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Farmland Preservation and Residential Density: Can Development Rights Markets Affect Land Use?

Virginia McConnell, Elizabeth Kopits, and Margaret Walls

This paper examines transferable development rights (TDRs) policies as a way to preserve farmland and change the density of development. Characteristics of TDR markets are described, including why they might promote efficiency, and the difficulties that arise in implementing them. Evidence from an established TDR program in Calvert County, Maryland, is used to assess the potential for TDRs to influence subdivision density, and to achieve local land preservation goals. The Calvert program has succeeded in creating an active and stable TDR market, and has therefore preserved a large amount of farmland in the region. But we find that the demand for additional density permitted with TDRs occurs mostly in rural areas and not in the higher density town centers and residential areas.

Key Words: land preservation, development, markets, density

Preservation of agricultural lands is a goal of many communities on the urban fringe, but most feel they are losing the battle against development forces. Many areas are losing increasing amounts of farmland to development each year, with high rates of housing growth and large lot sizes. Increased preservation in some locations combined with higher density development in others is an outcome that has appeal to many community planners. This paper examines a market approach to try to achieve these twin goals—the use of transferable development rights (TDRs) for preserving farmland.

The economics literature provides several possible arguments for why private land markets may under-provide farm and forested areas. These areas may provide public benefits in the form of scenic views, open space, ecological habitat, and rural character that private landowners do not fully internalize (Thorsnes and Simon 1999, Heimlich and Anderson 2001). On the other side, the negative environmental effects associated with some forms of development, especially low density development, such as congestion and infrastructure costs, may also not be fully taken into account by private markets (Brueckner 2000, Glaeser and Kahn 2004). We do not address in this paper whether and how much land preservation or development is optimal. Instead, we take the community goals as given, and examine the effectiveness of one type of program, TDRs, for influencing land use in the intended directions.

TDR programs can be applied in a number of different ways, but the basic principle is that landowners in certain regions are allowed to sell the development rights for their land to buyers who use them to increase density in other areas. Sellers give up permanent rights over development rights on their properties, and buyers use the rights to develop other properties more intensively than what is permitted by baseline zoning.

The devil, of course, is in the details of establishing these markets and making them work. One of the biggest problems in many programs lies on the demand side of the market—although farmers are often willing to sell their rights, especially if the zoning on their land is relatively restrictive, there is oftentimes not enough demand for addi-

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tional density in TDR receiving areas. In this paper, we explore this issue empirically using a unique dataset from a county that has had a long-running TDR program—Calvert County, Maryland.

We begin by discussing TDR programs in general, highlighting their strengths and weaknesses. Then Calvert's approach to designing the TDR market is described. Finally, we use detailed data on all residential subdivisions recorded in the county over the period 1967–2001 to estimate an econometric model of subdivision density and pay particular attention to how the TDR program has worked to affect density in the county.

The Calvert program has succeeded in preserving a large amount of farmland and in creating an active and stable TDR market. But we find that the demand for additional density permitted with TDRs occurs mostly in rural areas in this urban fringe county and not in the higher-density town center and residential areas. These results provide important lessons for other jurisdictions in how to design and implement TDR programs.

TDR Markets

In theoretical analyses of TDR markets, jurisdictions have a goal of a maximum amount of overall residential development. The TDR market then allows landowners to trade those permits with each other (Mills 1980, 1989; Thorsnes and Simon 1999). If landowners have different opportunity costs of not developing their land, some will end up selling development rights, while others will purchase rights and build at a higher density than is permitted with their initial allocation. By giving individual landowners the flexibility of going over or under their initial allocation while maintaining a cap on the overall number of rights, land parcels with different relative values in development are allocated to their most efficient uses.

In practice, the development rights sold in TDR markets are granted through zoning regulations. The essential element underlying existing land use patterns of developed and farmed parcels is the zoning rules in place, which usually establish the minimum average lot size.[1] Zoning has a long history and was initially designed to separate land uses in order to prevent negative spillovers among uses. Over the years most jurisdictions have extended the use of zoning to include not only separation of commercial and industrial activities from residential uses but also separation of different types of residential uses. Large lot zoning for residential development is often used now to limit growth in a jurisdiction. Many outer suburbs have zoning of 3–5 acres or more as minimums for each house. Zoning has been used more recently to try to separate farming uses from residential uses. Some areas have implemented very low density zoning, such as 1 lot in 25 or even 50 acres, as a way to prevent development of farmland.

TDR programs must be overlaid on existing zoning rules. The areas that are targeted for preservation (so-called "sending areas") have been conferred a certain number of lots through the underlying zoning, and these rights to develop can be transferred through the TDR market. Sometimes these areas are downzoned to low density, but rights can be sold from the property on the basis of the original, more dense zoning. In the so-called TDR "receiving areas," additional density above that allowable under zoning rules can essentially be purchased through the use of TDRs.

One argument made in favor of TDR programs is that they can mitigate inefficiencies that arise from traditional zoning policies. Mills (1989) argues that, although zoning rules and zoning differences across regions may improve efficiency and enhance land values in some cases, often those gains are lost as a result of rent-seeking behavior by landowners. Zoning increases rents for owners of those parcels that allow more dense development, creating incentives for landowners to spend resources to obtain zoning associated with the highest valued land uses. TDR markets can mitigate this behavior, especially if it is clear to developers that TDRs are the only way to increase density.

