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Making Markets for Development Rights Work

What Determines Demand?

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RESOURCES FOR THE FUTURE

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Abstract

Many economists see current land use patterns as inefficient due to various market failures, and planners argue that current patterns do not follow sound planning practice. One policy of interest to both groups is transferable development rights (TDR). TDRs allow the development rights from land that is preserved in an undeveloped state to be transferred to other areas where development can be made denser.

This paper addresses one of the greatest difficulties TDR programs face—insufficient demand. We develop a simple theoretical model and estimate a TDR demand function using data from Calvert County, Maryland, one of the only regions where data on individual sales are available. We find that baseline zoning is a critical determinant of TDR demand—demand is high in low-density rural areas but not in the relatively high-density residential areas. We also identify many subdivision characteristics that are significant in explaining TDR use.

Key Words: TDRs, density, zoning, subdivisions

JEL Classification Numbers: R14, R52, R21

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Making Markets for Development Rights Work: What Determines Demand?

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I. Introduction

There is widespread interest both in preserving undeveloped land as either farmland or open space and in reducing the problems associated with rapid suburban and ex-urban growth. Many economists see current land use patterns as inefficient due to various market failures, and planners argue that current patterns do not follow sound planning practice. One policy for promoting better land use that has been of interest to both groups is the establishment of transferable development rights (TDR) markets. These markets have the potential to preserve farmland or open space and to make developed areas more compact. Because they use private markets to achieve these goals, TDRs may result in more efficient land allocations without requiring the expenditure of public funds. In practice, however, most TDR programs have not worked as well as advocates had hoped. Keeping these created markets active requires adequate incentives for landowners to sell their development rights and a strong demand for higher-density development than what is permitted under baseline zoning rules. This paper addresses one of the greatest difficulties faced by many programs: insufficient demand for the purchase of development rights. We develop a simple model of the demand for TDRs and estimate the TDR demand function for a region with a long-standing TDR program.

Transferable development rights are a market-based local planning tool used to protect open land from development. They sever ownership of the right to develop property from ownership of the property itself, creating a market in the development rights. Typically, TDR programs work by first down-zoning properties in so-called sending areas—that is, restricting development in those areas—and then allowing landowners to sell their development rights as a

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means of compensation. Those rights can be used to increase the density of development in other regions, called TDR receiving areas.

Pruetz (2003) finds that approximately 142 TDR programs are in existence in the United States, with goals ranging from farmland preservation and protection of environmentally sensitive areas in suburban and ex-urban locations to building height limits and historical preservation in urban areas. Many of these programs, however, are inactive. They are on the books, but very few development rights have been transferred. The American Farmland Trust (AFT, 2001) estimates that TDR programs have preserved approximately 90,000 acres of land in the United States but that 40,000 of those acres—nearly half—are from the much-discussed program in Montgomery County, Maryland. Only eight programs, according to AFT, have preserved more than 1,000 acres each.

TDR markets usually are inactive not because of a lack of willing sellers—owners of down-zoned properties often are eager to make up for the reduction in property value by selling development rights—but because of a lack of demand. Transferable Development Rights allow developers to build more houses on a given number of acres than is permitted by the baseline zoning. This means that each house built will have a smaller lot. Developers have to believe that they will be able sell such houses and that they will be able to cover the additional costs incurred from having to purchase TDRs. There are a number of possible explanations for the lack of demand in the market for these rights. In some areas, lack of available infrastructure or environmental constraints limit the potential for higher density development. In others, baseline zoning is set at such a level that developers feel homebuyers would not want to purchase houses in more dense locations. In addition, existing residents may try to block or delay new, relatively dense development in their neighborhoods.

It is important to understand how TDR markets work and to explore ways to make them more effective at achieving their higher density goals. Mills (1980) shows in a theoretical model that TDRs are efficient and that they distribute the gains from development more equally among landowners than do direct land use controls. Thorsnes and Simon (1999) derive similar results in a graphical analysis and also argue that TDRs are likely to have much lower administrative costs than alternatives, such as a purchase of development rights program (PDR), a combined development tax/PDR program, and strict zoning. Mills (1989) emphasizes a further point: that TDRs are likely to mitigate the rent-seeking behavior that is commonplace with zoning. Carpenter and Heffley (1981, 1982) focus on the spatial equilibrium outcomes from a TDR market, and their simulation results show that the extent of any efficiency benefits depends on how the TDR program is set up, the elasticity of supply of residential space, and several other factors. In contrast, Johnston and Madison (1997) see the major role for TDRs as a means of compensating landowners for down-zoning and as a way of preserving specific geographic areas of land. Finally, the incentives provided by TDRs and how they are best used in combination with broader land use policies are emphasized by Fulton et al. (2004).

What is missing from the literature is any empirical analysis of TDR markets. In a recent paper, McConnell et al. (2005) analyze the factors that explain overall residential density in Calvert County, Maryland, a rapidly growing county on the fringes of the Washington, DC, metropolitan area. The main purpose of that paper was to examine whether zoning limits are the primary cause of low-density development or whether market forces tend to dictate this outcome. Calvert County's TDR program was incorporated into the empirical analysis as an added cost of building more lots, and we found evidence that allowing the use of TDRs in certain areas did increase the number of lots in new subdivisions. In this paper, we delve further into the details of the demand for TDRs in the Calvert County program, examining why TDRs are used in some locations and not in others and the factors that affect TDR use. Although Calvert County has one of the longest-running, active TDR programs in the country—the sale of TDRs has built more than 2,100 houses and permanently preserved more than 13,000 acres of farmland—only about a third of the subdivisions built during the 1982–2001 period were built using TDRs. In this paper, we attempt to examine which subdivisions use TDRs and the factors that determine demand.

The next section provides a simple theoretical model of a developer's decision over TDR use. Background on land uses in Calvert County, the TDR program, and underlying zoning in the county is explained in Section III. Section IV describes the data used in the econometric model and provides the econometric results. Section V concludes.

II. The Developer Decision: Choice over the Use of TDRs

TDRs provide a relatively new tool for allowing flexibility in zoning. If a community wants to encourage land preservation in some areas, landowners in those areas may be permitted to sell their development rights and put their land in a permanent preservation easement status. The development rights then can be used in designated regions that can accept additional density above the allowed baseline zoning.

We develop a simple model of the developer's decision about whether to use TDRs to achieve greater density at a development site. We restrict the analysis to the decision in receiving areas only. That is, we assume that the development site is in a region where the developer is permitted to purchase TDRs (up to some limit) to create a larger number of lots than the baseline zoning will allow. The question for developers is, given that TDRs can be used, should they use them and, if so, how many?

