

Do Land Preservation Programs Crowd out or Crowd in Each Other?
Evidence from the Rural Legacy Program in Maryland

Xiangping Liu
Department of Agricultural Economics
North Carolina State University
Xiangping_liu@ncsu.edu

Lori Lynch
Department of Agricultural and Resource Economics
University of Maryland, College Park
llynch@arec.umd.edu

October, 2009

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 impacts on land preservation due to their interaction with existing land preservation programs. The Maryland Rural Legacy program began in 1997 and designates large contiguous blocks of land in which it focuses its preservation effort. The question that we address in this research is whether the Rural Legacy program induces existing conservation programs to shift their preservation efforts into or out of Rural Legacy areas if the presence of the program crowds in or crowds out the efforts of the other programs. If a crowding-in effect is present and dominates a crowding-out effect, the existing programs shift their preservation activities into the designated areas, and vice versa. Using parcel level data and a propensity score matching method, we find that parcels in designated Rural Legacy areas are more attractive to preservation programs after the Rural Legacy program is introduced, thus resulting in a net “crowding-in” effect which increases the likelihood of preservation by about 10% and average preserved acres by about 3%.

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

JEL code: Q18, Q24, Q28, Q58

Do Land Preservation Programs Crowd out or Crowd in Each Other? Evidence from the Rural Legacy Program in Maryland

I. Introduction

Although Maryland has many land preservation programs that aim to permanently preserve land, the goal of preserving large contiguous tracts of land has not yet been achieved (Lynch and Musser 2003). Generally, land conservation programs in Maryland have conserved land in a scatter gun pattern rather than in targeted geographic regions. In an effort to address this shortcoming of previous efforts, Maryland introduced the Rural Legacy (RL) program in 1997 which highlights contiguity of preserved parcels. The RL program provides local governments or private land trusts special funding to preserve farm, forest, and ecologically important resource lands within designated areas. Maryland allocates funding to RL areas each year until all available parcels in the RL areas are preserved.

Before the RL program was introduced, quite a few conservation programs had been operating in Maryland to permanently preserve agricultural land. The Maryland Agricultural Land Preservation Foundation (MALPF) was introduced in 1977 by the Maryland Department of Agriculture and is the largest among them. MALPF restricts development of prime farm and forest land by purchasing agricultural conservation easements. The foundation has spent \$490 million to permanently preserve 0.3 million acres statewide by 2007. Transfer of Development Rights (TDR) programs were also introduced in Maryland in 1978. TDR programs are developed and administrated at the county level, and preserve land by transferring development rights from agricultural zones to designated development zones. By 2008, more than 80,000 acres have been preserved through TDR programs in Maryland. Lastly, the Maryland Environmental Trust (MET) was established in 1967 and accepts donation of conservation easements from landowners who earn tax benefits by donating the easements. By 2008, the MET has preserved 120,000 acres of land throughout the state. Besides the three programs, Maryland also has a number of other private conservation programs, including The Nature Conservancy, that preserve agricultural land through purchasing conservation easement.

The RL program is more spatially focused than all previous conservation programs and thus can be more influential within the areas it targets. In the nine-year period since it was established

(1998 to 2008), the RL program has designated 0.73 million acres as target areas for preservation, which accounts for about 11% of the total agricultural and forest land in Maryland. Up to 2008, the program has preserved about 9% of that its designated areas (58,217 acres) at a cost of \$163 million.

There is anecdotal evidence that the existing programs also have interests in, and have undertaken conservation activities in the designated RL areas prior to their designation as such. For example, MALPF focused 28% of its total activity, and TDR programs about half of their activity in Southern Maryland within the RL areas before they were designated. This suggests that the introduction of the RL program might have interaction effects with the existing conservation programs after its inception in 1997. This research examines how these conservation programs have interacted with each other. We focus on the introduction of the RL program in Southern Maryland and examine how conservation activities undertaken by this program impact the conservation activities of other existing programs.

The introduction of the RL program could interact with existing programs in various ways. First, the RL program's efforts can reduce other programs' preservation effort in the designated areas, which leads to a "crowding-out" effect. Similar to the example that federal spending crowds out private spending on public goods, other conservation programs might free-ride on the activities of the RL program and shift their preservation efforts out of the RL areas. Besides this type of free-riding behavior, the competition between the RL and other programs might increase the marginal preservation costs and thus further induce a crowding-out effect. Specifically, the RL program uses an Easement Valuation System (EVS) that rewards ecological benefits which are usually discounted by preservation programs when determining payments to landowners. The higher easement payments attract the landowners to participate the RL program even if their lands are qualified for the other programs. The RL program thus increases the landowners' expectation on easement payments and the costs of preservation for other programs within the designated areas. Lastly, the RL area designation could signal to housing consumers that this area's amenities are increasing, providing another source of increased demand and leading to higher asking prices for conservation easements.

While crowding-out may occur, there is also a possibility that the introduction of a RL area and the extra funding it provides could induce other existing conservation programs to exert more effort in the RL area, leading to a “crowding-in” effect. Contiguity may increase the marginal benefits of each acre preserved and both the RL and other programs could receive higher benefits from each additional acre preserved within the RL areas relative to parcels outside the RL areas. There may also be economies of scale or threshold effects which result a positive correlation between marginal benefits and preserved acres. Each of these effects may result in other conservation programs increasing their efforts in the RL areas.¹ Crowding-in behavior would manifest itself primarily as more preserved acres or expenditure by other programs within the RL areas than they would have undertaken had the RL program not there.²

Both the crowding-in and crowding-out effects might be present simultaneously and one may dominate the other. Which effect dominates depends on the relative strength of the factors that lead to those effects. If the competition among the preservation programs induces sufficiently high preservation costs, a crowding-out effect would dominate. However, if economies of scale and the value of contiguity is so strong that the marginal benefits from preserving parcels within the RL areas exceed any additional costs, the crowding-in effect would dominate the crowding-out effect.

If the crowding-in effect dominates, the existing conservation programs would shift their preservation efforts into the RL area after it is designated as such. In this case, we would observe more preserved acres within the RL areas than the RL program could afford by itself and more than the existing programs would have preserved in the area had the RL program not existed. If the crowding-out effect dominates, we would observe an increase in preservation costs, and/or that the existing preservation programs will have diverted their preservation efforts out of the RL

¹ Albers, Ando, and Batz (2008) have made the similar argument in their theoretical findings. From their theoretical model on the strategic interactions among land preservation programs, they find that public conservation crowds in private conservation if the benefit function of private land trusts reflects increasing marginal benefits with preserved acreage.

² The crowding-in effect may also manifest itself as matching funds and co-held conservation easements with the RL program. MALPF co-holds some easements with the RL program to reduce on-going monitoring expenses, but has not shared any easement acquisition costs with the RL programs. No co-held easements were identified in our study areas.

areas, resulting in fewer acres being preserved as compared to what would have been preserved had the RL program not existed.

To the best of our knowledge, there are two similar studies that have looked at potential crowding effects across land preservation programs. Using a township level spatial data in California, Illinois, and Massachusetts, Albers, Ando, and Chen (2008) studied whether public conservation activities affect the location choice of private land trusts. They use the land acreage that are permanently preserved to measure public conservation effort, and spatial lag and spatial error models to control for spatial agglomeration of private conservation activities. They find evidence that private-preserved acres are clustered together in space in the three States, which implies that private land trusts value contiguity of preservation. However, they find mixed results in crowding effect: public reserves crowd in the private land trusts' effort in California, and crowd out the land trust's effort in Illinois and Massachusetts.

