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# Lot Size, Zoning, and Household Preferences

*Impediments to Smart Growth?*

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# **Lot Size, Zoning, and Household Preferences: Impediments to Smart Growth?**

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## **Abstract**

The paper explores a number of issues related to lot size and urban density. First, trends in single-family residential lot size over the past 35 years are examined in eight counties in the state of Maryland. We find that there was a trend toward larger lot sizes in many suburban counties in the mid to late 1990s, and that there has been a general flattening of the density gradient in urban areas over the last few decades. We then examine the extent to which lot size is being constrained by regulation by comparing actual subdivision density to the allowable density under zoning rules. This analysis is done for three counties with different degrees of suburbanization. We find that only in the areas with the very large lot zoning does zoning seem to be constraining actual lots size. There is a good deal of excess capacity in the density that could be built, especially in the more densely zoned areas. Finally, recognizing that households have preferences for lot size and other housing characteristics, we provide some evidence about the strength of household preferences over lot size and their willingness to trade off lot size for other characteristics.

**Key Words:** land use, urban sprawl, density, lot size

**JEL Classification Numbers:** Q24, Q28, R14

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# Lot Size, Zoning, and Household Preferences: Impediments to Smart Growth?

Elizabeth Kopits, Virginia McConnell, and Daniel Miles \*

## 1. Introduction

One of the major obstacles to smart growth, as envisioned by the State of Maryland and other groups around the country, is the trend toward low-density development. Households appear to prefer large lots, and jurisdictions often set zoning rules that result in low average densities, especially in suburban areas. Even in more urbanized areas, when maximum allowed densities are set at higher levels, existing residents often try to reduce the density on any new development. This paper will explore issues related to lot size and urban density, drawing on evidence from the suburban Maryland region. The paper has three parts. First, we will examine the extent to which lot sizes have been increasing over time, and how those trends appear to vary by stage of development and by regulatory pressures. Next, we examine the extent to which lot size is being constrained by regulation, comparing actual lot size to the allowable density under zoning rules. Finally, we provide some evidence about the strength of household preferences over lot size.

With new methods of monitoring and measuring spatial land use features, there has been a good deal of interest in recent years on measuring patterns of urban expansion (e.g., Burchfield et al. 2006; Irwin, Bockstael, and Cho 2006; Knaap, Song, and Nedovic-Budie 2007). Locally, the State of Maryland monitors urban land use with satellite data<sup>1</sup>, and also provides comprehensive spatial land use information at the property level through the spatial data base "Property View" (Maryland Department of Planning 2005). These two data sources sometimes

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<sup>1</sup> Maryland Department of Planning; Land Use Land Cover in Maryland by Political Jurisdiction, Planning Data Services, GIS Section, Baltimore. [http://www.mdp.state.md.us/zip\\_downloads\\_accept.htm](http://www.mdp.state.md.us/zip_downloads_accept.htm).

show conflicting results for land uses and density levels, (Irwin, Bockstael, and Cho 2006), and for lot size data, the property level data is preferred. Knaap, Song, and Nedovic-Budie (2007) have used the property level data from Property View for one county to look at lot size trends as one of a number of indicators of urban sprawl. They find that lot sizes rose through the 1970s, but have actually fallen since that time. We use Property View data to examine trends in lot size for eight different counties in the Washington Baltimore region: Montgomery, Prince Georges, Howard, Anne Arundel, Calvert, Charles and Baltimore Counties. We focus on single family residential properties and find that levels and trends differ considerably across the region.

For a subset of counties, we are able to compare densities of the actual developments or subdivisions that have been built and examine how these differ from the allowed densities under existing zoning rules, including with the use of additional density through transferable development rights (TDRs). Levine (2005) has argued that it is large lot zoning that is causing low density urban expansion. However, from earlier work on Calvert County, Maryland, we found evidence that in many areas the actual densities are often well below the maximum allowed densities, meaning that average lot sizes are larger than permitted by zoning and TDR regulations. This is most evident in areas zoned for high density development, and less true in the low density areas (McConnell, Walls, and Kopits 2006; McConnell and Walls 2006). We explore this issue for a set of counties.

A central concern for policy-makers who would like to promote more compact suburban development patterns is to understand how households value lot size, and how they might trade off lot size for other housing attributes (e.g., house size and age). Using detailed data on over two decades of house sales in Calvert and Montgomery County, we estimate the value of lot sizes and how households trade off lot size for housing attributes. We also investigate the degree to which the value of a larger lot has changed over time in the two counties.

## **2. Trends in Density over Time, by County in Maryland**

There are conflicting statements and evidence about what has been happening to lot size and density trends in urban areas in recent years. There is concern that lot sizes are large in suburban jurisdictions, and have been increasing as development pushes the limits of urban areas to more distant locations. On the other hand, there is some evidence that lot sizes have stopped increasing and have even declined in certain suburban jurisdictions (Knaap, Song, and Nedovic-Budie 2007). It is likely that both are true. Lot sizes are the result of many competing forces. They depend not only on preferences which vary across households and can change over time, but also on economic and political forces. Lower land prices in more distant locations could be

expected to result in larger lots, as would higher incomes. High population growth rates and the associated attempts to limit and control new development that often accompany it can lead to higher land prices, and restrictions in the supply of housing, and in some places reductions in lot sizes (Glaeser et al. 2005).

