.0001
% cropland_1997 squared	0.0766	0.1859
% forest_1997 squared	0.7494**	0.1336
Acres*public sewer	-0.0581	0.0740
Zoning density squared	-0.0512	0.1293
Acres*waterfront	-0.0016	0.0018
% acres with depth to bedrock>72 inch squared	5.6530	4.0333
% acres with floodplain soil squared	-3.4399**	0.4883
% acres with soil erodebability low and very low squared	-1.1983**	0.4197
% acres with permeability medium or rapid squared	0.2076	0.3702
Zoning density*% acres with depth to bedrock>72inch	0.9366	3.7435
Zoning density*% acres with floodplain soil	-0.1758	0.5418
Zoning density*% acres with soil erodeability low and very low	-2.2449**	0.2783
Zoning density*% acres with permeability medium or rapid	2.5187**	0.2151
Constant	-1.3960	1.5416
Observations (Parcels >3 acres)	25,779	

* significant at 5%; ** significant at 1%

Table 5: Balancing test result

	Normal Kernel Matching (bandwidth=0.01)		Biweight Local Linear Matching (bandwidth=0.1)	
pre-treatment matching				
	Permeability	(64:54)	Permeability	(64:52)
	Erodeability	(20:16)	Erodeability	(20:15)
post-treatment matching including parcels preserved by RL program				
	Permeability	(63:54)	Permeability	(63:52)
	Erodeability	(20:16)	Erodeability	(20:16)
post-treatment matching excluding parcels preserved by RL program				
	Permeability	(63:54)	Permeability	(63:52)
	Erodeability	(21:16)	Erodeability	(21:16)
pre-treatment RL vs. post-treatment non-RL group				
	Permeability	(64:54)	Permeability	(64:52)
	Erodeability	(20:16)	Erodeability	(20:16)

Means for treated and control parcels are in parenthesis

Table 7: Effect of Rural Legacy designation on land preservation from identification strategy one (Parcels>10 acres)

	Normal Kernel Matching (bandwidth=0.01)				Biweight Local Linear Matching (bandwidth=0.1)			
	Rate		Acres		Rate		Acres	
	ATT	Se.	ATT	Se.	ATT	Se.	ATT	Se.
Pre-treatment								
$(1) = E_{\phi}$								
# RL parcels: 720								
# non-RL parcels: 6,865	0.026	(0.01)	1.57	(0.73)	0.026	(0.01)	1.49	(0.73)
Post-treatment								
$(2) = -2E_C + E_{RL} + E_{\phi}$								
# RL parcels: 672								
# non-RL parcels: 6722	0.101	(0.013)	10.96	(2.38)	0.101	(0.013)	10.94	(2.38)
Pre-treatment RL vs. post-treatment non-RL								
$(3) = -E_C + E_{\phi}$								
# RL parcels: 672								
# non-RL parcels: 6865	0.036	(0.01)	0.39	(0.78)	0.036	(0.01)	0.38	(0.77)
E_{ϕ}								
$= (1)$	0.026		1.57		0.026		1.49	
E_C								
$= (1) - (3)$	-0.01		1.18		-0.01		1.11	
E_{RL}								
$= (2) + (1) - 2*(3)$	0.055		11.75		0.055		11.67	

Table 6: Effect of Rural Legacy designation on land preservation from identification strategy two (Parcels>10 acres)

	Normal Kernel Matching (bandwidth=0.01)				Biweight Local Linear Matching (bandwidth=0.1)			
	Rate		Acres		Rate		Acres	
	ATT	Se.	ATT	Se.	ATT	Se.	ATT	Se.
Pre-treatment								
$(1) = E_\phi$								
# RL parcels:720								
# non-RL parcels: 6865	0.026	(0.01)	1.57	(0.73)	0.026	(0.01)	1.49	(0.73)
Post-treatment—exclude parcels preserved by RL program								
$(2) = -2E_C + E_\phi$								
# RL parcels: 628								
# non-RL parcels: 6722	0.041	(0.011)	1.97	(1.28)	0.040	(0.011)	1.94	(1.28)
Post-treatment—include parcels preserved by RL program								
$(3) = -2E_C + E_{RL} + E_\phi$								
# RL parcels: 672								
# non-RL parcels: 6722	0.101	(0.013)	10.96	(2.38)	0.101	(0.013)	10.94	(2.38)
E_ϕ								
$= (1)$	0.026		1.57		0.026		1.49	
E_C								
$= 0.5[(1) - (2)]$	-0.008		-0.2		-0.007		-0.23	
E_{RL}								
$= (3) - (2)$	0.06		9		0.061		9	

Table 8: Land value per acre for RL and non-RL parcels sold before and after 1997			
		RL parcels	non-RL parcels
pre-1997			
	land value per acre	16,258	15,720
		(18,358)	(17,238)
	# of parcels	545	5866
post-1997			
	land value per acre	23,622	21,122
		(18,016)	(14,385)
	# of parcels	288	3336

Note: The values are the mean land value per acre and standard deviation is in the parenthesis

Table 9: The effect of Rural Legacy designation on land value per acre		
	Normal Kernel Matching (bandwidth=0.01)	Biweight Local Linear Matching (bandwidth=0.1)
Pre-1997		
ATT	-610	-535
	(1,116)	(1,112)
# matched RL parcels	545	545
# matched non-RL parcels	5,857	5,855
Post-1997		
ATT	-1,058	-1,130
	(1,424)	(1,403)
# matched RL parcels	288	288
# matched non-RL parcels	3,333	3,333

Note:

1) The matching within pre-1997 transactions captures the impact of unobserved land characteristics on market value of land, and post-1997 matching captures the impact of RL and unobservables.
2) The standard error of the average treatment effect on the treated are in parenthesis.