While Albers, Ando, and Chen (2008) study federal, state, and local public programs that permanently preserve open space in their study areas, Parker and Thurman (2008) focus on only federal land conservation programs that permanently or temporarily preserving land. They construct 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, Wetland Reserve Program, and national parks. The private land trust acreage data are from The Nature Conservancy and Land Trust Alliance. Their analysis implies that the Land Trust Alliance appears to increase activities in the areas with high enrollment in federal conservation programs and retained parkland. Thus federal activities appear to crowd in Land Trust Alliance activities. However, both crowding-in and crowding-out effects are detected for Nature Conservancy's activities.

Different from Albers, Ando, and Chen (2008) and Parker and Thurman (2008), we study the crowding effects on preservation effort from newly designated preservation areas using parcel level data and consider all possible permanent conservation programs within our study area.³ Furthermore, we approximate conservation effort of each program in our study area using the

³ Parker and Thurman (2008) focus only on the preservation efforts of federal conservation programs and private land trusts and do not include state conservation programs in their study.

likelihood of parcels being preserved and the expected average acres of preservation. Our micro-level parcel data are rich and include characteristics that affect a parcel's predisposition to be preserved, including soil quality and presence of habitat.

In this research, we specify the conditions under which the crowding-in or crowding-out effect could occur and empirically test which effect dominates. To conduct our tests, we must construct the level of effort that the existing conservation programs would have exerted had the RL program not existed. In other words, we must construct the counterfactual.⁴ To construct such counterfactual, we use a propensity score matching method and different identification strategies that compare the preservation outcomes between observably the same parcels within and outside the RL areas over time. Our identification strategies allow us to separate the crowding effect of the RL program from other causal effects of land conservation in the RL area, such as, the direct effect of the RL program, and the effect of parcels' predisposition to be preserved within the RL areas. Specifically, we find that the dominating crowding-in effect increases the likelihood that a parcel is preserved by existing conservation programs by 8-12% within a RL area after the RL is designated and the average preserved acres increase by a total of approximately 3% over our study period.

II. Program Descriptions

IIa. Rural Legacy (RL) program

The RL program encourages local governments and experienced land trusts/nonprofits (hereafter referred as "sponsors") to identify contiguous tracts of high benefit resource land, and provides extra funding for sponsors to preserve those tracts. Sponsors identify priority preservation areas that are contiguous tracts of land and also determine the anticipated level of landowners' participation. The designated areas should be large enough to provide significant protection for multiple resource values, yet small enough to achieve preservation objectives within the proposed implementation time frame. A RL Board and an Advisory Committee, with the assistance from RL staff, review applications, interview sponsors, visit the actual sites, revise the

⁴ The direction of the crowding effects in our study is from the RL program to the existing programs. In the work by Albers, Ando, and Chen (2008), the direction is from public conservation programs to private land trusts. However, contrary to their research, we do not assume that the preservation activities of the RL programs are exogenous.

applications if necessary, and decide whether to approve the proposed RL areas. Upon approval, the sponsors can apply for money from the state each year through a competitive process and the money is awarded to RL sponsors based on fund availability. The grants cover the cost of conservation easements or fee simple purchases in the RL areas.⁵ Continuing funds are allocated to RL sponsors until all the parcels in the RL areas are preserved by the RL or other preservation programs.

The RL program prioritizes areas based on agricultural, forestry, habitat, and cultural resources present, as well as the level of conversion pressure and the economic value of the area's resource-based industries or services. When selecting tracts for designation as RL areas, the program uses a flexible selection mechanism compared to other existing programs. The RL program does not specify minimum requirements for soil quality, size or land use type. Instead, it 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. To determine the price offered to landowners, the RL program adopts an Easement Valuation System (EVS). The EVS uses appraisals combined with a point system that rewards ecological and other natural attributes of the parcels such as tract size and whether endangered species, wetlands, or other important wildlife habitat are present. These important natural features are often discounted in an appraisal approach, which tends to focus solely on market productivity of the land.

By April 2008, 30 RL areas covering 732,862 acres have been designated across Maryland and \$163 million has been allocated to preserve 58,217 acres of farmland, forests, and natural resource areas, or 9% of the total available acreage in the 30 RL areas.

Iib. The Rural Legacy areas in Southern Maryland

Our study area is the three counties that comprise Southern Maryland: Charles, Calvert, and St. Mary's counties. This area is within two hours of both Washington, D.C. and Baltimore, MD. It has experienced high population growth that outpaced both Maryland's growth rate and the

⁵ Three percent of the yearly grant amounts may be used to pay for administrative costs. One and a half percent of each easement purchase cost may be used to pay for program compliance costs for monitoring easements. The RL program encourages sponsors to limit the number of fee simple purchases in RL areas, however.

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 RL areas and have 84,102 acres approved in five RL areas. Two of the RL areas were designated after 2004 and thus have insufficient enrollment to be included in our analysis. The other three RL areas that are included in this study were designated in 1998, cover 59,884 acres, and have attracted total funds of \$23 million. Two of the three RL areas were expanded after they were designated (one in 2001 and the other in 2005) and focus on ecologically important land with heavy development pressures.

Table 1 indicates the amount of funds that have been released each year for the RL areas in our analysis and the number of acres protected. During our study period (1998-2005), all three RL areas acquired grants from the State in most years except for 2002, in which no new funds were allocated to the RL program. All the three RL areas have parcels enrolled within three years of designation, and by 2005, about 6,213 acres of land were permanently preserved through the RL program, accounting for just over 10% of the total land available in our three designated RL study areas.

Iic. Other permanent preservation programs in Maryland

Established in 1977, the ***MALPF program*** aims to preserve productive farmland and woodland and curb the expansion of random urban development. Compared to the RL program, MALPF's acceptance criteria are less flexible and its pricing scheme does not reward ecological values. MALPF only accepts parcels that are 50 acres or larger, have been enrolled in Agricultural District for at least 2-10 years, and meet minimum soil quality standards. Different from the EVS system adopted by the RL program, MALPF sets its maximum offer price based on a landowner's asking price or the calculated easement value, whichever is lower. A property's easement value is the difference between its computed agricultural value and its fair market value (determined by an appraiser). The agricultural value of a parcel is determined by a calculated rent that based on the soil productivity or the five-year average cash rent in the county.

From 1998 to 2006, MALPF has protected 110,801 acres throughout Maryland at a cost of \$240 million (Table 2). For comparison, the RL program has preserved 53,093 acres statewide at a cost of \$124 million. Although the MALPF program is larger than the RL program statewide, the RL program is a significant player in the areas it targets. In the nine years of our study period, the RL expenditures in our three RL areas are larger than the MALPF expenditures in the entire three counties. From 1998 to 2005, MALPF has preserved about 6,476 acres at an approximate cost of \$14 million in the three counties,⁶ while the RL programs preserved 6,213 acres at a cost of about \$18 million.

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. Different from the MALPF or RL programs, TDR programs do not require local or state governments to raise funds to acquire the easements. However, local governments have to define sending areas that have large blocks of undeveloped land, and receiving areas that can accommodate the development capacities to be transferred out of sending areas. Furthermore, easement costs of the parcels preserved under a TDR program are determined by the market: the demand for development rights and its supply. By 2004, there were 14,775 acres preserved in the three counties of our study through TDR programs. The costs of acquiring the conservation easements through the TDR programs by private entities are not known.