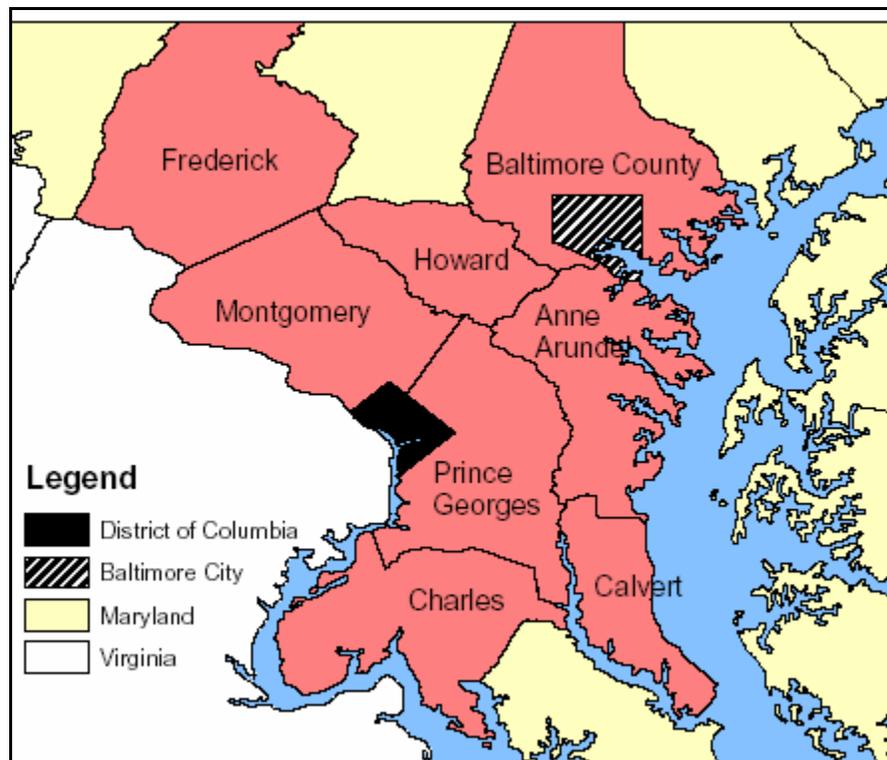
In this section, we take a simple look at trends in average lot size over time in an attempt to observe the general outcome of these complex interactions. We are also interested in what lot sizes and density look like in different parts of an urbanized area. Our study region, shown in Figure 1, includes eight suburban and exurban counties within the Washington-Baltimore metropolitan area: Montgomery, Prince Georges, Howard, Anne Arundel, Calvert, Charles, Frederick, and Baltimore. We use property level data to examine trends in single-family residential housing density and also the extent of high-density development.<sup>2</sup> Property data is more accurate for assessing density, compared to satellite data or other methods that have also been employed to assess the pattern and density of urban development (Irwin, Bockstael, and Cho 2006).

Table 1 shows the extent of variation in the amount of new single family residential development across the counties in our sample, and in lot sizes of that development. Over the whole area, single family housing comprises nearly 70 percent of all residential dwelling units, with the other 30 percent accounted for by condominiums and apartments. Calvert and Charles County have over 92 percent in single family units on one extreme, and more suburban counties of Montgomery, Prince Georges and Baltimore County have closer to only 50 to 65 percent of units built in single family units.

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<sup>2</sup> For each county, our dataset includes all residential parcels with a built structure (as indicated by the year the structure was built) and information on the size of the lot. To ensure that small structures (e.g., barns) were not considered as houses, the final sample includes only parcels with assessed improvement value over \$50,000. Parcels greater than twenty-five acres in size were also dropped from the dataset. The final dataset contained 970,012 parcels. The data were drawn from the State of Maryland's "Property View" database.

Figure 1. Maryland Study Region



Average lot size of recently built single family detached houses and townhouses range from over 1.2 acres in the more outlying counties of Calvert and Charles, to less than a half acre in Montgomery and Prince Georges, the two counties bordering Washington, DC. The other counties have average lot sizes that are between 0.5 and 0.75 acres. Median lot size is much lower, roughly 0.25 acres in all counties except Calvert, indicating that the distribution of lot sizes within a county tends to be skewed, with most of the lots being small but with a small number of large lot outliers. This is especially true in the more exurban counties. The degree of variation is high in all counties, with coefficients of variation between 2 and 2.5 in all counties, except Howard, Charles and Calvert Counties. With a coefficient of variation of 1.3, Calvert has perhaps the most homogeneous density of jurisdictions in the study region.

**Table 1. Density of New Single-Family Residential Development, Maryland Counties<sup>a</sup>**

County	% of all residential units built through 2005	Lot size of units built 1996-2005		
		Median	Mean	Std. Dev.
Anne Arundel	82.0	0.18	0.50	1.18
Baltimore County	47.9	0.18	0.67	1.46
Calvert	97.5	0.92	1.27	1.66
Charles	92.7	0.28	1.21	2.08
Frederick	86.7	0.23	0.68	1.71
Howard	73.8	0.30	0.68	1.19
Montgomery	66.9	0.18	0.47	1.10
Prince Georges	65.2	0.24	0.38	0.80
<b>Total</b>	<b>67.7</b>			

<sup>a</sup>Single-family development includes single-family detached dwellings and townhouse units.

Average lot sizes are much higher for multifamily housing units—condominiums and apartments—which are not included in Table 1. In most counties these developments average around 0.059 and 0.053 acres per unit, respectively, or densities close to 10 times those of the single family developments. Instead of 2 units to the acre as in the residential areas, there are closer to 20 units to the acre. We are not able to examine trends in multi-family development in more detail due to missing property level data on year built and lot size in many counties. However, based on the limited data that is available, there seems to be less variation in the density of these multi-family housing types compared to the single family development.