Finally, there are the distributional issues associated with TDRs. TDR policies have the political advantage of relying on private markets to achieve land use goals. No new expenditure of public monies is necessary except that needed to run the program. Many federal, state, and local dollars are being spent on programs to purchase agricultural easements outright for land preservation, but these dollars often fall well short of the amount needed to achieve community farmland preservation goals. TDRs are effectively a tax on new development for the preservation of land, and thus have great appeal to existing residents. TDRs are also often more politically acceptable than strict downzonings that do not compensate landowners for lost development potential.

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[1] Residential zoning limits are sometimes specified in terms of an absolute minimum lot size, i.e., no lot can be smaller than 1 acre. More often they are a minimum lot size averaged across the entire subdivision parcel. In the application analyzed below, Calvert County uses average minimum lot size zoning.

There are a number of issues that arise in the design and implementation of TDRs, however. The costs of preservation may be inefficiently high because some of those landowners who opt to maintain their land in an undeveloped state by selling TDRs may not have developed their properties anyway. For any number of reasons—including personal or family considerations, or the possibility that their land has relatively low value in development—they may prefer to continue farming, forestry, or other related activities rather than sell to a developer (Lynch and Lovell 2003). Programs usually allow entry into the program for all properties that meet a fairly broadly defined set of criteria. This leads to a type of adverse selection problem that has been identified in other voluntary environmental programs, most recently in the SO_2 trading program (Ellerman et al. 2000).

This adverse selection problem can also lead to *more* development than would occur under a straight zoning policy. The TDRs that landowners sell are used to build more houses elsewhere, so if properties that would not have been developed anyway are now selling TDRs, more development is occurring than would have in the absence of the TDR program (Levinson 1997).

Another issue is that efficiency in the TDR market requires TDRs to be traded at a single competitive price, resulting from the interactions of a large number of buyers and sellers. However, if one side of the market has some monopoly power, too few permits will be traded (Hahn 1984). For example, if there are relatively few developers and they have access to information about a large number of potential sellers of TDRs (farmers), then those developers may have some monopsony buying power. Field and Conrad (1975) argue that this can occur in many TDR programs, because developers are likely to be small in number and well organized relative to private property owners.

One of the biggest problems for TDRs in practice seems to be insufficient demand. This is because many local planners and other groups want additional density in receiving areas under TDRs to be put in urbanized areas that have infrastructure to accommodate higher density development. In many of these areas, however, the demand for density does not appear to be there. The development that does occur is in outlying areas, without the use of TDRs.

In the next section we examine the workings of a long-running, active, and stable TDR program. Land has been preserved, numerous transactions occur each year, and market prices have stabilized over time. We focus on the effect that the introduction of the TDR program and subsequent program changes have had on residential density in the different areas. The program is unique in that it allows a good deal of choice on the part of the farmers and developers about participation in the program.

Assessment of a TDR Program: Calvert County, Maryland

Calvert County is located in southern Maryland on the western shore of the Chesapeake Bay, approximately 35 miles outside of both the Washington, D.C., and Baltimore metropolitan areas. The county has historically been rural with a strong agricultural economy, but over the past 25 years has seen rapid development and sharp declines in farmland acreage. There are eight towns in addition to large areas of low-density residential rural regions. The western part of the county, particularly along the Patuxent River, has the best farmland in the county.

The Calvert TDR program, which began in 1978, focused on preserving farmland in order to maintain the rural character of the county. The program has been successful in the sense that there has been an active market over the years, with currently over 13,000 acres, or 10 percent, of the county permanently preserved under the program (McConnell, Kopits, and Walls 2003). The county's goal is to preserve another 8,000 acres through the TDR program and 40 percent of the county's land overall through the local and state programs combined (Calvert County Comprehensive Plan 2004). Figure 1 shows the number of TDRs sold each year.

In the Calvert TDR program, the regions targeted for preservation (TDR sending areas) include the designated agricultural area (DAA) zones, which primarily run along the western part of the county. Farmers in these areas can sell TDRs, but developers cannot purchase them for additional density. In all other rural areas of the county, property owners are allowed to either sell TDRs and preserve their land, or develop the land and use TDRs to increase density over baseline allowable levels. This feature of the program should lead to more efficient choices over which properties are developed and which are preserved, as described above. Developments in residential and town center areas are also allowed to purchase TDRs and develop above baseline zoning regulations. The zoning regions are summarized in Figure 2.

The baseline zoning in all rural areas has been relatively low density, and has been reduced twice in the last 30 years. In 1974 the whole county was downzoned from a maximum 1 house on 3 acres to 1 house on 5 acres. The residential areas have zoning that permits a maximum of 1 house per acre, and town centers allow 4 houses per acre. In 1999, due to concern over traffic and growth rates in the county, the entire county was downzoned again, by 50 percent everywhere.

As described above, since the early 1980s TDRs could be used to increase the density in either the rural areas outside of the DAAs or the residential areas (see Table 2 below for a summary of all of the zoning and TDR program changes, and Figure 2 for a map of the zoning regions). The ability of developers to use the development rights in a variety of regions allows an assessment of which areas have excess demand for higher density. This will be instructive for programs that are designating only certain areas to be receiving areas. If there is no demand for additional density in those areas, a TDR market will not develop.