Maryland Environmental Trust (MET) aims to protect land from development through donated conservation easements and has been in existence since 1967. Donors earn federal and state income tax credits, and enjoy the benefits of paying no property tax for 15 years after the donation date. Beyond 15 years, the owners of the donated land can still enjoy low agricultural property tax for their undeveloped land even if the land is not actively being farmed. By 2006,

⁶ The approximated MALPF conservation cost is calculated using the total preserved acres times the average conservation cost. The average conservation cost is calculated by dividing the total MALPF expenditures across Maryland (\$51 million) by the 14,609 acres preserved in the three counties from when it was established to 2005. The total acres preserved under MALPF are calculated from our data.

MET has preserved about 106,000 acres statewide and more than 10,000 acres in the three counties.

Private conservation programs that are operated by national and local land trusts also preserve land in Maryland through buying conservation easement. Almost 48,000 acres of agriculturally and ecologically significant lands have been protected by private organizations in Maryland up to 2009.

In summary, significant preservation activities have occurred in our study area from all the preservation programs since 1997. The MALPF has preserved almost half of its total acreage and TDR programs 40% since 1997. Significant portions of the preservation activities have been spent in the designated RL areas, which leads to almost 21% of total RL areas having been preserved compared to only 6% of the non-RL areas. The disparity in the preservation rates within and outside the RL areas suggests that these areas are more desirable to all conservation programs and therefore are attracting more preservation efforts (or RL sponsors tend to pick high preservation areas to designate RL areas). However, our raw data provide mixed evidence on a crowding-out or crowding-in phenomena. It suggest a crowding-out phenomena in the entire time span but a crowding-in phenomena in the nine-year time frame around 1997 (See Table 3). In the entire time span, all the existing programs spend larger shares of their total activities within RL areas pre-1997 than after that, which lead to an overall preservation share of 49% within the RL area pre-1997 and 41% after that. While in the nine-year time window centered on 1997, both MALPF and private conservation programs preserve larger shares of their total acreage within the RL areas post-1997, leading to a higher overall share of 57% post-1997 than 43% before 1997. The above evidences do not account for the impact of the factors that affect how desirable parcels are to existing programs. After controlling for those factors, we could detect whether a crowing in or crowding-out effect exists and dominates or vice versa.

III. Theoretical framework and empirical model

IIIa. Theoretical model

This section provides a conceptual framework of the land preservation programs' strategies and motivates our empirical approach. We start from individual landowners' decisions on preserving

land, aggregate to the preservation activity of the RL and the existing programs within and outside RL the areas, and then discuss the potential crowding effects of the RL program on the existing programs' efforts.

We assume in this model that a community is comprised of two areas: a RL area and a non-RL area. For ease of exposition, we refer to existing, non-RL programs as simply other conservation (OC) program. The existing OC program has been operating in the community to preserve the undeveloped land that otherwise would be developed. The RL program enters later and focuses on the parcels within the RL area, while the OC program preserves land throughout the community.

There are M units of undeveloped land in the RL area and N units outside RL area that would be developed in the future if not being preserved. A landowner i is endowed with one unit of land, and WTA_i is the landowner's willingness-to-accept for permanently giving up the parcel's development right.⁷ The easement payment that the OC program is willing to pay to landowner i is denoted by EV_i and the RL program is \overline{EV}_i . The easement payments are determined jointly by land characteristics and the programs' evaluation criteria but not by the RL or OC program's available budgets.⁸ γ_i is the proportion of the easement payment that the RL program is willing to pay to landowner i and $\gamma_i \in [0,1]$. $\gamma_i = 1$ if the unit i is enrolled only in the RL program, $\gamma_i = 0$ in the OC program, and γ_i takes any value in-between zero and one if the RL program provides matching funds to the OC program and the parcel's easements are co-held by both programs.

The owners of the M units of land within the RL area can choose to participate the RL or OC program, while the owners of the N units outside the RL area can only participate the OC program. The total easement payment that the preservation programs are willing to pay for land unit i is $\gamma_i \overline{EV}_i + (1 - \gamma_i)EV_i$ if it is within the RL area and EV_i outside the RL area.

⁷ 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.

⁸ In static framework, the WTA_i is not affected the amount of preserved land adjacent to the parcels, which is not the case in a dynamic framework. In addition, the parcels with high easement may not be preserved if budget is exhausted but will be preserved after new budget are available in a dynamic framework.

Whether parcels i is preserved or not depend on not only the easement payment that the conservation programs are willing to offer but also the willingness-to-accept of its owner, WTA_i . The landowner i is willing to preserve his land only if the easement payment exceeds his willingness-to-accept: $WTA_i \leq EV_i$ for parcels outside RL area and $WTA_i \leq \gamma_i \overline{EV}_i + (1 - \gamma_i)EV_i$ within the RL area. The parcel is preserved if the willing landowner i is paid the easement payment ($\beta_i = 1$) and is not preserved otherwise ($\beta_i = 0$).

We assume that the budgets for the OC and RL programs are always binding, which implies that not all the landowners who are willing to preserve their land are accepted by the programs.⁹ The land preservation programs aim to preserve all available units that would otherwise be converted until their available budgets are exhausted.

We define a crowding-in or crowding-out effect by comparing the OC program's preservation efforts in two cases: the baseline case in which only the OC program exists, and the case in which both programs operate. A crowding-in effect is detected if the OC program shifts its preservation effort into the RL area after the RL program is introduced, and we detect a crowding-out effect otherwise.

In the baseline case, only the OC program operates in the entire community. We assume that the benefits from preserving land units within the RL area are the same as that outside the RL area in the baseline case. The OC program's maximization problem is to preserve as many parcels as possible until its available budget, B , is exhausted: $\sum_{i \in M \cup N} \beta_i EV_i \leq B$. The OC program chooses an optimal cut-off value λ^* such that: $\beta_i = 1$ if $WTA_i \leq EV_i \leq \lambda^*$, and $\beta_i = 0$ if $EV_i \geq \lambda^*$. The λ^* takes the value at which the budget of the OC program is exhausted.

After the RL program is introduced, both the RL and OC programs operate in designated RL area. The maximization problems for both the RL and OC programs are the same: using their available budgets to preserve as many available units as possible in their preservation areas to maximize their preservation benefits. Specifically, the RL program preserves as many units of land as possible within the RL area given its budget constraint \bar{B} : $\beta_i \gamma_i \overline{EV}_i \leq \bar{B}$, and the OC program maximizes preservation benefits by preserving many units as possible in both the RL

⁹ This is a realistic assumption as most programs have a waiting list of interested landowners.

and OC areas given its budget constraint: $\sum_{i \in M} \beta_i (1 - \gamma_i) EV_i + \sum_{i \in N} \beta_i EV_i \leq B$. Different from the baseline case, the benefits from preserving land within the RL area may be higher than that from outside the RL area in the OC program's objective function.

The introduction of the RL program affects the OC program's activities in various ways. We discuss their direct and indirect interactions in the following six scenarios *A* to *F*: the Scenario *A* is a discussion of the case where OC program free-rides the RL program; scenario *B* to scenario *D* present the direct impacts of RL program on OC program's activities; scenario *E* is on the indirect effect through landowners' willingness-to-accept, and scenario *F* discusses another indirect impact through marginal benefits of preserving land in RL area.

Scenario A: the OC program may have incentive to free-ride the RL program's activities and the incentive increases with the RL program's budget level, \bar{B} . The higher the \bar{B} , the higher the OC program's incentive for free-riding as it expects that the RL program's budget is sufficient to preserve the parcels, $i \in M$, that it would have preserve. Thus the introduction of the RL program leads to a crowding-out effect, and the crowded-out effort preserves more parcels outside the RL area, $i \in N$.