To examine trends in lot size over time among the counties, we separate the counties into suburban counties of the Washington, DC and Baltimore suburbs from the more rural counties that are farther removed from the cities but still are affected by growth in the metropolitan region. The top graph of Figure 2 shows the average lot size trends for the suburban counties from the 1970 to 2005, and the bottom graph shows the trends for the ex-urban counties for the same period. Hammer et al. (2004) found in Midwestern regions, that there seemed to be little consistent upward or downward trend over time for the jurisdictions that studied. Although there no dominant trends across all of the counties in our study, we do find a number of results worth noting. First, in the suburban counties (top graph of Figure 2), we find that lot size was declining from the mid-1970s to the mid-1980s. Then from the late 1980s on, there is trend toward larger lot size, particularly for Montgomery, Prince Georges, and Baltimore counties.

We find that the ex-urban counties tend to have the opposite trend in lot size over time. Overall, their lot sizes are much higher, but we do see that in both Calvert and Frederick counties, lot sizes began to decline they have tended to decline in the late 1980s. This was not true for Charles County, where lot size tended to increase slightly over the same period.

Some of the changes in average lot size in certain counties can be explained by changes in local government regulations.<sup>3</sup> For example, in Montgomery County, there was a large reduction in average lot size fell 0.64 to 0.23 acres between 1978 and 1983. This coincides with the adoption of the transferable development rights (TDR) program in the county. In the early years of the TDR program, transfer activity was high with developers purchasing TDRs from farmers in the western part of the county in order to increase density in designated TDR receiving areas (see McConnell and Walls 2006) for details of the Montgomery County TDR program). The bottom graph in Figure 2 shows a similar decline in mean lot size in Calvert County around 1980 when the TDR program there was adopted, and a large drop in the late 1980s following a period of increased activity in its TDR market.<sup>4</sup> With the ability of developers to use TDRs to increase density in some areas with reductions in land converted to development in others, we would expect to see this affect on lot size with a TDR program.

There was also a change in zoning in Frederick County in the mid 1980sf, which required larger minimum lot sizes in the agricultural areas but allowed additional higher density options in the urban areas, particularly in Frederick City. The decline in mean lot size after 1988 after may reflect this change in zoning rules, and the generally fast rate of growth in subdivision development at residential densities in and around the city of Frederick.

These trends in the density of new units shown in Figure 2 are somewhat suggestive of what has been historically observed in U.S. cities, which is the flattening of urban density gradients over time (McDonald 1989). The downward trend in lot size in the exurban counties of Calvert and Frederick indicates that density of new development has increased in these outlying areas since the 1980s, while the suburban county densities appear to be quite constant over this period. This may provide some evidence of a trend toward more uniform density, or some

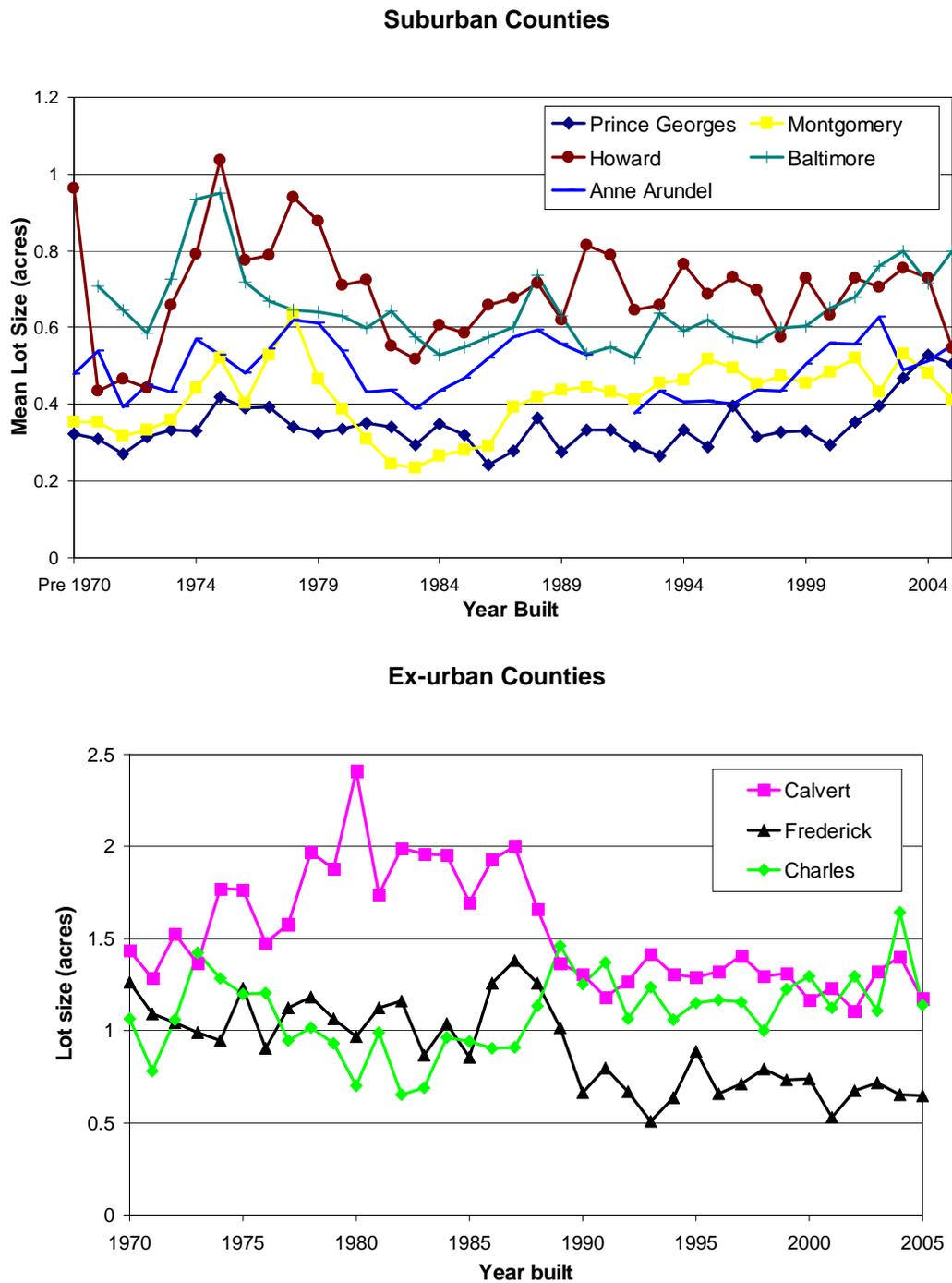
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<sup>3</sup> Since much of this development is occurring within subdivisions, there may be a lag between when density decisions are made (at the time of subdivision recording) and density levels observed in Table 1 and Figure 2 in the year houses are built.