Although the Calvert TDR market has not suffered from a lack of demand and has an active TDR market, it is subject to some of the other problems discussed above. There may be some adverse selection in which farms being offered as sending properties have particular characteristics. A substantial fraction of the farms that have sold TDRs are in the central and southern part of the county rather than the northern part. These are farms that, all else equal, have less value in development, so it is no surprise they are the properties that have been preserved. Some of these farms may not have been developed anyway. Hence, it is possible that more building occurred over the past two decades than would have resulted from the baseline zoning alone.

The TDR market started out with fairly low and variable prices, but prices have stabilized over time. Figure 3 shows the distribution of prices in each year of the program. The graph shows the maximum and minimum TDR price in each year, as well as the price range within which 50 percent of all private transactions occurred. Prices were lower and somewhat more variable in the early years of the program. There were actually few transactions during that period (see Figure 1), and the low prices observed are consistent with low-valued farms entering the program first, with their owners being paid just above the opportunity cost of keeping the land in farming. In the early years it was also difficult to find information about past sales. The county itself began to purchase and retire TDRs in the early 1990s and also initiated a newsletter providing information about the program, TDR prices, and past sales. In the following years, the number of transactions increased and prices began to stabilize.

Perhaps the most important aspect of the program is its effect on density in different parts of the county. We turn next to an empirical examination of that issue.

Empirical Analysis of the Calvert TDR Program on Subdivision Density

Specification

To examine how the TDR program affected density of development in the county, we develop a simple model of developer behavior. We assume that developers will build on any site available to them, and will build the number of lots that will maximize profits. Revenues from development of a site will depend on the number of lots, the size of the plat area, and the amenities at the site. Amenities include natural amenities such as the

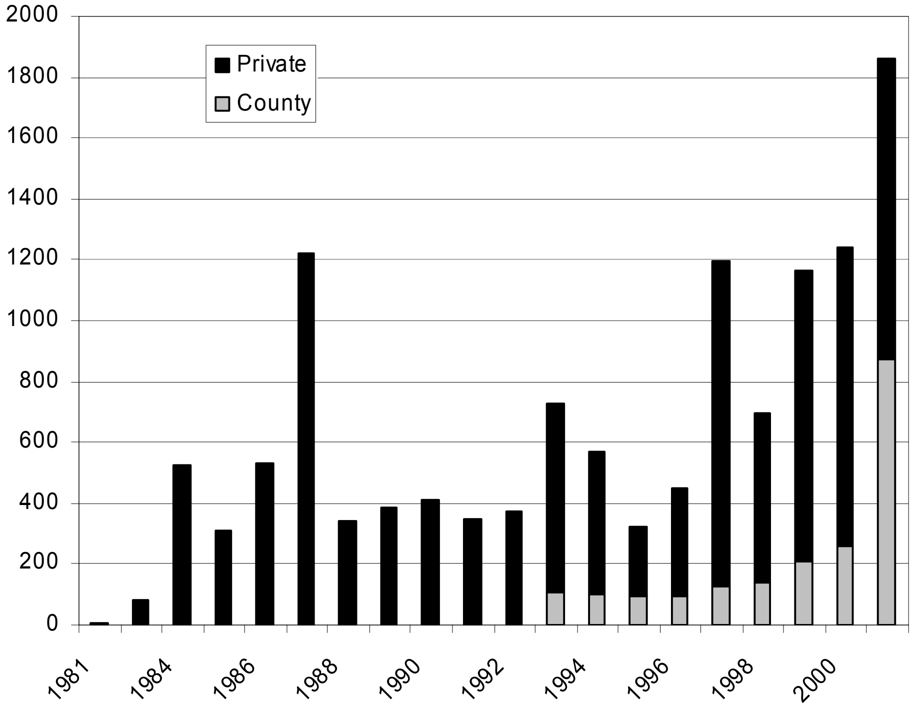

Figure 1. Number of TDRs Sold by Year, Calvert County TDR Program

topography of the land, and also the uses and types of properties immediately surrounding the site. Zoning, which pertains to the general region in which the property is located, can also affect the site's value if, for example, separation of land uses raises the value of a site for residential purposes (Fischel 1987). Finally, revenues will depend on location and accessibility variables since greater access to retail and employment centers should increase property values.

The developer's costs will also depend on the number of lots and the size of the plat area. Provision of infrastructure at the site affects costs and will depend on the zoning at the site and the soil and topography characteristics of the land.[2] Cannaday and Colwell (1990) show that even the shape of the parcel to be subdivided can affect the development costs. Finally, in the designated TDR receiving areas, developers will incur a cost for the development rights they purchase, t_i, at a price determined in the market for TDRs, P_{TDR}.[3]

We derive a log-linear reduced form equation for the profit-maximizing number of lots as a function of all of the exogenous variables. We specify the optimal number of lots in subdivision i as

$$(1)\quad \ln(l_i)^* = a + B_1 \ln L_i + B_2 n_i + B_3 u_i + B_4 d_i + B_5 s_i + B_6 z_i + B_7 p_{TDR} + e_i \ ,$$

where L_i = subdivision size, in acres,
n_i = vector of subdivision's natural amenities,
u_i = vector of neighboring land uses at the time subdivision is built,
d_i = vector of accessibility variables,
s_i = vector of soil and topography characteristics,
z_i = zoning variables, and
p_{TDR} = average TDR price,

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[2] For example, areas zoned for residential development may require sewers, whereas areas zoned rural are more likely to use septic systems.