Scenario B: The RL program can choose to compete or not to compete with the OC program in accepting parcels. The RL program competes with the OC program if it accepts parcel i that OC program would have preserved ($WTA_i \leq EV_i \leq \lambda^*$ and $i \in M$). The competition crowds out the preservation effort of OC program if the RL program leaves few eligible parcels to the OC program or the remaining unpreserved parcels within RL area are more expensive relative to the ones outside the RL area. The RL program can also avoid the competition by accepting only the parcels that the OC program is not interested or cannot afford to preserve: the parcels $i \in M$ with $EV_i \leq WTA_i$ or $EV_i \geq \lambda^*$. The OC program, thus, enrolls the same parcels as it would have preserved had the RL program not introduced. As a result, there is neither a crowding-in nor a crowding-out phenomena since the RL program's actions have no effect on the OC program's activities.

Scenario C: The RL program can offer higher easement payments to the parcels that are desirable to the OC program or only to the parcels that are not qualified to OC program. When

the RL program offers higher easement payments, $\overline{EV}_i \geq EV_i$, to the parcels that are desirable and affordable to the OC program (parcels $i \in M$ with $WTA_i \leq EV_i \leq \lambda^*$), the owners would prefer participating the RL program instead of the OC program. As a result, less units of land are available to the OC program in RL area, which crowds out its preservation effort. However, the RL program does not crowd out the OC program's effort if it offers higher easement payments only to the parcels that are not qualified or affordable for being enrolled in the OC program, i.e. the land units $i \in M$ with $EV_i \leq WTA_i$ or $EV_i \geq \lambda^*$.¹⁰

Scenario D: The RL program can provide matching funds to the OC program for preserving parcels within the RL area: i.e. subsidize their RL selections ($\gamma_i > 0$). Whether a crowding-in or crowding-out effect is present depends on the distribution of parcels' easement cost and the magnitude of the matching funds (the size of $(1 - \gamma_i)$). For example, if the matching funds are not large enough or the remaining unpreserved parcels within RL area are relatively more expensive compared to the ones outside the RL area, the OC program would shift its effort that is saved from preserving parcels i ($WTA_i \leq EV_i \leq \lambda^*$ and $i \in M$) out of the RL area for the affordable parcels there. The RL program in this case crowds out the preservation effort of the OC program, and more parcels ($i \in N$) outside the RL area are preserved. Alternatively, if the RL program is able to provide sufficiently large (γ is close 1) matching funds such that the parcels within RL area become sufficient less expensive, the OC program would exert more efforts within the RL area, and less parcels are preserved outside the RL area.

Scenario E : Beside the above listed direct impacts, the introduction of the RL program might affect OC program's activities indirectly through landowners willingness-to-accept, WTA_i . This can occur through two channels. First, landowners' expectation on easement payment may increase in the RL area due to the additional funding from RL program or if RL program offers higher easement payment. Second, the potential positive amenity spillover effect from neighboring preserved parcels might increase the market value of unpreserved land i and

¹⁰ We do not discuss the case in which the RL program offers lower easement payments to all parcels than OC program as it is not incentive compatible.

therefore its owner's WTA_i .¹¹ If this is the case, some of the units i ($WTA_i \leq EV_i \leq \lambda^*$ and $i \in M$) will be enrolled in the RL program rather than OC program, which lead a crowding-out effect.¹²

Scenario F: The above five scenarios share one common underlying assumption, the parcels within and outside the RL areas are of equal value to the OC program. However, the introduction of the RL program may increase the perceived marginal social benefits of preserving land in RL area due to economies of scale or the benefits of contiguity. Thus the parcels within the RL area contribute more to OC programs benefits and are assigned higher weights in the OC program's objective function. As a result, the ratio of the perceived marginal benefits to marginal costs increase and the OC program would be more willing to preserve parcels within the RL area even if they become more expensive, which lead to a crowding-in effect.

To summarize, if the OC program values the parcels within and outside the RL area equally (no economies of scale or value of contiguity), the RL program crowds out the OC program's preservation effort if at least one of the following four conditions present: (1), the RL program's decision rule would ensure that it accepts the parcels that are qualified for the OC program; (2), the RL program offers higher easement payments to the qualified parcels to the OC program; (3), the matching funds from the RL program are too little to sufficiently reduce the marginal costs of preserving parcels within the RL area; or (4), the RL program increases landowners asking price for conservation easement. A crowding-in effect exists if (1) RL program provides sufficiently large matching funds to the OC program, and (2) if the introduction of the RL program sufficiently increases the marginal values of preserving parcels in the RL areas. Both crowding-in and crowding-out effects may exist but one may dominate the other. A crowding-in effect dominates if the increment in perceived marginal benefits or the matching funds is sufficient larger than the increment in easement costs within the RL areas, otherwise a crowding-out effect dominates. When a crowding-in effect dominates which results in a "net" crowding-in

¹¹ Positive spatial amenity spillover effect implies that neighboring parcels adjacent to preserved parcels become more desirable and require higher easement payments than similar parcels that do not have preserved neighboring parcels.

¹² \overline{EV}_i and EV_i may also increase if there is positive amenity spillover effect. We abstract this case for simplicity purpose.

effect, the OC program exerts more preservation effort to enroll more parcels and acres in the RL area than it would have preserved had the RL program not introduced. As a contrast, the OC program shifts its effort out of the RL area and preserve fewer parcels and acres in RL area than it would have had the RL program not introduced if a crowding-out effect dominates or there is a net “crowding-out” effect.

IIIb. Empirical Model

Pre- and Post-treatment periods

The land preservation programs enroll parcels at different points of time. For example, a parcel that is preserved after a RL area is designated can be preserved at any time 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 nine-year period frame before and after the introduction of the RL program. We define the nine years before the RL program was introduced (1989 to 1997) as the pre-treatment period, and nine years after it was introduced as the post-treatment period (1997-2005).

Our data contain the information on when a parcel was preserved and by which program, which allows us to trace back its historical preservation status. We assign the pre-treatment preservation status as not being preserved, and the post-treatment preservation status as being preserved if a parcel is preserved after 1997.

Empirical specifications

We denote RL as the treatment status of a parcel: the parcel is treated if it is in the designated RL area ($RL=1$) and control otherwise ($RL=0$). The treatment period is denoted by t : pre-treatment period is t_0 and post-treatment period t_1 . Our outcome variable set is denoted as Y_{it}^{RL} for a parcel i in period t and treatment status RL . We examine two outcome variables: the likelihood of a parcel being preserved and the preserved acreage of a parcel. The likelihood of preservation takes value 1 if it is preserved and 0 otherwise, the preserved acreage of a parcel is its acreage if the parcel is preserved and zero otherwise. The outcome variables are determined by a set of exogenous variables, X_i , whether a parcel is in the designated RL area or not, RL_{it} ($RL_{it} = 0$ or 1), and whether the crowding-in or the crowding-out effect dominates, C_{it} . The impact of