<sup>4</sup> Kopits, McConnell, and Walls (2008) find the number of lots created through the purchase TDRs in Calvert increased on average by 3 lots per year in subdivisions using TDRs over 1983-1987, all else equal.

flattening of the density gradient in the overall metropolitan region. We would, of course, need to include multi-family units in any analysis to fully address this issue.

**Figure 2. Mean Lot Size of New Single-Family Development<sup>a</sup>, Maryland Counties, 1970-2005**



<sup>a</sup>Single-family development includes single-family detached dwellings and townhouse units.

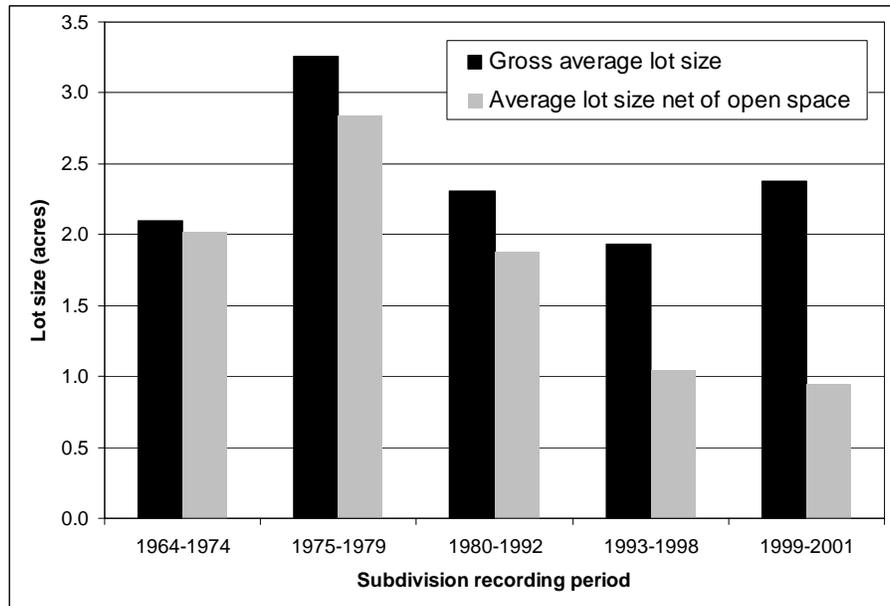
One other qualification to the density estimates provided in Figure 2 is that the discussion thus far has focused on actual lot size of all single-family housing. Since most suburban and ex-urban housing occurs within subdivision developments, it is also interesting to look at how density has changed at the subdivision level. Increasingly, many subdivisions include "clustered" development, in which houses are located on a portion of the total land area and the remainder is left as open space. In some communities, the zoning law mandates clustering; in others, clustering is recommended but not required. Proponents of clustering requirements argue that undeveloped areas (e.g., undisturbed forest, pastureland, recreation facilities, trails, etc.) convey value, not only to the residents of the subdivisions themselves, but also to the broader community, by preserving more of the aesthetic and rural character of the community and improving environmental quality through habitat protection or water pollution reduction in the region (Arendt, 1992). In communities on the urban-rural fringe, clustering residential developments may be one option in the local government's toolkit for maintaining an agricultural base and curbing sprawl.

Among the eight counties examined here, the effect of clustering over time is most apparent in Calvert, where mandatory clustering for all major subdivisions has been in place since 1992. Figure 3 shows average lot sizes within Calvert County by different time periods.<sup>5</sup> Although the average gross lot size, calculated as total subdivision acreage divided by the number of houses, has remained relatively high and constant over time, the average lot size net of open space has declined. This provides some indication of the extent to which clustering has been increasing in the county in recent years. Gross lot size is trending up in the late 1990s due to a major countywide downzoning that occurred in 1999, but actual house lots continued to fall in size slightly, reflecting more open space in subdivisions.<sup>6</sup>

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<sup>5</sup> The time periods are chosen to reflect zoning and other changes in the county. Note that these periods generally do not match up with the years shown in Figure 1, since houses are often built several years after a subdivision is recorded.

<sup>6</sup> The net lot size should correspond to our mean lot size estimates from Figure 2 above, and they are roughly consistent.

**Figure 3. Gross vs. Net Density of New Major Residential Subdivisions, Calvert County**

### 3. The Relationship between Minimum Zoned Lot Size and Actual Lot Size

Zoning rules establish either the minimum allowable lot size, or the maximum number of units that can be built per acre or both. These rules are set by local government and vary spatially both within and across jurisdictions. And, zoning rules can be changed by local government over time. It has been argued in the planning and economics literature that zoning which requires large minimum lot sizes may be contributing to urban sprawl (Levine 2006, Fischel 1999). In counties such as Calvert that have increased the allowed minimum lot size in some areas (referred to as downzoning) in an attempt to limit growth, we would expect average actual lot sizes to increase. But, are zoning limits the major factor determining lot size? If lot sizes tend to be right at the minimum allowed lot size, that suggests zoning limits may be binding on developer decisions over density. This would be consistent with the argument made by some policy analysts that in many communities the role of zoning has become exclusionary, or used for the purpose of excluding additional development, especially high density development (Fischel, 2004). Outer suburbs are more likely use this type of low density zoning, so we may be more likely to see lot sizes determined by zoning in those areas.