[3] Here we assume that only one TDR is needed to create one additional lot.

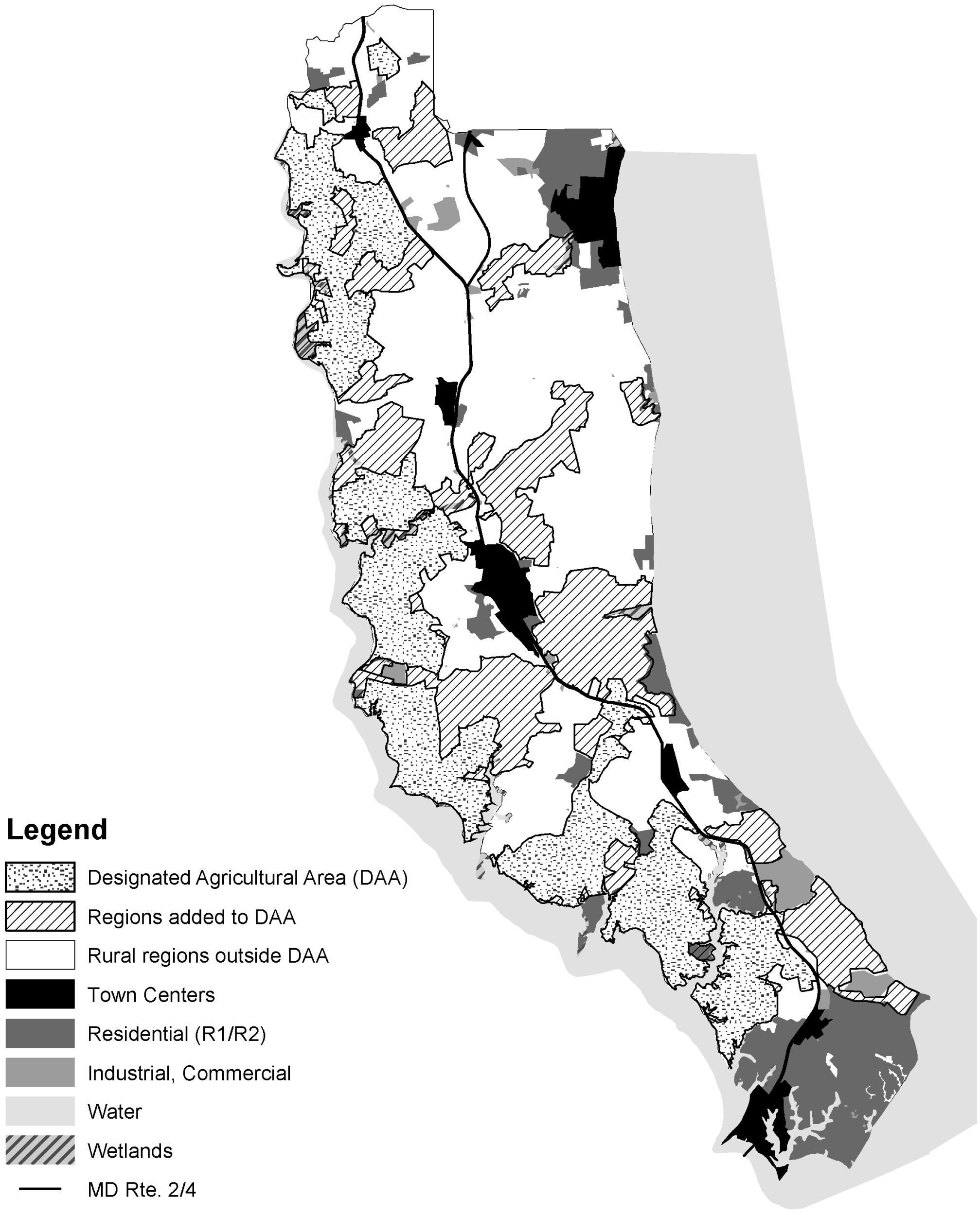
Legend
Designated Agricultural Area (DAA)
Regions added to DAA
Rural regions outside DAA
Town Centers
Residential (R1/R2)
Industrial, Commercial
Water
Wetlands
MD Rte. 2/4

Figure 2. Zoning Map, Calvert County, Maryland

and estimate equation (1) by OLS, using data on all major subdivisions recorded in Calvert County over 1967–2001.[4]

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[4] We test for spatial autocorrelation in this model using a weighting matrix in which we assign positive and equal weight to adjacent subdivision 'neighbors'. Using the Moran I test, we cannot reject, at the 95 percent confidence level, the null hypothesis that no spatial correlation exists; the test statistic is 1.279 and 1.035 for the row-normalized and non row-normalized weighting specifications, respectively. (Lagrange multiplier and robust Lagrange multiplier tests for spatial error dependence and a spatial lag could not be rejected either.)