We also assume that the developer has already made the decision about where to build and is deciding about whether to use TDRs to increase density at that site. While it is true that the developer could make the decision about the use of TDRs jointly with the decision about where to build, there is evidence, at least in the jurisdiction that we are examining, that these decisions are separate. Many developers in high-growth suburban areas will build a subdivision on virtually any greenfield site that becomes available to them. Thus, they will purchase land for development where and when they can (Jaklitch 2004). For each parcel, the developer makes an individual decision about whether to use TDRs.

The decision to use TDRs is derived from the profit-maximizing decision developers make about how densely to build on any parcel. We assume developers will build the number of lots on a given site (choose density) to maximize profits. Whether they use TDRs will depend on whether profits can be enhanced by the additional density that TDRs allow.

We model the profit-maximizing decision as a function of the variables that affect the revenues and costs of development, many of which vary with the location of the parcel to be subdivided.[1] In addition, the developer faces the zoning and TDR purchase limits at that location.[2] The number of lots in the subdivision, l_i, will affect revenues, R_i, but also will influence development costs, C_i. In addition, revenues will depend on the total acreage of the land parcel, or subdivision plat area, L_i, since a larger parcel with a given number of lots will have greater value. Revenues from the plat also will depend critically on the amenity characteristics of the site, A_i. These include the natural amenities of the site itself, n_i, such as the number of trees and topography, and the land uses of the properties immediately surrounding the site, u_i. The surrounding land uses can have a complex effect on the value of development. There may be increased value from being adjacent to like uses, or there could be positive spillover effects from different uses. For example, the more preserved open space or parkland surrounding

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[1] It is useful to distinguish here between the developer and the builder. We are modeling the developer's decision to subdivide the parcel into buildable lots. Developers may then sell lots to builders or build the houses themselves.

[2] In some jurisdictions, developers or builders might be able to influence the zoning rules governing a property through petitions and zoning variances. Here, we treat the zoning as exogenous, which is in keeping with the empirical analysis that follows later in the paper.

a subdivision site, the higher the residential value at that site. However, the increased value from the surrounding preserved areas might be greater for low-density development than for high-density development. Or, higher density surrounding residential uses might make higher density of the new subdivisions more likely. The opposite may result, however, if higher density of surrounding developed areas means there are more residents to object to new, high-density development. Hence, it is difficult a priori to predict the effect of surrounding land uses on the choice over the number of lots. Finally, revenues will depend on location and accessibility variables, d_i, since greater access to employment centers should increase property values.

The developer's costs will be determined by the number of lots, l_i, the size of the plat area, L_i, and the soil and topography characteristics of the land, s_i.[3] Cannaday and Colwell (1990) show that even the shape of the parcel to be subdivided can affect the development costs.

In almost all communities today, the developer faces a limit on the number of lots he can put in any subdivision because of zoning rules. These rules usually establish the minimum average lot size, $\bar{z}$.[4] Zoning rules have a long history and were initially designed to separate land uses in order to prevent negative spillovers among these uses. Separation of uses expanded over the years to include not only separation of commercial and industrial activities from residential uses but also separation of different types of residential uses. Thus, most communities have a variety of zoning categories with different limits on lot sizes or equivalently, the number of housing units per acre. The ability to purchase TDRs allows the developer to achieve a greater density (or smaller lot size) than zoning rules allow. In our model, developers can purchase development rights, t_i, at a price determined in the market for TDRs, P_{TDR}, and use them to increase density in region r.[5] In most TDR programs, however, the ability to use TDRs for greater density is not unlimited. There is a minimum average lot size even with the purchase of TDRs; hence, there is a limit on the number of TDRs that may be used in subdivision i, which we identify here as $\bar{t}_i$.

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

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

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

The developer's decision is to choose the number of lots, l^*, to maximize profits

$$\max_{l} \pi_i = R_i(l_i, L_i, A_i(n_i, u_i), d_i, \bar{z}_i) - (C_i(l_i, L_i, s_i) + p_{TDR} * t_i) \qquad (1)$$

subject to the following constraints:

$$\bar{l}_i = L_i / \bar{Z}_r, \quad i \in r \qquad (2a)$$

$$t_i = l_i^* - \bar{l}_i \quad \text{and} \quad t_i \geq 0 \qquad (2b)$$

$$\bar{l}_i + t_i \leq L_i / \bar{Z}_{TDR} \qquad (2c)$$

where $\bar{Z}_r$ is the minimum average lot size allowed under baseline zoning in region *r*, and $\bar{Z}_{TDR}$ is the minimum average lot size allowed with the use of TDRs in region *r*.

The first constraint shows the limit on the number of lots that can be built under the baseline zoning—that is, $\bar{l}_i$ is the maximum number of lots that can be built without purchasing TDRs. The second constraint is that TDRs can be used to build additional lots beyond the baseline, but the number of TDRs must be nonnegative. And finally, the number of baseline zoning lots plus TDR lots must be equal to or less than the maximum number allowed under TDR purchase rules.

If the profit-maximizing number of lots is less than or equal to the allowed number under the baseline zoning, then the developer will have no demand for TDRs. If $l_i^* > \bar{l}_i$, the developer will purchase $t_i = l_i^* - \bar{l}_i$. In this case, the demand for TDRs, t_i, will be a function of the arguments of the revenue and cost functions from equation (1), the price of TDRs, and baseline zoning constraint in place, $\bar{z}_i$. The developer cannot buy more than the allowed limit of TDRs, however. For convenience, let *W* represent the arguments of the profit function (1) above. Then

$$W = (L_i, A_i(n_i, u_i), d_i, s_i, \bar{z}_i) \qquad (3)$$

and we can write the TDR demand equations as

$$\text{for } l_i^* \le \bar{l}_i, \qquad t_i = 0, \tag{4a}$$

$$\text{for } \bar{l}_i < l_i^* < L_i / \bar{Z}_{TDR}, \qquad t_i = f(W_i, P_{TDR}, \bar{z}_i), \tag{4b}$$

$$\text{for } l_i^* \ge L_i / \bar{Z}_{TDR}, \qquad t_i = \bar{t}_i. \tag{4c}$$

where $\bar{t}_i = L_i / \bar{Z}_{TDR} - L_i / \bar{Z}_i = L_i / \bar{Z}_{TDR} - \bar{l}_i$ is the maximum number of TDRs that can be purchased for subdivision *i*.