C_{it} on preservation outcomes within and outside the RL area goes in opposite directions and it has no impact on the preservation outcomes in the pre-treatment period: $C_{it} = 0$ in period t_0 and $C_{it} = 1$ in period t_1 . The RL program does not directly affect the outcomes for both pre-treatment and post-treatment periods in the OC area ($RL_{it_0}^0 = RL_{it_1}^0 = 0$) and in pre-treatment period in the RL area ($RL_{it_0}^1 = 0$ and $RL_{it_1}^1 = 1$). The outcome equations for the parcel i if it is within (equation (1)) or outside (equation (2)) the RL area are:

$$Y_{it}^0 = g_t(X_i) + \beta_{it}(X_i) * C_{it} + U_{it}^0 \quad (1)$$

$$Y_{it}^1 = g_t(X_i) + \beta_{it}(X_i) * C_{it} + \alpha_{it}(X_i) * RL_{it}^1 + U_{it}^1 \quad (2)$$

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

The different parameters of interest can be expressed as the follows. First is the direct effect of the RL program on the outcomes E_{RL} , and the E_{RL} can be written as:

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

Second, the crowding effect of the RL program on the preservation effort of the OC program E_C , which can be expressed as:

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

Third, the effect of time-invariant unobservable ϕ_i that is donated by E_ϕ :

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

Fourth, the effect of the exogenous parcel attributes X_i , E_X :

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

Last, the effect of local economic growth that is denoted by E_θ :

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

The left-hand side value of the equations (8)-(10) can be estimated from comparing the outcomes of the similar parcels within and outside the RL area at different time periods. The equations 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 sufficient to identify all the parameters. However, if we can eliminate the time effect E_θ by imposing the same time frame centered on the year when the RL program was introduced, the rest of the parameters can be identified. In this case, we rule out the time-varying factors, e.g. dramatic changes in the funding from other programs or local economic situation over time periods, which is supported by the evidence in table 2.¹³ By ruling out these factors, the parameter E_θ is cancelled out from equation (10), and (10) becomes

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

For a parcel within the RL area and a parcel outside the RL area that are observably identical, the following conditions hold. First, the pre-treatment outcome is not affected by the RL program (as the program did not exist) and the difference in pre-treatment outcome between the two parcels captures the effect of the OC program's predisposition to preserve parcels within the RL area. Second, the post-treatment outcome for the parcel outside the RL area is indirectly affected by the RL program through the potential crowding effect. Therefore, the difference between the

¹³ As shown in table 2, the 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 likely to be comparable for pre- and post- treatment periods.

post-treatment outcome for the parcel outside the RL area and pre-treatment outcome for the parcel within the RL area captures the crowding effect in addition to the predisposition effect. Third, their difference in post-treatment outcome captures the crowding effect, predisposition effect, and direct effect of the RL program. The three unknown effects, E_{RL} , E_C , and E_ϕ , can then be identified by the three equations (8), (9) and (11).

This strategy, however, is based on the assumption that the impact from local economic growth and the available budget of the OC program is eliminated completely. The presence of E_θ , however, 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. For example, if there is a dramatic increase in the OC program's preservation effort in post-treatment period in the entire community, we are more likely to find that the crowding-in effect dominates even if it actually does not, and the crowding-in effect would be overestimated if there is indeed a crowding-in effect.

Identification strategy two

Our data record whether a parcel is preserved by the RL program or the OC program and it is clear that the RL and OC programs do not provide matching funding in our study area. We thus can eliminate the direct effect of the RL program by excluding its preserved parcels. The equation (9) is now restricted to a sub-sample of parcels that are preserved by the OC program and becomes:

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

The equation (8) together with (12) identifies E_C and E_ϕ . Plugging E_C and E_ϕ into equation (9), we can solve for E_{RL} . This strategy does not need equation (10), which allows us to avoid the possible bias due to the time effect. However, it assumes that the crowding effect is from RL program to other conservation programs. In other words, it assumes that the RL program's preservation effort or funding allocation does not react to the operation or the available funding of the existing programs.

IV. Data sources and parcel attributes

To identify the crowding effect of the RL program on the existing conservation programs, we collected data on all parcels greater than three acres in the three Southern Maryland counties. We collected parcel level information, such as land preservations, the most recent property transactions, parcel characteristics and soil conditions, percentage of each land use, proximity of ecological values, and distance to major cities in the DC and Baltimore Metropolitans areas. We also collected the information on census demographics, and proximity of local economic situation at census block group level.

We acquired the boundary of the RL areas in 2004, its conservation easement acquisitions, conservation costs, and dates of acquisition from the Maryland Department of Natural Resources. Information on the land preservation and the acquisition dates for the parcels preserved by MALPF, TDR programs, and other private conservation programs were also collected. We collected data for MALPF parcels through 2005, for the Maryland Environmental Trust and county level Transfer of Development Rights programs through 2004, and for private conservation groups (Nature conservancy, private land trusts) through 2005. We also calculated the number of preserved acres within 1 mile of radius for each parcel.

The primary source of our parcel level data is the MDPropertyView 2002 Database (MDPVD) which developed by Maryland Department of Planning (MDP). This data provide information on parcel's most recent transactions and parcel level information. The parcel transaction information includes sales price (arm's-length or non arm's-length), assessment value for the land and any structures, the most recent market transaction dates. The parcel attributes are also provided in this data which include parcel size in acreage, general zoning code, waterfront access, public sewer availability, housing construction, subdivision designation, geographic coordinates, and a unique account number for each parcel. The MDPVD Database is created by the MDP and is updated annually by the agency as a series of county-level files. The 2002 data include the transactions up to October 2003. The parcels are spatially referenced, which allow us to link them to other state and federal spatially referenced data sets.

We extracted parcel level land use, soil, and other characteristics from the digitized maps provided by the MDP. These maps, however, do not contain parcel boundary. We therefore

created buffer parcels to serve as proxies for the true parcel boundaries and to extract these data.¹⁴ The created buffer parcels were intersected with the spatially referenced data to extract land use, soil, and other characteristics for the parcels in our study areas.

We extracted land use information for the year of 1973, 1997 and 2002. Our land use categories include 1) low-density residential, high-density residential, and urban open space for our parcels in urban areas, 2) cropland, pasture, feed production and storage, and forest for agricultural and forest land, 3) water, 4) wetland, and 5) barren land. Some of the categories were aggregated from the original detailed land use categories from the MDP and the percentage of each category was calculated for each parcel.¹⁵

Soil data are from the MDP's 1973 work to classify and map all Maryland soils. This work is completed in conjunction with the U.S. Department of Agriculture Soil Conservation Service. We grouped soil by productivity, erosion potential, permeability, stoniness and rockiness, depth to bedrock, depth to water table, slope, stability, and susceptibility to flooding.¹⁶ Our categories define soil slope, soil erodibility, permeability, runoff potential and floodplain soils, which are most significant for land use planning purposes in this research.

We also computed the percentage of Maryland's Sensitive Species Project Review Areas and Non-tidal Wetlands of Special State Concern (Department of the Environment and DNR 1998) for each parcel to proxy for the ecological values. These areas include rare, threatened, and endangered species and rare natural community types (Maryland DNR 2003). Besides, we also

¹⁴ 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: $\text{radius} = [(\text{acres} * 4046.87) / 3.1416]^{1/2}$. With the radius and the parcel centroid for each land parcel, the Buffer Selected Feature command in ArcView creates noncontiguous circular buffer parcels.

¹⁵ Specifically, we aggregated the original medium-density and high-density residential to our high-density residential land; crop, orchard/vineyard, and other crop into crop category; feeding operations/agricultural buildings, feeding operations, and agricultural buildings, storage into feed production and storage; deciduous forest, evergreen forest, mixed forest, and brush into forest category; extractive, beaches, bare rock, and bare ground as barren land.