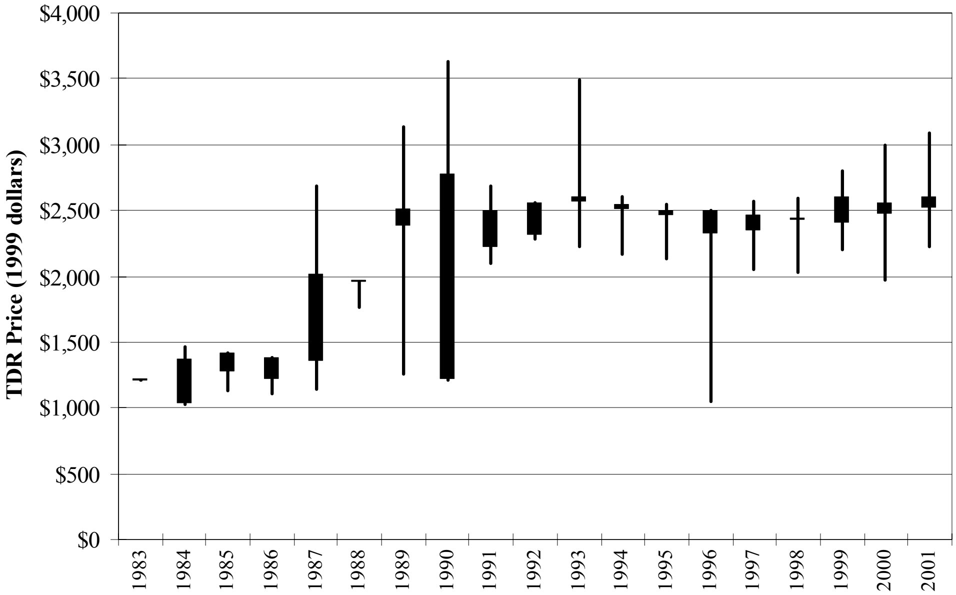

Figure 3. TDR Price Distribution, Calvert County TDR Program

It is important to note that we are treating the zoning variables as exogenous in this model. It has been argued in the literature that local zoning is endogenous in estimates of density functions (Rolleston 1987, McMillen and McDonald 1991). In our analysis, the initial zoning designations of, for example, residential and town center, capture separation in land uses. We focus on the changes in rules brought about by the introduction of the TDR market and also the downzoning of the rural areas. Decisions over zoning related to the TDR market had to do with soils and other characteristics of the properties, and can be considered exogenous to developer decisions. The downzoning was county-wide and was done to limit overall growth, and can also be treated as exogenous.[5]

Data

Table 1 summarizes many of the characteristics of the subdivisions in the sample. The sample consists of 398 subdivisions built over the 1967–2001 period, with the average subdivision built in year 1986. The size of the subdivisions varies from 4 acres to almost 600 acres; average size is 71 acres. The average number of lots per subdivision is 27, but varies from 3 to 268. Some subdivisions are surrounded by between 40 and 50 percent preserved land, while others are adjacent to no open space; some are completely surrounded by other development, some by no other development.[6] The average subdivision lies approximately 12 miles from the northern border of the county and about 1.5 miles from Route 2/4, the main commuting highway in the county. Most of the region relies on septic systems because the sewer system is not extensive. In our sample, only 2.3 percent of subdivisions have sewer available. In addition, the average subdivision in our sample has steep slopes (at a grade of 15 percent or higher) in 37 percent of its land area, and soils

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[5] Unlike many local governments, Calvert County generally does not allow rezonings or exemptions to zoning rules on a case-by-case basis. The only exception is that parcels deeded before 1975 retain some grandfathered lots, as compensation for the 1975 3-acre to 5-acre lot downzoning. We account for this in our empirical analysis.

[6] The percentage of surrounding land in a given use is calculated as the share of the subdivision perimeter that lies in the specified land use *at the time of subdivision recording*. Hence, an adjoining farm is considered to be *surrounding land in preservation* only if the farm was preserved (i.e., sold TDRs or was placed under easement through some other program) by the year that the subdivision in question was recorded.

Table 1. Selected Summary Statistics of Subdivision Sample (N = 398)

Variable	Mean	Std. Dev.	Min.	Max.
Total number of lots	27.211	31.499	3.000	268.000
Total plat area (acres)	70.647	71.353	4.029	589.590
Length of subdivision perimeter (feet)	8,211.555	4335.655	1947	33992
% subdivision land in steep slopes	36.756	29.795	0	100
% subdivision land in difficult soils	17.983	19.769	0	100
Within 1 mile of Patuxent River / Chesapeake Bay	0.221	0.416	0	1
Sewer service availability	0.023	0.149	0	1
% surrounding land in preserved open space / farmland (privately held)	1.666	5.969	0	42.916
% surrounding land in parkland	1.353	5.538	0	48.671
% surrounding land in subdivisions	17.751	21.341	0	100
% surrounding land in commercial / industrial zone	2.591	8.676	0	100
Distance to the top of the county	12.527	7.558	0.340	31.208
Distance to Route 2/4 (in miles)	1.503	1.148	0.005	4.840
Average annual TDR price (1999$)[a]	1,248.498	1105.587	0	2,582
Year of subdivision recording	1,986.862	8.946	1967	2001

[a] TDR price is averaged over those subdivisions that used TDRs in a given year.

that are otherwise difficult for development in 18 percent of its land area.[7]

Zoning rules in the county have changed in rather complicated ways over time, beginning with the first zoning of rural lands in 1967 and ending with the comprehensive downzoning that occurred in 1999. The baseline results of the model are for the 5-acre zoning that held for all rural areas from 1975 to 1981, when the first TDR was available for use in a subdivision. The dummy variables used in the econometric model and listed in Table 2 capture zoning effects relative to this baseline.