Any changes in the factors that affect revenues or costs from development change the optimal density, l^*. Also, different zoning rules mean different levels of profit and new constraints. Any of these can affect whether the subdivision falls under equations (4a), (4b), or (4c). Using our detailed subdivision level data from Calvert County, Maryland, we estimate the TDR demand equation in section IV and derive results for how differences in the underlying parameters affect TDR demand.

III. The Calvert County TDR Program: Background and Residential Development Outcomes

Calvert County is located in southern Maryland on the western shore of the Chesapeake Bay. The county is a 215-square-mile peninsula formed by the bay and the Patuxent River estuary. The county seat, Prince Frederick, lies in the middle of the county and is approximately 35 miles southeast of Washington, DC, 55 miles south of Baltimore, and 37 miles south of Annapolis, Maryland. Although a historically rural, agriculture-based county, Calvert County has seen rapid population growth over the past 20 to 30 years because of its proximity to major centers of employment. In the decade of the 1990s, it was the fastest growing county in Maryland, with a population increase of more than 45%, well above the state average increase of 10.8%. Average population density, however, remains low.

Over the years, the county government has exhibited increasing concern over the significant loss of farmland and open space resulting from these trends. In 1967, Calvert County adopted its first Comprehensive Plan in which all rural land was zoned to a maximum density of 1 dwelling unit per 3 acres. In 1974, the county updated the plan to reflect a "slow growth" goal and changed the maximum density to 1 dwelling unit per 5 acres. Despite the 5-acre minimum lot requirement, significant amounts of farmland were lost to development throughout the 1970s. So around 1980, the county attempted to curb the trend by adopting a transferable development rights program.[6]

Table 1. Maximum Density Allowed by Zoning in Calvert County, Maryland

	1981–1998		1999 to present	
Zoning classification	*Baseline zoning*	*Density allowed with TDRs*	*Baseline zoning*	*Density allowed with TDRs*
Rural				
DAA	2 units/10 acres	2 units/10 acres	1 unit/10 acres	2 units/10 acres
Rural Communities	2 units/10 acres	5 units/10 acres	1 unit/10 acres	5 units/10 acres*
Residential	10 units/10 acres**	40 units/10 acres	5 units/10 acres	40 units/10 acres
Town Centers***	40 units/10 acres	140 units/10 acres	20 units/10 acres	140 units/10 acres

TDR = Transferable Development Rights

DAA = Designated Agricultural Area

* Density in Rural Communities that are within 1 mile of a Town Center can go as high as one unit/acre with the use of TDRs.

** Prior to 1999, multifamily homes and townhouses were allowed in a small part of the Residential zone (known as R-2). Density could go as high as 140 units/10 acres in these areas without the use of TDRs. After 1999, all residential areas (R-1 and R-2) had the same zoning and TDR rules.

*** The Town Center zoning classification came into effect in 1983.

[6] The county has implemented other complementary land preservation programs. In 1988, the county adopted an adequate public facilities ordinance that halts building when it is determined that public facilities such as schools cannot handle additional growth. Critical Areas near waterways were outlined in 1989 (as required by the state), and maximum residential density was reduced to 1 dwelling unit per 20 acres in those areas. Land also has been put into protective status through numerous state easement purchases and easement donation programs. All of this information is summarized in Calvert County Planning Commission (1997).

Table 1 shows the density permitted in the county since the TDR program began, both with and without the use of TDRs. Most of the county's prime farmland and forested areas lie within the so-called Designated Agricultural Areas (DAAs), though there is still a great deal of farming in the rural regions outside the DAAs, also known as Rural Community (RCs). As can be seen in the table, prior to 1999, TDRs could not be used to increase the density of development in DAAs; thus, these could only be TDR sending areas. Residential and Town Center zones are targeted TDR receiving areas, as are RCs.

Figure 1 shows the zoning classifications on a map of the county. The farming regions that the county is aiming to protect, and which may only be TDR sending areas, are shaded with green dots and dashed blue lines. The green dotted areas are the DAAs and the dashed blue lined areas are regions that were added to the DAAs after 1992.[7] The white indicates areas zoned as RCs, which can be either sending or receiving areas for TDRs. The yellow and orange areas are, respectively, Town Centers and Residential areas; Commercial and Industrial zones are shown in purple. Though not zoning per se, land that is preserved through state, federal, or private conservation programs or that is county or state parkland is shown in brown.

Table 1 and Figure 1 highlight some interesting features of the Calvert County TDR program. Compared with other programs in the United States, Calvert County's is one of the most unconstrained. The county has not delineated specific geographic areas of the county for preservation and development. Land in either of the rural zones can be preserved and these areas cover many different parts of the county. Moreover, no part of the county has extremely restrictive baseline zoning. Development can occur at a maximum density of 1 dwelling unit per 5 acres of land in all rural areas. By comparison, many other TDR programs down-zone sending areas to 1 house per 25, 40, or even 50 acres (Pruetz 2003). Finally, Calvert County's is one of the few programs that we know of where the receiving areas are not only in high-density zones. TDRs may be used in Residential and Town Center areas as well as in the relatively low-density

[7] In 1992, additional farmlands called Farm Community Districts (FCDs) were designated as sending areas only and effectively became part of the DAAs. All of the sending area-only regions now are generally referred to as FCDs or Resource Preservation Districts (RPDs). Since the original DAAs now are a subset of the FCD/RPD regions, for simplicity, in this paper we will continue to refer to the sending area-only regions as DAAs and the regions that were added on in 1992 as "regions added to DAAs."