¹⁶ we grouped depth to bed rock as high if the depth to bed rock is larger than 72 inches, moderate if 20-40 inches, as low if smaller than 20 inches. We grouped the slope as high if it is larger than 15%, moderate if between 8-15%, low if between 1-8%. We also grouped erodibility, permeability, and runoff into the levels of very low, low, moderate, high or very high. We calculated the percentage of soil being in different categories for each parcel.

calculated the percentage of a parcel in estuarine wetland status from the Maryland Wetland Map (Maryland DNR 1998) as another approximation for ecological and amenity value.

Our census demographics and social economic variables were collected from the US Census Bureau for 1990 and 2000 at block group level. Our parcel GIS data were overlaid with the census block boundaries to extract the census information for each parcel. We also calculated the distance of the parcels to Washington, D.C., Baltimore, and other major cities in miles using U.S. Census Bureau road networks.

Table 4 reports the mean preservation rate and acres for the RL and OC areas. Overall, parcels are more likely to be preserved and more acres are preserved in post-treatment period in both the RL and OC areas. However, more acres and a larger proportion of parcels are preserved within the RL areas than outside the RL areas in both pre- and post-treatment periods. The OC programs have preserved 2.48 more acres and 4.6 more percentage points within the RL areas than outside the RL areas in pre-treatment period. After the RL program was introduced, the differences in preservation rate and preserved acres are even larger: the difference in acreage 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 the RL areas still have a highly chance of being preserved than the parcels outside the RL area; the rate increase by 13.4 percentage points and the acres by 5.33.

V. Empirical Approach and Estimations

Va. Propensity score matching method: the violation of Stable Unit Treatment Value Assumption (SUTVA) and multiple causal effects

The matching method (also randomized experiment) implicitly uses the assumption of "no interference between units" (Cox, 1958, p19) or the Stable Unit Treatment Value Assumption (SUTVA) named by Rubin (1986). This assumption requires 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 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 the matching method is the direct impact of a treatment only if this assumption holds. However, this assumption might be invalidated if individuals interact with 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 the ATT. Rather, it is the 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 the 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 an individual affects any other individual's outcome as 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 interactions 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 of all the others' treatment assignment. The scalar function takes two values: 1 if a large proportion of kindergartners are retained and 0 if not. Therefore, the number of causal effects in their study is reduced to a manageable level.¹⁷

¹⁷ 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 the problems of causal inference".

In the case of the RL program, the violation of SUTVA in “conventional” way is that RL areas’ 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 the OC program’s preservation effort in or out of the RL areas, the number of causal effects is therefore reduced to two: the crowding effect of the RL program on the OC program, and the direct effect of the RL program. The crowding effect is the indirect effect of the RL program 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 the effects.

Vb. Propensity score estimation and matching methods

Our 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 the RL areas and the pre-treatment outcomes. We specify the Logit model to provide the best prediction of a RL area designation. These parcel-level variables include proxies for ecological, agricultural, and forestry values, and development pressure.

Specifically, 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 the RL areas. Soil quality indicators such as distance to bed rock, permeability, and erodibility are also included as the RL program values those attributes. Table 5 reports the estimated coefficients for predicting a parcel’s inclusion in a RL area.

Figure 1 is the distribution of the estimated propensity scores for parcels within and outside the RL areas. The figure indicates that their distributions are not very compatible, with the parcels outside the RL areas 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 in the sense that they return the smallest mean squared errors. We thus adopt the two matching protocols in our analysis.

Vc. Empirical results

We restrict the matching analysis to parcels greater than 10 acres since these are the ones most likely to be preserved. We match the parcels within the RL areas with the parcels outside the RL areas with the similar propensity scores, and then use the matched parcels outside the RL areas to construct counterfactuals for the parcels within the RL areas. The differences between the two matched groups in the pre-treatment and/or post-treatment outcomes are the estimates of the right-hand side values for the equations (8) -(12).

After matching, we conduct a balancing test to check whether our matched parcels within and outside the RL areas are observably the same on the covariates. A standardized T-test is employed to check whether the means of the conditional variables are statistically the same between the matched parcels. Our balancing test results indicate that our matched parcels within the RL areas are similar at the 5% level to their matched counterparts outside the RL areas for most conditional variables, except the variable of permeability and erodibility. The parcels within the RL areas tend to have high permeability and low erodibility level than their matched counterparts. Theoretically, parcels with higher permeability and lower erodibility levels would be more likely to be developed rather than preserved. The failure of the balancing test of the two variables could induce a downward bias in the estimated predisposition effect but might have little impact on our estimated crowding effect and the direct impact of the RL program as the downward bias might be cancelled in our equation manipulations.

For strategy one, we use all parcels in our data, including the parcels being preserved by the RL program. First, we compare the outcomes in the pre-treatment period between the matched parcels within and outside the RL areas for the equation (8). Second, we compare the outcomes in the post-treatment period between the matched groups for equation (9). Thirdly, we compare the post-treatment outcome of the matched parcels outside the RL areas with the pre-treatment outcome of the parcels within the RL area for the equation (11).

For strategy two, we exclude the parcels that are preserved by the RL program from our analysis. The estimations of the equation (8) and (9) are the same as that from the first and second steps for strategy one. We then exclude the parcels that are preserved by the RL program and compare the post-treatment outcome between the matched parcels within and outside the RL areas for the equation (12).

Estimation results for crowding effect, E_C , predisposition effect, E_ϕ , and finally the direct effect of the RL program, E_{RL} , are presented in Table 6 for identification strategy one and in Table 7 for strategy two. From identification strategy one, the estimated right-hand side values for the equation (8) and (9) are all significant at 5% level. The estimated value is significant at 5% level only for the likelihood of preservation for equation (11). However, the estimations from all matching protocols are significant at 5% level for equation (12). The estimations 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 within and outside the RL areas. Such difference attracts the OC programs to exert more preservation efforts within the RL areas before the RL program was introduced. The identification strategy two finds a crowding-in effect in terms of both the likelihood of preservation and the preserved acres. Strategy one finds a crowding-in effect in the likelihood of preservation and a crowding-out effect in the acres preserved. This mixed estimation results from strategy one may be due to unintended time effect.

The crowded-in preservation efforts increase the preservation probability in the RL areas by 0.7-1.0 percentage points, and the preserved acres by 0.2-0.23 per parcel. Hence, the funds from the RL program further stimulate the preservation activities within the RL areas and increase the likelihood of preservation by 10% and acres preserved by about 2-3% within the RL areas.

Vd. Robustness check-the impact of the RL designation on land value

As a robustness check, we study the impact of the RL designation on the market value of residential and undeveloped land.¹⁸ This section serves as a test on whether the RL designation affects the market value of land and therefore, landowners' willingness-to-accept of the 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 values for the parcels within and outside the RL areas and sold before and after 1997 is presented in Table 8 and the matching results are in Table 9. The mean sales price per acre are similar for parcels within and outside the RL areas before or after 1997, with parcels within the RL areas being sold at a price \$538 higher than parcels outside the RL areas before 1997, and \$2500 after 1997. We conduct matching over parcels sold before and after 1997 respectively. For the parcels that are observably the same, the parcels within RL areas are sold at an prices that are \$500-610 lower than the ones outside the RL areas before the introduction of the RL program. After the RL program was introduced, the price gap becomes larger and reaches \$1,000. The matching results show that RL designation may reduce land value slightly. However, none of the estimated impacts are statistically significant, which indicates that the parcels within the RL areas are equally valuable as the parcels outside the RL areas. The RL designation has no statistically significant impact on the market value of land. It therefore implies that RL designation have little impact on the WTA of landowners.