Regression Results

The OLS regression results are shown in Table 3. The first three sets of variables capture the density restrictions across different zoning categories, including the limits established under the TDR program and the downzonings, as explained in Table 2. The dummy variable for residential and town center zoning captures the features of a more urban environment and, as we would expect, is associated with more lots in a subdivision than the baseline rural areas. On average, residential and town center subdivisions have more than double the density in the rural 5-acre zoning regions.

All of the rural areas prior to 1975 had less restrictive zoning, 3-acre lots compared to 5-acre lots from 1975 on. This explains the positive and significant coefficient on the "Rural areas, pre-1975" zoning variable. Finally, the "Grandfathered parcel" variable is a subdivision-specific dummy variable equal to one if the subdivision is in a rural area and built in 1975 or after but had some grandfathered lots from less restrictive densities in place in earlier years. The results show that grandfathered parcels, all else equal, will have about 20 percent more lots per acre.

The next four variables in Table 3 suggest how well the introduction of the TDR program worked to reduce density in some areas and increase it in others. The dummy variables "Rural areas outside DAA, 1981+" and "Residential, 1981+" indicate

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[7] The *STEEP* and "difficult soils" variables are constructed based on soil classification data from the state of Maryland. "Difficult soils" include soil classes that are stony or part of a floodplain that make them difficult or more expensive to develop.

Table 2. Variables Capturing Zoning and TDR Program Changes, 1967–2001

Variable	Definition	Regulatory Action
Rural areas, pre-1975	= 1 if in rural area and recorded before 1975; 0 otherwise	*1975 Downzoning:* Base density in all rural regions reduced from 1 lot/3 acres to 1 lot/5 acres
Rural areas outside DAA, 1981+	= 1 if in rural areas outside of DAA and recorded since 1981; 0 otherwise	*1981 TDR Program Adoption:* Rural areas outside of designated agricultural areas (DAA) allowed to build up to 1 lot/2 acres with TDRs
Residential, 1981+	= 1 if in residential areas and recorded since 1981; 0 otherwise	*1981 TDR Program Adoption:* Residential areas allowed to build up to 4 lots/acre with TDRs
Regions added to DAA, 1992+	= 1 if in areas that were added to the DAA and recorded since 1992; 0 otherwise	*1992 TDR Program Change:* Certain areas changed to DAA status, where TDRs could no longer be used to increase density
Rural areas (non-DAA) within 1 mile of town center	= 1 if in rural areas outside DAA and lie within 1 mile of a town center; 0 otherwise	*Additional TDR Density Bonus:* In non-DAA rural areas within 1 mile of the town center, TDRs could be used to increase density up to 1 unit/acre
Rural areas, 1999+	= 1 if in rural areas and recorded since 1999; 0 otherwise	*1999 Downzoning:* Max base density in all rural regions reduced from 1 lot/5 acres to 1 lot/10 acres (no change in max density possible with TDRs)
Residential/town center, 1999+	= 1 if in residential areas or town centers and recorded since 1999; 0 otherwise	*1999 Downzoning:* Max base density reduced by half (no change in max density allowed with TDRs)

the TDR receiving areas for the rural and residentially zoned areas, respectively. We would expect more density in these areas after 1981 when they became eligible to be receiving areas and were able to use TDRs to increase density. Allowable density with the use of TDRs after 1981 increased by more than two times in the rural areas, and by four times in the residential areas. The results in Table 3 show that density levels did increase in the rural areas, but certainly not by the maximum allowable amount; approximately 18 percent more lots were built, on average. However, there was no statistically significant effect on density in the residential areas. Thus, the TDR program led to some increased density, but only in the rural receiving areas, and even in these areas, not by nearly as much as was allowed by law.

In 1992, some rural regions were taken out of TDR receiving area status and put into the preservation areas (DAA). Thus, we expect the coefficient on the variable "Regions added to DAA, 1992+" to be negative, because developers building there after 1992 would no longer be allowed to use TDRs to increase density. It is of the expected sign, and indicates that density is about 15 percent lower in these areas after 1992.[8] Finally, subdivisions built in rural receiving areas and located within one mile of a town center were allowed to purchase additional TDRs.[9] These areas would be expected to have higher density, perhaps due to their close proximity to more densely populated areas. Indeed, the coefficient is positive and significant; density is approximately 14 percent higher, on average, than in the rest of the rural TDR receiving regions after 1981.

The final two zoning dummy variables examine the effect of the 1999 downzoning. Recall from earlier discussion and from Table 2 that baseline zoning in both the rural and residential areas was reduced by 50 percent in 1999 but that subdivisions in most of these areas could go back to the previous zoning limits with the purchase of TDRs. This makes for an interesting test of the influence of the TDR program. To get to the density levels allowed prior to 1999, developers had to purchase additional TDRs. The results suggest

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[8] Note that the coefficient is significant at only the 80 percent level.

[9] Density in these areas could go as high as 1 lot per acre with the use of TDRs.