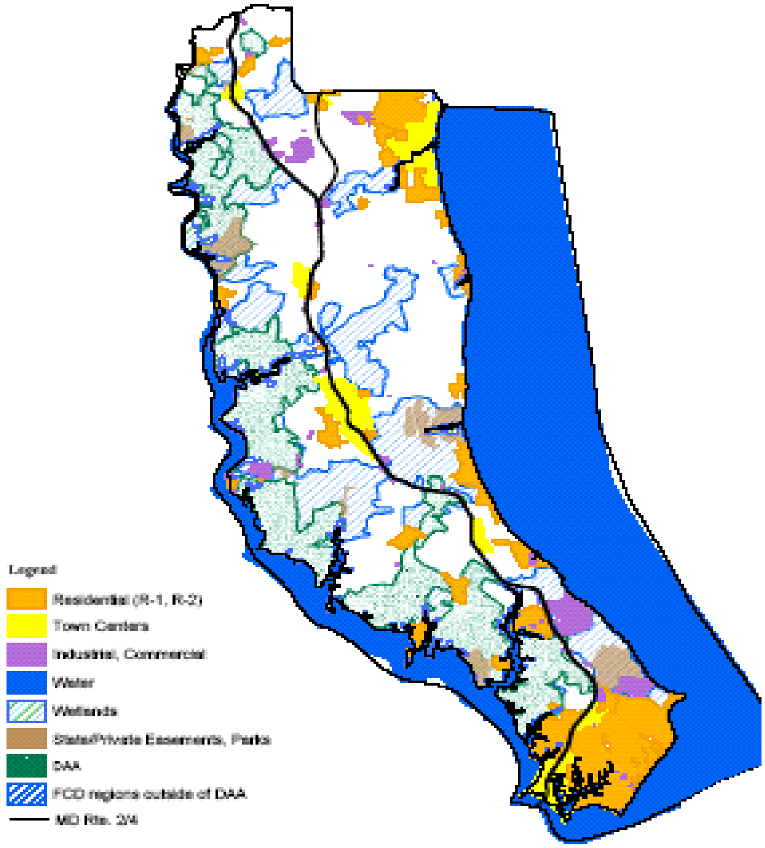

Figure 1. Zoning Map of Calvert County, Maryland

RCs. Landowners in the RCs may choose either to: (a) sell TDRs, thereby permanently preserving their lands from development; (b) develop their lands without using TDRs up to a maximum of 1 unit per 5 acres; or (c) purchase TDRs and develop to a greater density.

One countywide down-zoning occurred over the sample period. As shown in Table 1, in 1999, the baseline density (i.e., the number of lots that can be built without using TDRs) was reduced by 50% in all zoning categories. However, TDRs could be purchased to get back to the same maximum density levels allowed prior to 1999. Hence, after 1999, all regions of the county, including DAAs, were eligible receiving areas for TDRs.[8]

Another program change that occurred over the sample period was that in 1993 the county began to buy TDRs in order to retire them, under its Purchase and Retire (PAR) program. Since that year, the county also has provided better information to potential buyers and sellers. The planning office publishes a newsletter that provides information on prices, as well as the names and telephone numbers of surveyors and engineers in the county who may know of potential buyers. These actions seemed to have had some stabilizing effect on TDR prices (see McConnell et al. 2003). The additional information provided to market participants also lowered transactions costs to developers, thereby potentially increasing the private market demand for TDRs.

There is some indication from descriptive analysis that overall subdivision density is increasing. The average amount of acreage developed each year has remained roughly constant before and after the TDR program was enacted. Annual new subdivision acreage averaged 820 acres before the program began (during 1967–1980) and 880 acres over the 1981–2001 period.[9] The number of new lots recorded each year, however, increased by 35% over the two periods; an average of 318 new building lots were developed during the 1967–1980 period, compared with 429 during the 1981–2001 period.

Table 2 shows the percentage of new subdivisions developed using TDRs by zoning classification and by time period. Countywide, just under 40% of new subdivisions recorded in the sample period used TDRs. Nearly 50% of subdivisions built in RCs used TDRs, however, compared with only 9% of subdivisions in the Residential and Town Center zones. These

[8] It is important to note that we treat the variables capturing the down-zoning as exogenous in this model. It has been argued in the literature that local zoning, especially over a period of time as long as that considered here, is likely to be endogenous (Rolleston 1987; McMillen and McDonald 1990, 1991; McDonald and McMillen 2004). Because our data are at the subdivision level and we are modeling the individual developer's decision, we feel it is reasonable to treat zoning as predetermined. Moreover, the down-zoning was countywide and was a result of concern over population growth and the size of the transportation system. Also, 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 three-acre to five-acre lot down-zoning. We account for this in our empirical analysis as discussed below.

[9] This fact should not be construed as suggesting that the TDR program was a failure; without knowing the counter-factual, it is difficult to say exactly how the amount of acreage in new residential development has been affected by the program. As stated above, 13,000 acres of farmland have been preserved from development through the TDR program (and an equivalent amount through other county and state preservation programs).

findings suggest that developers may have been satisfied with the baseline zoning in the residential zones but not in the RCs. The table also shows the increase in TDR usage since the 1999 down-zoning. Over the 1999–2001 period, TDRs were used in 64% of new subdivisions in RCs. They were used to a similar degree even in DAAs, the targeted preservation areas, after 1999 once developers were allowed to purchase TDRs to achieve the pre-1999 permitted density.

Table 2. Percentage of New Subdivisions Using TDRs in Calvert County, Maryland, by Recording Year and Zoning

	Subdivision recording year			
Zoning	1982–1992	1993–1998	1999–2001	1982–2001
Residential/Town Centers	0%	5.9%	42.9%	8.9%
Rural				
DAA	0%	0%	64.3%	44.8%
Rural Communities	27.7%*	58.5%	63.6%	48.1%
Countywide	31.5%	43.1%	60.5%	39.9%

DAA = Designated Agricultural Area

*This includes the handful of subdivisions that used TDRs in the regions that were added to the DAAs in 1992.

IV. Estimation and Results

Specification

We estimate the developer's demand for TDRs derived in Section II as a two-limit tobit model. Rewriting (4a)–(4c) in standard tobit notation, the reduced-form equation for the optimal number of lots built with TDRs can be specified as

$$t_i^* = f(W_i, P_{TDR}, \bar{z}_i) + \varepsilon_i \qquad (5)$$

$$t_i = 0 \quad \text{if } t_i^* \le 0$$

$$t_i = t_i^* \quad \text{if } 0 < t_i^* < \bar{t}_i$$

$$t_i = \bar{t}_i \quad \text{if } t_i^* \ge \bar{t}_i$$

where t_i* is the latent variable,

t_i is the observed number of TDR lots in subdivision *i*,

$\overline{z_i}$ is the zoned minimum average lot size for subdivision *i*,

$\bar{t}_i$ is the maximum number of TDR lots allowed for subdivision *i*,

W_i represents the arguments of the profit function (equation (1)), and

P_{TDR} is the TDR price.

Our sample includes all subdivisions in Calvert County that were allowed to use TDRs from 1983 (the year the first TDR was sold to a developer) to 2001.[10] Those subdivisions not using any TDRs are left-censored at zero. Subdivisions in which the developer built the maximum number of TDR lots allowed are right-censored at the TDR limit. Recall from Table 1 that the maximum density allowed with TDRs depends on the zoning category and year of subdivision recording. Therefore, the maximum number of lots that can be built with TDRs varies by subdivision, meaning the upper limit in our tobit regression varies across observations.