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

¹⁸ 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.

values overall. Therefore, our estimations of the crowding effect and the impact of the RL program on land preservation appear robust.

VI. 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 effort of the existing preservation programs.

Using parcel level data in Southern Maryland and a propensity score matching method, we elicit the impact the RL program on the preservation efforts of the existing conservation programs. We propose our identification strategies based on the reasonable assumptions on the multiple casual effects from the RL program and the detailed information on parcel preservation status for each program in each year.

After carefully controlling for the factors that affect the RL area designation and the likelihood of preservation, we find that a crowding-in effect exists and dominates the potential crowding-out effect. Our empirical results imply that the designated RL areas attract more preservation efforts from other conservation programs. Such crowding-in effect increases the likelihood of preservation by around 0.1 percentage point, which is a 10% increase in the preservation rate of 8% within the RL areas in our sample. The crowding-in effect, however, appears to have a smaller impact on the acres preserved. It only increases the preserved acres by 0.2 which is only 2-3% of the average preserved acreage within the RL areas.

Our empirical analysis on the market value of land in the RL areas finds no statistically significant impact of the RL designation on the market value of land. Our result suggests that the RL program has not changed the willingness-to-accept of landowners for preserving their land due to the change in land market value. We conclude that the crowding-in effect is due to the economies of scale or the value of contiguity.

While we find that the RL program attracts more preservation effort in its designated areas, it is not clear yet whether the net crowding-in effect reduces or induces more 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, the 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 of unprotected lands. Thus, as a next step, we plan a study examining the impact of RL program on landowners' asking price for land preservation and land conversion. The crowding-in effect could slow down land conversion in RL areas and strengthen the effect of the RL program on land conversion.

Reference

- [1]. Albers H., A. Ando, and M. Batz, (2008), “Patterns of Multi-Agent land Conservation: Crowding in/out, Agglomeration, and Policy”. *Resource and Energy Economics*, 30(2008):492-508.
- [2]. Albers H., A. Ando, and X. Chen (2008), “Spatial-econometric Analysis of Attraction and Repulsion of Private Conservation by Public Reserves”. *Journal of Environmental Economics and Management* 56(2008):33-49.
- [3]. Bureau of Labor Statistics (2003). Consumer Price Index. All Urban Consumers. U.S. Department of Labor. <http://data.bls.gov>.
- [4]. Cox, D. R. (1958). *Planning of Experiments*. New York, Wiley.
- [5]. Frölich, M. (2003). *Programme Evaluation and Treatment Choice*. Springer ISBN:3540443282
- [6]. Geoghegan, J., L. Lynch, and S. Bucholtz (2003). “Capitalization of Open Spaces: Can Agricultural Easements Pay for Themselves?” *Agricultural and Resource Economic Review* 32(1):33-45.
- [7]. Halloran, M. E., and Struchiner, C. J. (1995). “Causal Inference in Infectious Diseases” *Epidemiology*, 6, 142.151.
- [8]. Heckman, J., L. Lochner, and C. Taber (1998). “General Equilibrium Treatment Effects: A Study of Tuition Policy” *The American Economic Review* (Papers and Proceedings), 88, 381.386.
- [9]. Hong, G., and S. Raudenbush (2006). “Evaluating Kindergarten Retention Policy: a Case Study of Causal Inference for Observational Data.” *Journal of the American Statistical Association*, 88, 221-228.
- [10]. Irwin, E. G. (2002). “The Effects of Open Space on Residential Property Values”. *Land Economics* 78 (4): 465-480.
- [11]. Lynch, L. and W. N. Musser (2001). “A Relative Efficiency Analysis of Farmland Preservation Programs”. *Land Economics* 77(4): 577-94.
- [12]. Maryland Agricultural Land Preservation Foundation (MALPF Task Force) (2001). Report of the Maryland Agricultural Land Preservation Task Force. <http://www.mdp.state.md.us/planning/MALPP/FINAL2.pdf>.

- [13]. Maryland Department of State Planning (1973). Natural Soil Groups Technical Report: Maryland Department of State Planning Publication No. 199.
- [14]. Maryland Department of Natural Resources (DNR) (2003). Sensitive Species Project Review Areas, 2003.
- [15]. Maryland Department of the Environment & Maryland Department of Natural Resources, Wildlife and Heritage Division (1998). Nontidal Wetlands of Special State Concern (WSSC). Maryland Department of Natural Resources, Annapolis, Maryland.
- [16]. Maryland Department of Natural Resources (1998). Maryland Wetland Map
- [17]. Hong, G., and S. Raudenbush (2006). "Evaluating Kindergarten Retention Policy: a Case Study of Causal Inference for Observational Data". *Journal of the American Statistical Association*, 88, 221-228.
- [18]. Nickerson, C. J., and D. Hellerstein (2003). "Protecting Rural Amenities through Farmland Preservation Programs". *Agricultural and Resource Economics Review* 32(1), 129-144.
- [19]. Parker, D. and W. Thurman (2008). "Crowding out Open Space: the Effect of Federal Land Programs on Private Land Trust Conservation". University of California, Santa Barbara. Working paper.
- [20]. Roe, B., E. G. Irwin, and H. A. Morrow-Jones (2004). "The Effect of Farmland, Farmland Preservation, and Other Neighborhood Amenities on Housing Values and Residential Growth". *Land Economics* 80 (1): 55-75.
- [21]. Rubin, D. B. (1986). "Comment: Which ifs have Causal Answers". *Journal of the American Statistical Association*, 81(396): 961-962.
- [22]. Sobel, M. E. (2006). "What Do Randomized Studies of Housing Mobility Demonstrate? Causal Inference in the Face of Interference". *Journal of the American Statistical Association*, vol. 101 (476): 1398-1407.
- [23]. Towe, C., C. Nickerson, and N. Bockstael (2008). "An Empirical Examination of the Timing of Land Conversions in the Presence of Farmland Preservation Programs" *American Journal of Agricultural Economics*, forthcoming.

Table 1: Available grants for the Rural Legacy Areas in Southern Maryland counties: Calvert, Charles, and St. Mary's Counties by year and funds were made available

	Calvert County Calvert Creeks RL area		Charles County Zekiah Watershed RL area		St. Mary's County Huntersville RL area	
RL approved in RL expanded in	1998 for 20,527 acres		1998 for 15,000 acres 2001 for 16,000 acres		1998 for 5,000 acres 2005 for 3,357 acres	
	RL grants (\$)	Acres enrolled	RL grants (\$)	Acres enrolled	RL grants (\$)	Acres enrolled
1998			1,500,000			
1999	2,000,000		500,000		1,500,000	
2000	1,800,000	348	1,000,000	559	800,000	1,538
2001		615	1,500,000	259	3,700,000	
2002		401	1,000,000	367		
2003	1,500,000		1,000,000	417		
2004	600,000		202,218	136		1,183
2005		297		93		
2006			750,000	175	300,000	
2007			3,000,000			
2008	750,000		500,000			
Total to date	6,650,000	1,660	10,202,218	2,007	6,300,000	2,720

Note that the information on geographic distribution of RL grants in FY1998 are not identified, although we know that there are total \$10.8 million was allocated to the newly designated RL areas including all three. The funds for Zekiah Watershed RL area is from county RL program documentation. The state canceled and reverted encumbrances on projects previously approved but funds not spent by the sponsor in FY2002. The available funds for Zekiah Watershed RL area is from the reverted funds.

Source: Available funds are from Maryland Board of Public Work –after meeting agenda summary (1998-2008), and Acres enrolled up to 2005 are calculated from our data acquired from the Maryland Department of Natural Resources.