On the other hand, more urbanized areas and inner suburbs that are already developed are more likely to employ zoning rules that attempt to maintain "like uses" or to prevent spillovers among uses. Recently, mixed use zones that include commercial and different residential

densities in the same development have become more common. Are these areas also likely to build at the maximum allowable lot size? McConnell, Walls, and Kopits (2006) estimated a density equation for subdivisions in Calvert County and found that while the underlying zoning influenced density, other factors were also important. They did find, however, that rural areas were more likely to be built at the limit of the allowable density. In contrast, inner urban areas that are zoned more densely, tend to be built at densities below the allowable zoned levels. We extend this work by looking at three counties each with different degrees of urbanization and development. The three are Calvert County, which is a primarily rural county with a few small urbanized areas, Charles County which has several larger urban areas but has many rural areas as well, and Montgomery County, much of which is part of the suburban area of Washington DC. All three counties have seen rapid development over the last 20 years. We examine how the ratio of actual lot size to the allowed minimum lot size varies across the range of allowable densities permitted in each county.

Since most residential development occurs within subdivisions, we used subdivision level data for our analysis. We include data on each subdivision with 3 more lots recorded over 1967–2001 in Calvert, 1980–2004 in Montgomery, and 1992–2005 in Charles County. We obtained the following data for the three counties: the year the subdivision was approved and the existing zoning rules at the time, any exemptions to the zoning rules such as for transferable development rights (TDRs), the land area of the project, and the number of units approved.

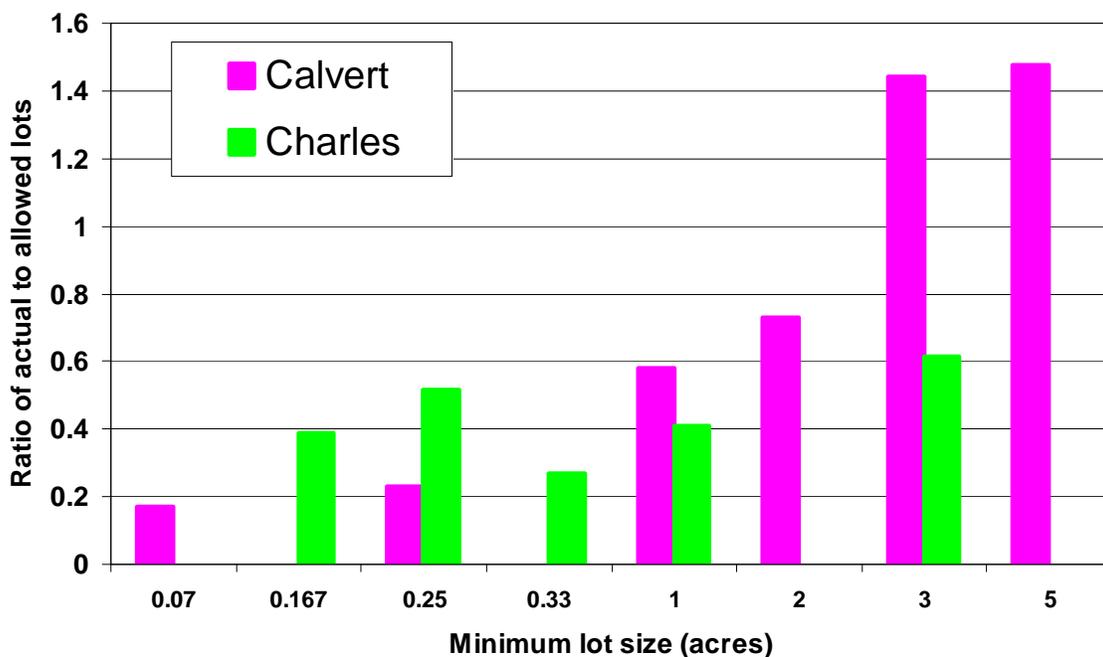
The exceptions to the zoning rules are important to this analysis. Each of the three counties examined here has a TDR program, by which housing units can be transferred from one area to another. The use of TDRs allows for additional density in some "receiving" areas; that is, it allows density to be higher than the zoning rules allow in those areas. In other areas, land is protected and there will be no development. The maximum allowable number of additional units with TDRs is always specified as part of the TDR receiving area designation. In our analysis below, we account for the allowed use of TDRs to have higher allowed density. In addition, in all jurisdictions, there are cases where zoning limits on a particular property are grandfathered to an earlier zoning allowance. In these cases, we are likely to see some properties developed at higher densities than existing zoning regulations would allow.

### ***Calvert and Charles Counties***

We begin with an examination of the two more rural counties in this three county analysis, Calvert and Charles. To determine whether subdivisions in these counties are being built close to zoning limits, we calculate the allowed number of units in subdivisions under the

zoning rules in place, and compare those to the actual number of units built. We organize these data by zoning level for each of the counties in Figure 4 below. The allowed minimum lot size in a given zoning area (for example, minimum lot size 1 house per acre) is shown along the x-axis. The allowed minimum includes the use of TDRs in zoned areas where they are permitted.