Data

Table 3 summarizes some of the key characteristics of the sample of subdivisions that use TDRs and those that do not. In total, 228 subdivisions were built in TDR receiving areas over the 1983–2001 period, with the average subdivision built in 1992. The size of the subdivisions varies from 4 acres to almost 600 acres, and the average size of those using TDRs is roughly double that of those that did not use TDRs. The average number of TDR lots in subdivisions using TDRs is 19 but varies from 1 to 76.

[10] This means that subdivisions in DAAs that were recorded prior to 1999 are not included in the sample since TDRs only were permitted in these regions after the down-zoning.

Table 3. Summary Statistics of Subdivision Sample, N = 228

	Subdivisions using TDRs, N=91		Subdivisions not using TDRs, N=137	
Variable	Mean	Std. Dev.	Mean	Std. Dev.
Number of lots built with TDRs	19.466	16.364	0.000	.
Total plat area (acres)	97.003	88.509	47.666	46.853
Length of subdivision perimeter (feet)	9828.813	4483.373	6606.606	3470.757
% subdivision land in steep slopes	38.406	29.029	35.561	29.604
% subdivision land in difficult soils	16.046	13.130	16.880	19.664
Within 1 mile of Patuxent River/Chesapeake Bay	0.143	0.352	0.241	0.429
Sewer service availability	0.011	0.105	0.044	0.205
% surrounding land in parks or private preserved open space/farmland	1.548	4.462	3.515	9.074
% surrounding land in open space area of another subdivision	5.940	9.893	3.619	8.367
% surrounding land in high-density residential use	0.919	3.124	7.605	16.457
% surrounding land in low-density residential use	33.214	20.698	29.299	21.117
% surrounding land in commercial/industrial zone	2.502	6.716	3.858	11.720
Distance to north end of county (meters)	16995.150	9678.308	23238.860	13101.850
Distance to Route 2/4 (miles)	1.189	1.077	1.533	1.282
Access to Town Centers (index variable)	77707	741254	972508	8581315
Annual TDR price (1999 dollars)*	2188.87	441.782	2065.99	480.317
Year of subdivision recording	1993.440	5.546	1991.241	5.289
Time trend	11.440	5.546	9.241	5.289
Subdivision recorded since 1993	0.560	0.499	0.365	0.483
Residential/Town Center	0.044	0.206	0.299	0.460
Grandfathered parcels	0.132	0.340	0.679	0.469

TDR = Transferable Development Rights

*TDR price is averaged over those subdivisions that used TDRs, not all subdivisions.

The figures in Table 3 show that the average percentage of surrounding land in preserved acreage is small, less than 4%, but ranges from 0 to 50%.[11] Similarly, there is considerable variation in the amount of adjacent residential development; some subdivisions are completely surrounded by other development and some by no other development. The average amount of surrounding land in high-density residential use varies considerably across the two types of subdivisions; those using TDRs have on average less than 1% of their perimeter adjoining high-density residential development (defined as having lots smaller than 1 acre), whereas more than 7% of land surrounding non-TDR subdivisions is in high-density residential use. The average subdivision is approximately 13 miles (20,700 meters) from the northern border of the county and is about 1.4 miles from Route 2/4, the key north-south commuting highway.

Most of Calvert County relies on septic systems because the sewer system is not extensive. In our sample, less than 2% of TDR subdivisions have sewers available and less than 4% of the non-TDR subdivisions are on sewers. Using data from the state of Maryland's soil classification system, we also are able to calculate the percentage of the subdivision acreage that falls into each of the soil and land types. From this, we construct variables that show the percentage of the total subdivision acreage that is steeply sloping (at a grade of 15% or higher) and the percentage in other "difficult" soils, that is, areas that are part of a floodplain or that have stony or clay-like soils that are relatively unsuitable for residential development or are expensive to develop. We find that the average subdivision in our sample has steep slopes in a little more than 35% of its land area and difficult soils in 16% of its land area.

The annual TDR price (in inflation-adjusted 1999 dollars) averaged a little more than $2,000 per TDR over the sample period, rising at an average annual rate of 6.3% from 1983 to 2001; however, most of the increase occurred in the first decade of the program. Between 1983 and 1993, the average real price more than doubled, rising from $1,211 (in 1999 dollars) to $2,578. Between 1993 and 2001, on the other hand, real prices remained relatively constant. (For more detail on TDR prices, see McConnell, Kopits and Walls [2003].) In Calvert County, a developer needs five TDRs to build one additional lot; thus, over the sample period, the average cost of each TDR lot to the developer was more than $10,000.

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[11] 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 only is considered to be surrounding land in preservation or parks 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.

Tobit Regression Results

The regression results are displayed in Table 4. The first column provides the tobit coefficients that show the effect of a change in the independent variables on the latent variable, t_i*. These can be used to obtain information about the effect of changes in an explanatory variable on the observed dependent variable, t_i, given the information that it is uncensored (McDonald and Moffit 1980). These, the correct regression effects for uncensored observations, are displayed in the third column of the table. Specifically, they show the change in the expected number of TDR lots built in a subdivision given a change in the independent variable for the subdivisions that did buy some TDRs (but did not go to the maximum TDR limit).[12]

In addition, one can calculate the marginal effect of a change in each factor on the probabilities of crossing either the upper or lower censoring threshold. The second column shows the effect of a unit change in each independent variable on the probability that a subdivision will have at least one TDR lot calculated just for the subdivisions that didn't use any TDRs (i.e., the left-censored observations). Similarly, the last column gives the marginal effect of a change in an independent variable on the probability of buying less than the maximum number of TDRs allowed calculated for the subdivisions that were observed to be at the TDR limit (i.e., the right-censored observations).[13]

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[12] Assuming $f(W_i, P_{TDR}, \bar{z}_i) = \beta' X_i$, where X_i is a vector of all the explanatory variables, then the marginal effect of the k-th independent variable, X_k on the expected observed dependent variable, given that it is uncensored, is given by

$$\partial E(t_i \mid 0 < t_i^* < \bar{t}_i) / \partial X_{ik} = \beta_k \left[1 - \frac{\phi_{2i}(\bar{t}_i - \beta' X_i)/\sigma + \phi_{1i}(\beta' X_i)/\sigma}{\Phi_{2i} - \Phi_{1i}} - \frac{(\phi_{2i} - \phi_{1i})^2}{(\Phi_{2i} - \Phi_{1i})^2} \right]$$

where β_k is the tobit coefficient estimate on the k-th variable and $\Phi_{2i} = \Phi\left[(\bar{t}_i - \beta' X_i)/\sigma\right]$ and $\Phi_{1i} = \Phi\left[(-\beta' X_i)/\sigma\right]$, with corresponding definitions for ϕ_{1i} and ϕ_{2i} (see Maddala 1983). The computed partial derivative is averaged over all the uncensored observations to obtain the marginal effects displayed in the third column of Table 4.