Table 3. OLS Regression of Subdivision Density (with robust standard errors)

Dependent Variable: ln(Lots)	Coefficient	Standard Error
Zoning variables		
Residential / town center	1.356***	(0.167)
Rural areas, pre-1975	0.484***	(0.105)
Grandfathered parcel	0.207***	(0.053)
TDR dummy variables		
Rural areas outside DAA, 1981+	0.183**	(0.072)
Residential, 1981+	-0.143	(0.169)
Regions added to DAA, 1992+	-0.142	(0.107)
Rural (non-DAA) within 1 mile of town center	0.136**	(0.057)
Downzoning dummy variables		
Rural areas, 1999+	-0.115	(0.102)
Residential / town center, 1999+	-0.403**	(0.201)
Surrounding land uses		
% surrounding land in privately owned agricultural preservation status	-0.009***	(0.003)
% surrounding land in parks	-0.012**	(0.005)
% surrounding land in another subdivision	0.002	(0.001)
% surrounding land in commercial / industrial zone	0.003	(0.005)
% parks * residential / town center	0.045***	(0.009)
% subdivision * residential / town center	-0.007***	(0.003)
% commercial / industrial * residential / town center	-0.004	(0.006)
Subdivision size and characteristics		
ln(acres)	0.877***	(0.118)
STEEP (% land in steep slopes)	-0.063*	(0.033)
ln(acres) * *STEEP*	-0.003	(0.003)
ln(perimeter)	-0.126	(0.214)
ln(perimeter) * *STEEP*	0.008*	(0.005)
% land in difficult soils	-0.001	(0.001)
Sewers	0.345*	(0.210)
Accessibility variables		
Distance to northern end of county	-0.0032	(0.0034)
ln(distance to Route 2/4)	-0.048**	(0.021)
Access to town centers	0.120***	(0.022)
Time trend	0.004	(0.006)
Average annual TDR price ($1999)	0.0000376	(0.0000428)
Constant term	0.167	(1.479)
R^2	0.7698	
No. of observations	398	

*** indicates statistically significant at the 99 percent level, ** indicates statistically significant at the 95 percent level, and * indicates statistically significant at the 90 percent level.

that developers found the extra expenditure worthwhile in the rural areas but not in the residential and town center zones. We can see this from the fact that the coefficient on the “Rural areas, 1999+” variable, although negative, is not significantly different from zero, thus average density of new subdivisions in these areas is not statistically different from average rural density before 1999.

The coefficient on the “Residential and town centers, 1999+” variable is negative and significant at the 99 percent level. This suggests that developers did not choose to purchase TDRs to get back to pre-1999 levels and even reduced the number of lots per acre in new subdivisions built in these areas. In fact, new subdivision density is about 40 percent lower. Thus, in Calvert County, it appears that the costs to developers of achieving higher density with TDRs are not worth the benefits in the higher density residential areas but are worth the benefits in the relatively low density rural areas.

Surrounding Land Uses

We expect that an important influence on the density of a subdivision is the land uses of the properties immediately surrounding the site at the time it is developed. In Table 3, the four surrounding land variables are the percentage of land on the perimeter of the subdivision that is (i) developed land (another subdivision), (ii) permanently preserved in farmland or forestry (either through the TDR program or one of the state easement programs), (iii) parkland, or (iv) a commercial/industrial property. Each of these enters the model separately and is interacted with the residential and town center dummy variable.[10]

There is a small positive effect on density when there is greater percentage of surrounding land in other subdivisions in the rural areas, though the coefficient is positive only at the 85 percent level. In the residential and town center areas, however, the effect of a larger percentage of the border as subdivision neighbors has a negative and significant effect on density. If 10 percent more of the border is in other subdivisions, density will be about 7 percent lower than on a similar site in the rural region. This result provides some evidence that existing residents, particularly in higher-density areas, may attempt to keep density of incoming subdivisions lower. We find additional support for this argument in another paper that examines the factors influencing the demand for additional density through the purchase of TDRs (Kopits, McConnell, and Walls 2005). There, we find consistent evidence that TDR use falls when more adjacent high-density development exists at the time the subdivision is built. This is counter to the perception that infill or new development in urbanized areas occurs at higher densities over time.

We are also able to address another issue often raised by farmland preservation advocates. One of the criticisms about the Calvert TDR program is that TDR sending areas are not geographically separated from TDR receiving areas. There is concern that preserved tracts will be non-contiguous and development will be intermingled with farming, and that this will limit the viability of agriculture (Daniels 1997). Although we are not modeling the location decision and thus cannot fully address this issue here, our inclusion of the surrounding land variables in the model is suggestive of whether the free market tends to put more or less dense subdivisions next to preserved farms. We find the coefficient on the preservation variable to be negative and statistically significant, indicating that a 10 percentage point increase in the amount of preserved farmland on the boundary of the subdivision leads to a 10 percent decrease in the number of lots built in that subdivision.

The coefficient on the percentage of the subdivisions that are adjacent to parkland is also negative, significant, and of similar magnitude to that of adjacency to preserved private land in the rural areas. In residential and town center areas, however, the coefficient is positive and highly significant. These findings are consistent with recent hedonic studies of the value of open space which show that parks are particularly valuable in urban locations (for a review of this literature, see McConnell and Walls 2005).

Finally, the percentage of a subdivision’s boundary that is in commercial or industrial status does not appear to affect density in either the residential/town center zones or rural areas.

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[10] The effect of surrounding uses is likely to be different in the more urbanized areas especially because the rural areas have subdivisions with relatively large lot sizes—many have averages of more than 5 acres per lot. We do not include an interaction term with “percent preserved” and “residential and town center” because there are no subdivisions adjacent to permanently preserved parcels.