**Figure 4. Ratio of Actual to Allowed Lots, Subdivisions Built in Calvert and Charles Counties<sup>7</sup>**



Calvert County is the most rural of the three counties, but it has seen the fastest rate of growth in development. Between 1990 and 2000, the population grew by nearly 50 percent. In an effort to maintain productive farmlands and the rural character of the region, the County actively pursued various land preservation programs, and has one of the most active and broadly-applied TDR programs in the country. There are several aspects of Calvert County that differentiate it from the other counties examined here. First, it has attempted to use zoning to limit growth. As mentioned above, there have been some major downzonings in Calvert County, one in 1999 and again in 2004, which reduced the number of units that could be built on any property. Second, it

<sup>7</sup> For Calvert County, the data are from 398 subdivisions of size 3 lots or greater, from 1967-2005. For Charles County, the data are for 306 subdivisions with 3 lots or more built from 1990 to 2005.

has a unique and active TDR program that allows TDRs to be used to increase density of development in both rural and urbanized areas of the county.<sup>8</sup> The ability of developers to use TDRs to increase density in Montgomery and Charles counties is limited to urbanized areas.

Figure 4 includes results for Calvert County for 398 subdivisions recorded over 1967–2001, in six different zoning categories. Each bar shows the ratio of actual lots built to the allowed number averaged across all of the subdivisions in each zoning category. The lowest density Rural Preservation areas are shown on the far right, with a minimum lot size of 5 acres. Rural areas allowing the use of TDRs require a minimum of 2 acres per lot as shown in the middle bar. Town Centers permit the smallest minimum lot size of 0.07 acres: that is, with TDRs they can build as many as 14 units per acre, shown to the far left in Figure 4.

We find that subdivisions are much more likely to be close to the limit in the outlying rural suburbs in Calvert County. In the lowest density areas with 3 and 5 acre minimum lot sizes, the total units built are actually greater than the number allowed, due to the presence of some lots where density was grandfathered from an earlier time period.<sup>9</sup> In contrast, the residential and Town Center areas (bars to the left) are built at densities well below density limits permitted by zoning. The TDRs allow density to go to quite high levels in the Town Centers, because that is where the County wants to see more development, but it is clear from the figure that those areas are being developed well below allowable limits. For example, in Town Center areas, maximum allowable density is 14 units per acre or lot size of .07 acres (when TDRs are used), but the actual density at which developers are building in these areas is only 2.8 units per acre or average lots size of about .35 acres. In fact, in the Town Center and residential areas, there is effectively no additional density above the baseline zoning with the use of TDRs. Almost all of the additional density through TDRs is going into the rural areas.

The Charles County results are also shown in Figure 4. Charles County includes the rapidly growing area of Waldorf, which is a larger urbanized area than any in Calvert County. The area around Waldorf is designated as a development district, and has the only residential zoning in the County, with areas zoned for low density, medium density, and high density (minimum of 0.2 acres per lot). Most of the rest of the County is zoned as Conservation or Rural Conservation which requires a minimum lot size of at least 3 acres. There is a TDR program in

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<sup>8</sup>The full regulations for Calvert County are described in McConnell, Kopits, and Walls (2006).

<sup>9</sup>The early zoning in the rural areas had been at 3 units per acre.

Charles County that allows additional development through the purchase of TDRs only in the development district and not in any of the rural areas. For various reasons, the TDR program has not been nearly as active as the program in Calvert County.<sup>10</sup> TDRs were initiated in Charles County in 1993, but only 9 subdivisions purchased them for additional density out of about 120 subdivisions in the development district that could have used them. The subdivisions that did use TDRs were built mostly in the low density residential areas, with just a few in the medium density areas. No TDRs were used in the high density residential areas.

Figure 4 shows the comparison of actual and allowed densities for 306 subdivisions built in Charles County between 1990 and 2005. As in the Calvert County analysis, the graph shows the ratio, averaged over all subdivisions facing the same zoning density limit. The zoning categories in Charles County are very simple. Almost all rural areas require a minimum lot size of 3 acres, shown as the Charles county bar on the far right of the graph. There are also a small number of areas with “Rural Residential” zoning, allowing a minimum of one acre lots. The bars to the left of these are the different zoning types in the development district. These areas can all use TDRs, and the minimum lot size on the horizontal axis reflects this ability to use TDRs. For example, the bar that is farthest to the left for Charles County are the areas zoned for high density residential. Their base allowable density without TDRs is 5 houses on an acre, and with TDRs, 6 houses on an acre can be built. Therefore, the minimum lot size is 1/6, or 0.167 acres. The zoning limits specified reflect the ability of each of these areas to use TDRs.

The results show that the ratio of actual to allowed lots is much more uniform in Charles County than in Calvert County, and in no area is the actual density very close to the allowable density. The ratios range from about 60 percent in the rural areas (bar on the far right) to about 30 percent to 40 percent in the residential zones. The actual to allowed density is slightly lower in the residentially zoned areas, with the lowest in the “low density residential” areas, or those with minimum allowed lot size of 0.33 of an acre.

### ***Montgomery County***

Montgomery County is the largest and most populated of the three jurisdictions. It includes areas that are part of the major suburbs of the Washington, DC metropolitan area, but other areas which have a farming tradition and continue to provide a rural base for the County.

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<sup>10</sup> See Walls and McConnell (2007) for more detail on the Charles and Calvert TDR programs.

The County has experienced the pressures of rapid growth in recent years, but it is also in a situation where most of its land area is either developed or has been permanently preserved in farmland or parkland. The County designated a large agricultural area in the northwest section of the County for preservation in 1980, at which time the entire area was downzoned to a minimum lot size of one unit on 25 acres. The TDR program in the county was initiated to preserve this area and transfer the density to areas considered to be more suitable for development. Only certain local areas were designated as possible TDR receiving areas. To make clearer the County's choices over density, we will separate the analysis below by subdivisions that were not able to use TDRs and those that could use them.