[13] The marginal effect on the probability that the developer buys at least some TDRs is given by $\partial P(t_i > 0)/\partial X_{ik} = \beta_k \phi_{1i} / \sigma$. Averaging over all the non-TDR (left-censored) observations yields the estimates displayed in column two of Table 4. Similarly, the marginal effect on the probability that the developer does not purchase the maximum number of TDR lots allowed is given by $\partial P(t_i > 0)/\partial X_{ik} = -\beta_k \phi_{2i} / \sigma$; the mean value (for the right-censored observations) is shown in the fourth column.

Table 4. Tobit Regression of TDR Demand (With Robust Standard Errors)

Dependent Variable: Number of lots built with TDRs	Coeff. (std. err.)	Marginal effect on $P(t_i>0)$	Marginal effect on $E(t_i \| 0<t_i^*<\bar{t}_i)$	Marginal effect on $P(t_i<\bar{t}_i)$
Zoning/TDR dummy variables				
Residential/Town Center	-21.502 (7.486)***	-0.207	-9.244	0.316
Recorded since 1993	9.795 (6.504)	0.094	4.211	-0.144
Grandfathered parcels	-28.015 (3.929)***	-0.269	-12.044	0.412
Residential/Town Center, recorded since 1999	28.967 (11.600)**	0.278	12.453	-0.426
DAA, recorded since 1999	28.571 (9.553)***	0.275	12.283	-0.420
RC recorded since 1999	21.997 (8.707)**	0.211	9.457	-0.323
Subdivision size and characteristics				
Acres	0.502 (0.163)***	0.005	0.216	-0.007
STEEP (% land in steep slopes)	-0.458 (0.147)***	-0.004	-0.197	0.007
Acres * STEEP	-0.006 (0.002)***	-0.00006	-0.00272	0.00009
Perimeter	-0.005 (0.002)**	-0.00005	-0.00213	0.00007
Perimeter * STEEP	0.00010 (0.00003)***	0.000001	0.000045	-0.000002
% land in difficult soils	-0.164 (0.093)*	-0.002	-0.070	0.002
W/in 1 mile Patuxent/Chesapeake	-3.785 (4.155)	-0.036	-1.627	0.056
Sewers	24.237 (9.734)**	0.233	10.420	-0.356
Surrounding land uses				
% park/private agricultural preservation	-0.498 (0.206)**	-0.005	-0.214	0.007
% open space of other subdivision	0.017 (0.153)	0.0002	0.007	-0.0003
% high-density residential use	-0.489 (0.168)***	-0.005	-0.210	0.007
% low-density residential use	-0.136 (0.063)**	-0.001	-0.058	0.002
% commercial/industrial zone	-0.167 (0.262)	-0.002	-0.072	0.002
Accessibility variables				
Distance to north end of county	-0.001 (0.0001)***	-0.000006	-0.000259	0.000009
Distance to Route 2/4	-0.991 (1.384)	-0.010	-0.426	0.015
Access to town centers	-1.95 (1.31)	-0.019	-0.837	0.029
Time trend				
T	9.759 (3.771)***	0.025	0.627	0.053
t^2	-0.390 (0.159)**			
Annual TDR price ($1,999)	-0.030 (0.012)**	-0.000288	-0.012887	0.000441
Constant term	49.490 (13.475)***			
Sigma	14.513 (1.463)			
No. of observations	228	137	80	11
No. of observations: 228, Left-censored: 137, Uncensored: 80, Right-censored: 11				

TDR = Transferable Development Rights DAA = Designated Agricultural Area RC = Rural Community

***Indicates statistically significant at the 99% level; ** at the 95% level; * at the 90% level

Zoning/TDR Variables. The variables that capture baseline density limits across different zoning categories, including the limits established under the TDR program and the down-zonings, are highly significant and have the signs that we would expect. These dummy variables all are specified relative to the baseline of five-acre rural zoning that prevailed in rural areas prior to the 1999 countywide down-zoning.[14] Relative to this baseline and holding subdivision size constant, the first coefficient suggests that Residential and Town Center zoning leads to fewer TDR lots. On average, TDR subdivisions in Residential or Town Centers buy nine fewer TDR lots than those in the rural areas. In addition, a Residential or Town Center designation causes a 0.21 decline in the probability that a non-TDR subdivision would purchase any TDRs and a 0.32 increase in the probability that a subdivision does not go to the maximum TDR limit. This supports evidence from Table 2 that subdivisions going into the more densely zoned Residential or Town Center areas are less likely to buy TDRs than subdivisions going into the RCs.

Coefficients on the three dummy variables capturing the effect that the down-zoning had in each zoning area all are found to be positive and significant. As shown in Table 1, the 1999 down-zoning reduced the baseline density (i.e., the number of lots that can be built without using TDRs) by 50% in all zoning categories. However, TDRs could be purchased to get back to the same maximum density levels allowed prior to 1999. The results suggest that developers found the extra expenditure worthwhile, to some degree, in the rural areas but not in the Residential and Town Center zones.

Interestingly, the marginal effect on the expected number of TDR lots is greater in the DAAs than in the rural areas outside the DAAs, known as RCs. Given that some TDRs were used, on average 12 more TDR lots were created in a DAA subdivision but only 9 more TDR lots were created in a RC subdivision. Since this is relative to the TDR use before 1999, this means that subdivisions in RCs did not purchase TDRs back up to the realized pre-1999 densities (which were higher in the RCs than in the DAAs) to the same degree as in the DAA areas. This

[14] Although the right-censoring limit is accounting for the maximum density allowed with TDRs, it is still important to include the zoning variables as explanatory variables because they control for differences in the baseline density rules (i.e., the number of lots that can be built without TDRs). Similarly, the grandfathering dummy is also included because it is controlling for a different "baseline" zoning allowance. We do not need to include a dummy for rural subdivisions within 1 mile of a Town Center. The reason for this is that it does not reflect any difference in baseline zoning. As noted in Table 1, subdivisions in these areas are allowed a greater density bonus (to 4 lots/acre), but this is accounted for in the censoring.

finding could reflect the fact that developers in the RCs already were buying TDRs before 1999 and the marginal value of TDR lots after the down-zoning would have been lower than in the DAAs.