Subdivision Characteristics and Other Factors

The remaining variables in Table 3 control for other market factors that may influence density decisions of developers. A key subdivision characteristic is the size of the subdivision plat area in acres. The coefficient on "ln(acres)" is significant and close to 1, indicating that increasing the amount of available acreage by a given percentage leads to approximately the same percentage increase in the number of lots built.

We find that the percentage of subdivision acreage in steeply sloping land has a negative effect on density as expected, and the coefficient is significant at the 90 percent level. The variable that interacts size and the percent steep slopes ("ln(acres) * % land in steep slopes") is also negative, indicating that the positive effect of a larger acreage on the number of lots built is somewhat offset when the subdivision is more steeply sloped. However, the coefficient on this variable is significant at only the 80 percent level.

The variable "ln(perimeter)" controls for the shape of the subdivision. For a given acreage, the longer the length of the perimeter of the subdivision, the more irregular will be the shape of the parcel. Since it may be more difficult or costly to build a large number of lots on an irregularly shaped tract of land, we expect this coefficient to be negative. The estimated coefficient is negative, but is not significant. Costs of development might also be affected by the quality of the soils at the site. The coefficient on our "difficult" soils variable is negative as expected, but small in magnitude and not significantly different from zero.[11]

The final subdivision characteristic we control for is whether the subdivision is in an area that has access to a sewer system. We expect that adjacency to sewer systems will increase the number of houses that can be built, and we do find the coefficient is positive and significant at the 90 percent level. Density is roughly one-third higher in these areas.

According to the conventional urban models, higher density development should take place in regions more accessible to major cities and closer to the highways leading to those cities. In the case of Calvert County, this means that we expect subdivisions in the northern and north-central regions of the county to be denser than those to the south. The variable indicating distance to the northern tip of the county measures this accessibility, but it is insignificant. We find the subdivision's proximity to the major commuting road, Route 2/4, to be as expected: a subdivision that is farther away from the major road is less dense. The results also indicate that increased proximity to shopping and other commercial areas significantly increases subdivision density. We measure this proximity by the subdivision's location relative to all of the town centers in the county, using a simple gravity index that is increasing in the size of the eight town centers and decreasing with distance to them.

The time trend should reflect any general trend in density that may have occurred over this relatively long time scale of the analysis. We expect that the trend would have been toward less density over time, due to declining commuting costs and increasing demand for large lots through most of this period. The coefficient is negative but is not significant.

Finally, because the cost of purchasing TDRs should affect a developer's decision about how many lots to build in a subdivision, we include the annual average price of a TDR, in inflation-adjusted terms, as an explanatory variable. We find that it is not statistically significant in explaining choice over density. This may be because in the period after about 1993, the price was relatively constant. See Figure 3.

Conclusions

Many communities today are struggling with how to balance population growth and a rising demand for housing with a desire for preservation of farmland and open space. In this paper, we examine one policy tool that promotes more preservation of farmland in some regions and higher density of development in others, a system of transferable development rights (TDRs). With TDRs, the total amount of development can remain roughly unchanged over time in a given jurisdiction, but farmland is preserved through private market transactions with no expenditure of public dollars for the purchase of easements.

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[11] This result could be because recent advances in wastewater management technologies have reduced the importance of soil characteristics for building (LaGro 1996).

Because of these and other attributes, TDR programs have been established in many regions around the United States. However, most existing TDR markets are inactive, thus preventing communities from achieving their land preservation goals.

We review some of the potential advantages and disadvantages of TDR programs and examine one particular program that has been successful in achieving a region's farmland preservation goals. The Calvert County, Maryland, program has had a market for development rights for over 25 years and has placed over 10 percent of the county's land under permanent easement.

This paper focuses on the incentives created by the Calvert County TDR program to direct development away from areas targeted for preservation and toward areas considered acceptable for development. The unique feature of the Calvert program is that development rights can be used to increase density above baseline levels in several different zoning regions. The Calvert TDR program appears to have had the intended effect of directing density away from the areas designated for agricultural preservation and has certainly been successful in preserving a significant amount of farmland acreage. What is most instructive, however, is that there appears to be a clear preference on the part of developers to use TDRs to increase density in the rural areas and not in the higher density town centers and residential areas.

This finding suggests a reason why many existing TDR programs may be languishing. Most planning agencies want to direct development toward high-density areas with existing infrastructure and often limit TDR use to these regions. This paper finds that little of the additional density allowed by the purchase of TDRs is going into these urbanized areas.

There are several possible explanations for this result. One is that it is purely demand driven—there is little demand by households for housing at higher densities than the baseline in the residential areas, but there is demand for higher density than the 5-acre per lot minimum in the rural areas of our study area. The other explanation is that there is something preventing higher density development in urbanized areas. Existing residents in residential areas may perceive that there are costs from new development at high densities in their own neighborhoods. There is certainly a good deal of anecdotal evidence that existing residents attempt to block new developments in their neighborhoods, or to at least reduce their density. We find some empirical evidence to support this view. In the residential areas, the more a new subdivision is bordered by other subdivisions, the lower will be the density of the new subdivision. We do not find this same result in the rural areas.

In summary, jurisdictions wishing to preserve large amounts of farmland are faced with difficult choices. They may have to raise enough money to buy development rights outright, or if they want to use a more market-based approach such as TDRs, they may have to accept some residential development in more rural locations.

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