Figure 5 shows the results for the non-TDR subdivisions in Montgomery County. For this analysis, we used the just over 1,000 subdivisions built with 3 or more units built over the period from 1980 to 2004. There are a large range of possible zoning areas shown on the horizontal axis, from areas zoned at very high density of 50 units on an acre (far left on the graph) to very low density of one unit on 25 acres. The pattern of actual lots built compared to the allowable number does not follow a clear pattern. The lowest density zones—the preservation areas zoned at one unit on 25 acres and the rural areas zoned at one unit on 5 acres—have ratios that are over one. That is, the average lot size is actually smaller than the minimum required by zoning rules. This is because these areas have some grandfathered or exempt properties that allowed owners to build more lots than allowed by zoning. In general, the zoning limits in these areas do seem to be determining lot size.

However, the areas zoned for minimum lot size between 1 and 2 acres have lot sizes that on average well above these minimums. Developments at about 8 to 12 units per acre or average lot sizes of 0.13 to 0.08, seem to be built at densities close to the limit. Units at these densities are primarily townhouse developments. Actual densities relative to allowable fall again at some of the very high densities, such as at minimum lot size of 0.06 or about 17 units per acre. These developments are at only 60 percent of the allowable limit even without TDRs.

**Figure 5. Ratio of Actual Subdivision Density to Allowable Zoned Density, Non-TDR Subdivisions Recorded 1980-2004, Montgomery County, Maryland**

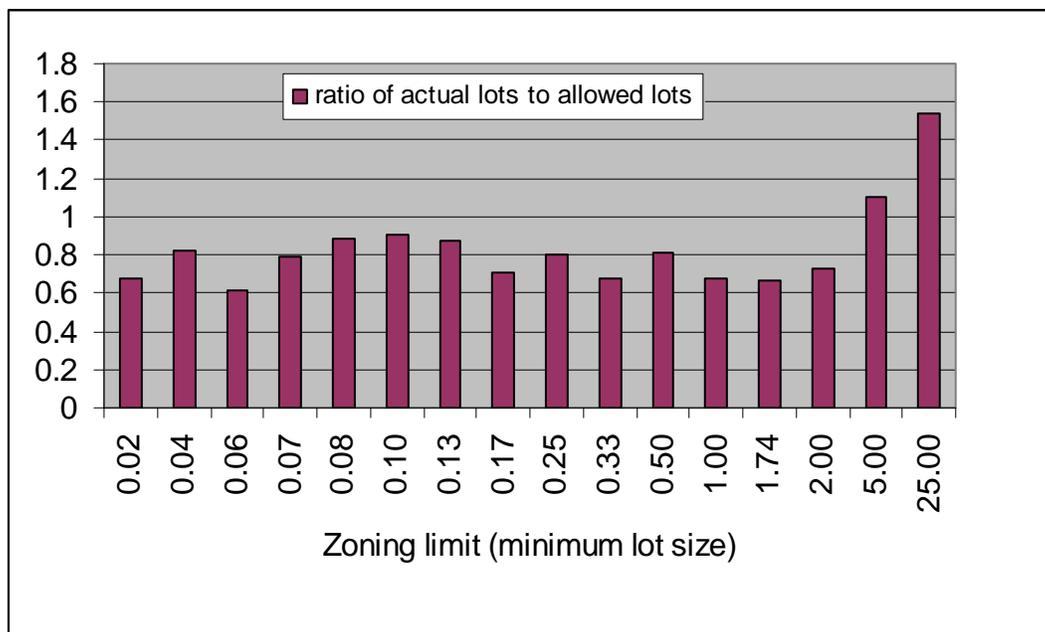


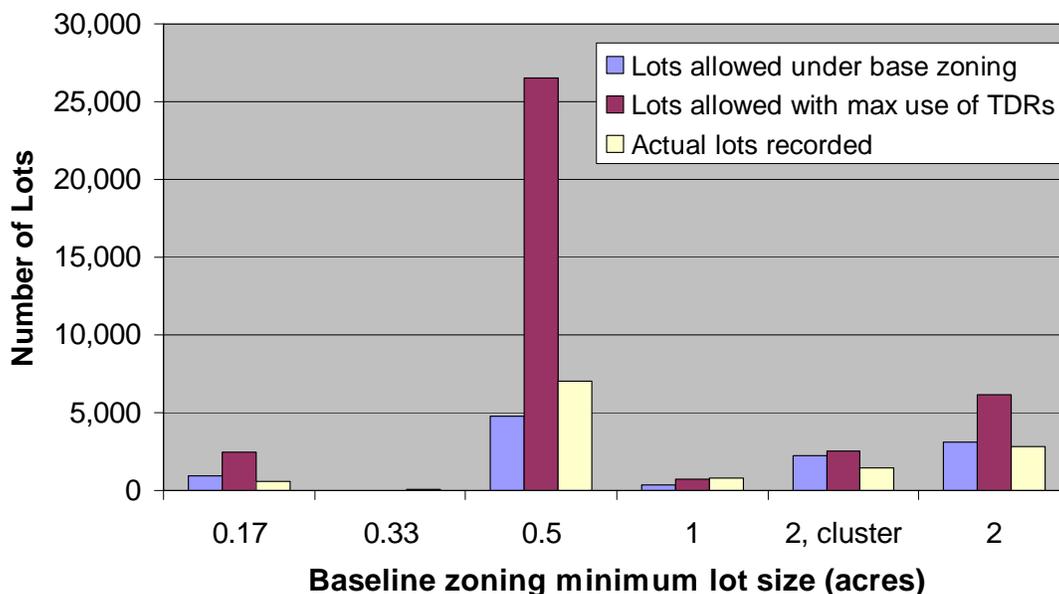
Figure 6 shows the allowed and actual densities for the subdivisions that could use TDRs. The location of receiving areas for TDRs in Montgomery County was left up to each of about thirty Planning Areas that have responsibility for local land use Master Plans. Many planning areas did not designate any TDR areas, and those that did tended to allocate only small areas for TDR use. The allowable limit on the use of TDRs is effectively different in almost every receiving area. We were able to determine which areas were designated TDR receiving areas, and what their limit was for the use of TDRs.<sup>11</sup>