Consistent with the impact on TDR use before the down-zoning, fewer additional TDRs were used in Residential or Town Center TDR subdivisions after 1999; in subdivisions using TDRs, three more TDR lots were created than in the pre-1999 rural areas. The marginal effect on probability of using any TDRs is similar across the different zoning categories. After 1999, the probability of a non-TDR subdivision purchasing any TDRs increased by more than 0.21 and the probability of being below the maximum TDR limit declined by more than 0.32.

In addition to controlling for the zoning changes, we include a dummy variable to capture any change in TDR use after the county entered as a participant in the TDR market in 1993. We find the coefficient on the "Recorded since 1993" variable to be positive, but the result is not statistically significant. This suggests that there was no significant increase in TDR use after the county began buying and retiring TDRs through the PAR program. However, the coefficients on the time trend terms indicate that TDR use did increase over time, although at a decreasing rate. At the mean subdivision recording year (1993), TDR use increased by 0.63 lots per subdivision each year. This may be capturing an increase in familiarity or understanding of the TDR program rules on the part of the developers or a countywide increase in the demand for smaller lots on the part of homebuyers.

Finally, we have included a dummy variable to control for the presence of grandfathered lots. 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 three-acre to five-acre lot down-zoning. The "Grandfathered parcel" variable is a subdivision-specific dummy variable equal to one if the subdivision had some grandfathered lots from less restrictive densities in place in earlier years. We find, as expected, that the presence of grandfathered lots decreases the number of TDR lots in a subdivision. For the subdivisions that purchased TDRs, adding grandfathered lots will reduce the number of TDR lots by 12, all else being equal. The results also show that adding grandfathered lots reduces the probability that any TDR lots will be purchased by 0.27 and increases the probability that a subdivision will not reach the maximum TDR density allowed by 0.41.

The results described in this section highlight the advantages of the Calvert County data for this analysis. The TDR program combined with the down-zoning provides an interesting way to look at the effects of the baseline zoning rules on TDR demand. Since in practice all TDR programs are used in conjunction with zoning regulations, it is important to have a good understanding of how changes in the underlying zoning parameters change developers' preferences for TDRs. In Calvert County, it appears that the costs to developers of using TDRs are not worth the benefits in the higher density residential areas but are worth the benefits in the relatively low-density rural areas. This may mean that Residential and Town Center subdivisions are able to achieve their desired density levels under the baseline zoning rules. We now turn to the economic factors likely to influence TDR use.

Subdivision Size and Characteristics. Among the key subdivision characteristics included here is the total size, shape, and topography of the subdivision. Total subdivision acreage and the percentage of land that is in steep slopes (*STEEP*) enter the equation both separately and interactively. The length of the perimeter of the subdivision (*Perimeter*) is included as a measure of the shape of the subdivision. For a given acreage, the longer the perimeter, the more irregular will be the shape of the parcel. It may be more difficult or costly to build a large number of lots on an irregularly shaped tract of land compared with one that has a more regular shape, thus we expect this coefficient to be negative. We also interact this shape parameter with the steep variable, expecting the shape of the subdivision footprint to affect the relationship between the amount of steep slopes and the building potential of the site.

As seen in Table 4, we find that TDR use increases with total subdivision acreage, as expected. The negative coefficient on the variable that interacts size and the percent steep slopes (*Acres*STEEP*) indicates that the positive effect of a larger acreage on the number of TDR lots is somewhat offset when the subdivision is more steeply sloped. Evaluated at the mean value of *STEEP*, the results suggest that a 10-acre increase in subdivision size leads to approximately 1 more TDR lot in subdivisions using TDRs.

The coefficient on *STEEP* also is negative and significant at the 1% level. Evaluated at the mean subdivision size, we find that a 10-percentage-point increase in *STEEP* leads to 0.22 fewer expected TDR lots in subdivisions buying TDRs. The estimated coefficient on *Perimeter* is also negative but, somewhat surprisingly, we find the coefficient on the *Perimeter-STEEP* interaction term to be small but positive, indicating that the more irregular the shape, the less the effect of steep slopes on the number of lots that can be built. When evaluated at the sample mean of *STEEP*, we find that a 10,000-foot increase in the subdivision perimeter leads to three fewer TDR lots.

In addition to the shape and topographical characteristics of the site, we control for the quality of the soils in the subdivision. We find the coefficient on our “Difficult soils” variable to be negative as expected but small in magnitude; a 10-percentage-point increase in Difficult soils reduces the number of TDRs lots by 0.7 in TDR subdivisions.

We also include a dummy variable that measures whether the site is within one mile of the Patuxent River or the Chesapeake Bay—TDR use may be lower in these locations because consumers may demand larger lot sizes on waterfront properties and because the state’s “Critical Area” designation may limit density near the bay and the river.[15] On the other hand, these are desirable locations, so we might expect more building and, thus, higher TDR use, in these areas, all else being equal. It is possible that these two effects offset because although the coefficient is positive, it is not significantly different from zero.

The final subdivision variable indicates whether the subdivision is in an area that has access to the sewer system. We expect adjacency to sewer systems will increase the number of houses that can be built, since developments that can tie into the sewer system will not have to develop alternative sewage treatment or septic systems. We find sewers to be a strong determinant of TDR demand; in subdivisions that are already using TDRs, the presence of sewers leads on average to 10 more TDR lots per subdivision. Sewer availability also increases the probability that a non-TDR subdivision will purchase TDRs by 0.233 and decreases the probability that a subdivision will remain below the maximum TDR density by 0.356.

Finally, we can summarize the marginal effect of changes in subdivision characteristics on the probabilities of crossing either censoring threshold (displayed in the second and fourth column of Table 4). With the exception of sewer availability, changes in the other subdivision characteristics generally are not found to have large impacts on either the probability of buying at least one TDR or the probability of being under the maximum TDR limit. For example, even a 10-acre increase in the total subdivision size only would increase the probability of buying TDRs by 0.02 (evaluated at the mean of *STEEP* for the non-TDR subdivisions). Similarly, a 10-percentage-point increase in the amount of land in steep slopes or difficult soils would lead to a 0.002 or 0.02 decline in the probability of buying TDRs, respectively (evaluated at the mean subdivision size and perimeter of non-TDR subdivisions).

[15] For more about Critical Areas, see Walls and McConnell (2004).