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

Fiscal Year	MALPF				RL Program			
	Annual Net new MALPF acreage	Annual new funding for easement acquisitions (\$)	Per acre acquisition costs(\$)	Per acre accepted asking price(\$)	Annual net new RL acreage	Annual actual spending on acquisition (\$)	Per acre acquisition costs(\$)	Annual new funding for easement acquisition(\$)
1992	-29	0						
1993	8,341	11,472,760	1016*	1213*				
1994	6,783	11,000,311	1617	1918				
1995	7,851	11,120,874	1384	1633				
1996	6,552	10,109,481	1537	1697				
1997	11,797	16,324,722	1382	1470				
1998	12,460	20,378,116	1634	1688	376	400,000	1,064	10,800,000
1999	14,241	23,109,183	1619	1650	812	2,274,071	2,802	25,000,000
2000	18,781	32,609,436	1683	1818	10,831	27,487,510	2,538	28,000,000
2001	12,966	25,246,645	1944	2223	14,268	36,678,263	2,571	29,600,000
2002	19,283	37,582,057	1958	2676	11,940	31,068,632	2,602	
2003	15,307	33,687,626	2199	2400	5,231	14,035,464	2,683	5,700,000
2004	2,448	7,315,417	2982	3779	6,060	12,404,772	2,047	8,027,218
2005	6,687	22,246,850	2802	3189	1,834	8,196,670	4,470	2,907,591
2006	8,628	39,443,428	4492	5475	1,741	5,673,703	3,259	14,021,705
2007	15,161	90,980,431	5952	8010				26,050,000
Total	265,691	490,980,431			53,092	138,219,085		150,106,514

* Value is for 1977-1993

Source: The information for MALPF is from Maryland Agricultural Land Preservation Foundation five year annual reports, Fiscal Year 2003-2007, and for RL program are from Maryland Broad of Public Work.

Table 3: Preserved acreage within and outside RL areas by conservation programs

	1978-2005	1989-2005
MALPF		
Total acres preserved	17,312	9,823
before 1997	10,154	2,664
after 1997	7,158	7,158
in RL area	2,665	673
in RL area before 1997	2,132	140
in RL area after 1997	533	533
% acres in RL area to total acres before 1997	0.21	0.05
% acres in RL area to total acres after 1997	0.07	0.07
TDR		
Total acres preserved	15,186	11,547
before 1997	8,710	5,084
after 1997	6,476	6,463
in RL area	6,418	4,174
in RL area before 1997	4,467	2,236
in RL area after 1997	1,951	1,938
% acres in RL area to total acres before 1997	0.51	0.44
% acres in RL area to total acres after 1997	0.30	0.30
MET		
Total acres preserved	15,538	12,009
before 1997	5,900	2,370
after 1997	9,639	9,639
in RL area	3,359	2,094
in RL area before 1997	1,715	450
in RL area after 1997	1,644	1,644
% acres in RL area to total acres before 1997	0.29	0.19
% acres in RL area to total acres after 1997	0.17	0.17
Private conservation program		
Total acres preserved	7,629	1,093
before 1997	1,289	769
after 1997	6,340	324
in RL area	3,308	751
in RL area before 1997	1,026	506
in RL area after 1997	2,282	244
% acres in RL area to total acres before 1997	0.80	0.66
% acres in RL area to total acres after 1997	0.36	0.75
Total acres preserved in RL area by RL program		6,521
All existing conservation programs		
Total acres preserved in RL area	15,750	7,692
in RL area before 1997	9,340	3,333
in RL area after 1997	6,410	4,359
% acres in RL area to total acres before 1997	0.59	0.43
% acres in RL area to total acres after 1997	0.41	0.57

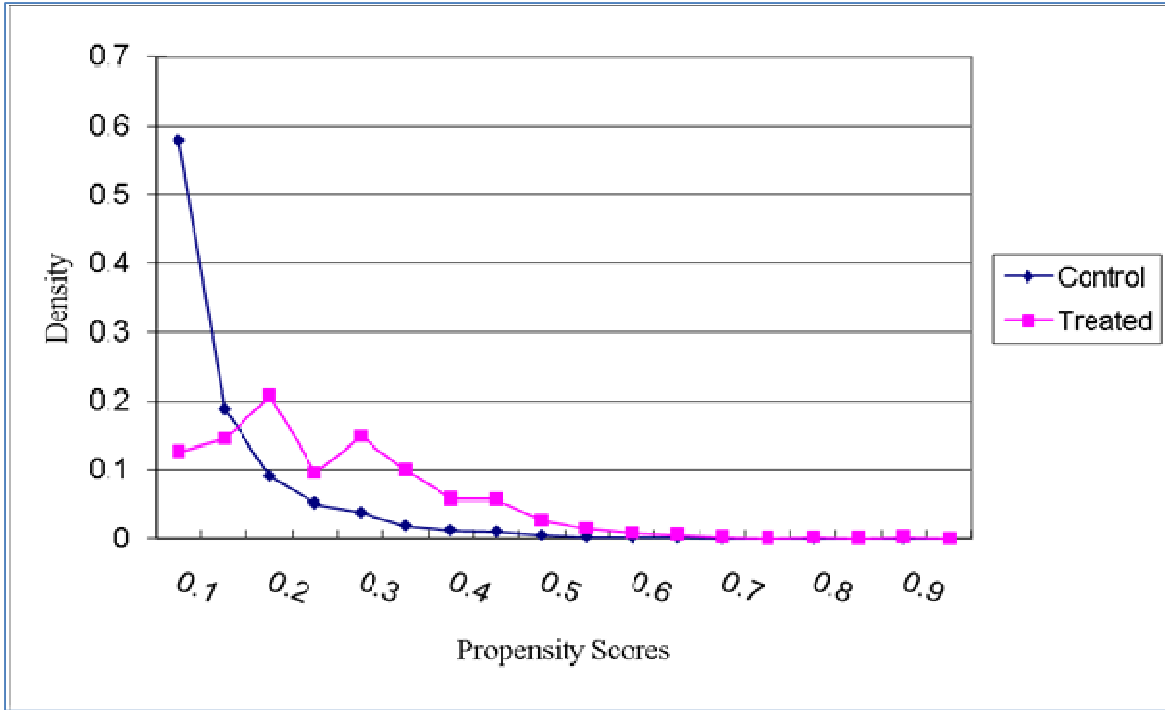


Figure 1: Distribution of the estimated propensity scores

Table 4: Rate of preservation and acres preserved in RL and OC areas before and after 1997

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

Note: Standard deviation is in the parenthesis

Table 5. Estimated Coefficients for the Propensity Score Logistic Regression

Dependent Variable	Log likelihood = -5927.4692	
Independent Variables	Estimated Coef.	Std Err.
Pseudo R2 = 0.1779		
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 erodibility 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 6: 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_ϕ									
# 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 OC									
(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 7: 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_ϕ									
# 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 parcels within and outside the areas and sold before and after 1997

		Parcels within RL areas	Parcels outside RL areas
pre-1997			
	land value per acre	16,258 (18,358)	15,720 (17,238)
	# of parcels	545	5866
post-1997			
	land value per acre	23,622 (18,016)	21,122 (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 the 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 (1,116)	-535 (1,112)
# matched RL parcels	545	545
# matched Non-RL parcels	5,857	5,855
Post-1997		
ATT	-1,058 (1,424)	-1,130 (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 the unobservables.
- 2) The standard errors of the estimated impacts are in parenthesis.