Surrounding Land Uses. Detailed data on existing uses of the land surrounding each subdivision allows us to examine specific ways that surrounding land use might affect TDR use, especially the density of the existing residential development. As discussed in the previous section, our five surrounding land use variables indicate the uses in effect at the time the subdivision was initiated. In Table 4, we find that a larger percentage of land on the perimeter of the subdivision in parks or permanently preserved in farmland or forestry (either through the TDR program or one of the state easement programs) decreases the probability that a developer will choose to buy TDRs or the number of TDRs purchased. A 10-percentage-point increase in the amount of surrounding preserved land leads to two fewer TDRs lots in subdivisions that use TDRs. This could reflect the fact that with higher end housing, a greater amount of surrounding preserved land increases the marginal profit to developers from building subdivisions at lower density, thus reducing TDR demand in those locations. .

We also find consistent evidence that TDR use falls when surrounding residential densities are higher. Relative to no surrounding development, a 10-percentage-point increase in the amount of the perimeter that is adjacent to low-density residential development (specified as greater than one-acre average lot size) leads to 0.5 fewer lots being built with TDRs. An equal change in the perimeter adjacent to higher density development (with average lot size of one-acre or less) has a significantly larger effect on TDR demand: the expected number of TDR lots declines by two in subdivisions already using TDRs.[16] This lends support to the notion that existing residents may be able to exert some influence over the density of new developments in their neighborhoods. Alternatively, if developers are allowed to use TDRs in receiving areas by right (as is claimed to the be case in Calvert County), then the negative coefficients on the surrounding residential use variables in Table 4 could reflect an increase in the amount of open land the developer chooses to reserve in the subdivision (either through an increase in open space areas or through larger lot sizes) to buffer the new residents from being directly adjacent to high-density existing development. The percentage of a subdivision's boundary that is in either another subdivision's open space area or a commercial or industrial zone does not appear to affect TDR demand; neither coefficient is statistically significant.

Accessibility variables. According to the conventional urban models, higher density development should take place in regions more accessible to major cities and closer to the

[16] The magnitude of this effect becomes even larger if the cutoff between high vs. low density is increased to ½ acre lots.

highways leading to those cities. In the case of Calvert County, we would expect developers to purchase more TDRs for subdivisions in the northern end of the county than for those in the southern areas. To capture this effect, we include a variable measuring the distance from the subdivision to the northern most point of the county. We find the coefficient to be negative and significant as expected; moving 1,000 meters (0.62 miles) farther south leads to 0.2 fewer TDR lots in those subdivisions already purchasing TDRs. The corresponding results in columns 2 and 4 in Table 4 suggest that such a change would have little effect on the probability of buying TDRs at all.

In addition to the subdivision's distance from major cities, we also expect subdivisions that are farther from major roads and commercial areas to be less dense and hence to use fewer TDRs. We find the subdivision's proximity to the major commuting road, Route 2/4, to be negative as expected but statistically insignificant. We measure proximity to shopping and other commercial areas by the subdivision's location relative to the Town Centers in the county. To do this, we create a simple gravity index that is increasing in the size of the eight major town centers and decreasing with distance from the subdivision location.[17] We find that the index has no significant effect on the demand for additional density in Calvert County.

TDR Price. The final explanatory variable included in the model is the annual average price of a TDR in inflation-adjusted terms. As expected, the results show that an increase in TDR price is statistically significant in explaining the number of TDRs purchased. In subdivisions using TDRs, a $1,000 increase in the TDR price (which corresponds to an increase of $5,000 per TDR lot) leads to nearly 13 fewer TDR lots. This change also would decrease the probability of using TDRs at all by 0.29 and increase the probability that a subdivision remains below the maximum TDR threshold by 0.44. Although this is a seemingly large impact, TDR price changes of this magnitude did not occur rapidly over the sample period. This may be because the price was relatively constant in the period after about 1993, rising only slightly each year.

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[17] The "Access to Town Centers" index is defined as: $I_i = \sum_{k=1}^{c} (M_k / d_{ik}^2)$ where i denotes the subdivision, c is the number of town centers, M_k is the size of town center k, and d_{ik} is the distance from subdivision i to town center k.

V. Conclusion

The data from Calvert County's 23 years of experience with TDRs provides a unique opportunity to evaluate the performance and efficiency of a real-world TDR market. The Calvert County program is one of the first programs to allow markets to price development rights and to allocate land between development and preservation. It is also one of the few active TDR markets in the country and is unusual in the degree of flexibility it allows landowners and developers in making density decisions in sending and receiving areas. This stands in contrast to many other TDR programs around the country that have had little market activity and low or fluctuating prices. This makes the Calvert County TDR program an ideal laboratory to examine what contributes to market activity, especially on the demand side of the market.

Estimating a tobit model of the number of TDR lots a developer chooses to put in a given subdivision, we are able to identify many of the factors that influence the demand for TDRs. We find that both baseline zoning rules and economic variables are important in determining TDR use. The baseline zoning levels in receiving areas are crucial. All else being equal, developers use far fewer TDRs in subdivisions located in the more densely zoned Residential or Town Center areas than in the rural receiving areas.

This gives some indication that the baseline zoning limits in the Residential zones and Town Centers are roughly set at desired density levels. In at least some of the RC areas, however, the baseline zoning is lower in density than would be attained through market outcomes. The relationship of baseline zoning to desired density is therefore critical in creating demand for TDRs. If planners want to use policies such as TDRs to direct additional density primarily toward existing urbanized, higher density areas, they will need to think carefully about the baseline zoning that exists in those areas to understand whether such outcomes can be achieved with TDRs.

Sewer availability seems the most important determinant of TDR demand of the subdivision characteristics we examined here. Other factors do influence the expected number of TDRs purchased in those subdivisions already using them, but it takes large differences in the characteristics to cause a subdivision that previously wasn't using them to start buying them. We find that there is more TDR use over time in the county and that price does have an influence on developer purchases of TDRs.

The land uses surrounding a new subdivision were found to have an effect on the use of TDRs and therefore the density of the development. Having a larger fraction of the subdivision perimeter adjacent to permanently preserved open space resulted in fewer lots built with TDRs, other things the same. An awareness of permanently preserved land surrounding the site may enhance its value for a more rural, lower density development, perhaps with higher-end housing. Another interesting result is that, all else being equal, an increase in the amount of surrounding higher density subdivisions reduces TDR use. This could be that homebuyers in relatively rural, ex-urban areas like Calvert County prefer not to be adjacent to other residential development. Alternatively, existing residents may perceive higher density development as imposing more costs on the community and therefore may seek to influence the use of TDRs to create higher density. This result suggests that there is some leapfrog development occurring, especially in the rural community areas. Even so, there is more permanently preserved land in total, and the development that does occur is denser due to the active TDR program. Other areas considering the use of TDRs have a number of different lessons to draw from this experience.

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