As shown in Figure 6, the zoning category in which most TDRs were allowed was the 0.5 acre lot size, or 2 houses on an acre. This is a common zoning category in the region and is fairly low density. But with TDRs, these areas could in principle be built at over 10 units per acre. It is clear from the graph that very few TDRs were actually used to increase density above the base level. For just about all of the categories of zoning in areas where TDRs could be applied, many

<sup>11</sup> The County has an overall limit on the TDRs that can be used in any zoning category, but the Planning Areas tend to set the limits on the individual receiving areas well below that County limit. See McConnell, Walls, and Kelly (2006).

more TDRs were allowed than the actual number used. Some subdivisions were built in TDR designated areas, and did not use TDRs at all.

**Figure 6. Total Number of Baseline Lots, Lots Allowed with TDRs, and Actual Lots, Subdivisions Recorded in TDR Regions, 1980–2004, Montgomery County, Maryland**



**Concluding Thoughts**

Overall, we find some evidence that in the most rural areas, subdivision development densities are strongly affected by the zoning rules. We find this in Calvert and Montgomery Counties, but somewhat less so in Charles County. This could be due to the fact that in Charles County, the minimum lot size is never greater than 3 acres, whereas it is 5 acres or higher in the other counties. We also find some evidence that in the residential areas, especially those that are zoned for relatively high density, developers are not building as densely as allowed. The ability to use TDRs in these counties offers the opportunity to developers to build at densities that are often much higher than the base zoning allows. However, many times TDRs are not used and almost nowhere are they used to the limit of possible density.

In summary, except in the most rural areas, lot sizes do not appear to be determined by zoning rules but by other factors. Whether this is due to household preferences for lower density, or the ability of local residents to block higher density is an interesting and still open question. In the next section, we are able to look a bit more closely at household preferences for lot size.

#### 4. Household Preferences for Lot Size

Given that densities are often observed to be well below the levels allowed by zoning regulations, it is clear that an important part of what drives the building of houses on large lots is individual preferences. This section sheds light on these preferences by estimating a simple hedonic property value model for Calvert and Montgomery County. The hedonic price technique has the virtue of relying on observed behavior, rather than hypothetical surveys, to elicit values, and it has the advantage of controlling for many other factors that affect housing prices. Although there are many hedonic studies looking at the value of different amenities (including different types of open space), our analysis is unique because we are able to control for all subdivision and neighborhood level characteristics while focusing on the effect of lot and house specific characteristics.

We use the model to examine how the value of lot size has changed over time and how households trade off lot size for housing structure characteristics. By conducting the analysis for both Calvert and Montgomery Counties, we are able to determine how preferences vary across jurisdictions with different characteristics. Findings from the Calvert analysis have implications for ex-urban counties in which sprawling residential development, where lot sizes are large. Results from Montgomery County will reflect conditions and preferences that exist in more inner suburban regions that are already quite densely developed.

For this analysis, we limit the sample to subdivisions that had at least 10 house sales over the study period. In the Calvert County sample, this allows us to include 3,352 individual house sales occurring over 1981–2001 within 89 subdivisions. The Montgomery sample includes 22,575 sales within 1,148 subdivisions occurring over 1981–2005. Table 2 provides summary statistics for the house specific variables included in the model. Gross floor area and house age are similar across the two counties, with the average house being 2000 to 2600 square feet and 6 to 7 years old at the time of sale. Lot sizes are larger in Calvert, however, with mean lot size of 1.5 and 0.37 in Calvert and Montgomery, respectively. As expected, housing prices are much higher in the more urban Montgomery County, where the mean value is \$366,522, while it is \$193,233 in Calvert County.

**Table 2. Summary Statistics for Single Family House Sales, Calvert and Montgomery County, Maryland**

Variable	Calvert				Montgomery			
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Sale price (nominal \$)	193233	72655	50400	765291	366522	227567	50000	5000000
Lot size (acres)	1.525	1.587	0.057	30.410	0.327	0.373	0.026	13.120
Gross floor area (sq ft)	2081.89	802.88	704	6575	2640.40	963.48	648	20891
Age (years)	5.84	10.01	0	186	6.87	8.17	0	114
Sale year	1994.39	5.07	1981	2001	1996.90	6.53	1981	2005
#Sales	3,352				22,575			
#Subdivisions	89				1,148			

We assume households choose housing characteristics, location and amenities to maximize utility. Under this assumption and a housing market in equilibrium, we can use the hedonic price model (see Rosen (1974) to examine consumer behavior with regard to housing choices. The hedonic price function can be specified as  $P = f(l, C, S, T)$ , where  $P$  is the price of the property,  $l$  represents the lot size,  $C$  is a vector of structural characteristics (age, square footage, etc.) associated with the house, and  $S$  represents a vector of subdivision characteristics, accessibility measures and neighborhood amenities. We control for all observed and unobserved attributes in  $S$  that are common to all houses within a subdivision by including subdivision fixed effects in the model. We also control for inflation and factors affecting countywide demand for housing over time by including sale year dummy variables represented in the equation by  $T$ .

Table 3 shows the results of the hedonic equation estimation. The characteristics of the house we include in addition to lot size are house size in floor area square footage, and the age of the house. Because our primary interest is in lot size and how households might trade off lot size for other housing attributes in these two different jurisdictions, we interact lot size with the other housing characteristics. We also include an interaction term between lot size and the year in which the house sold to determine if the willingness to pay for lot size has changed over time. The top section of Table 3 shows the coefficient estimates for lot size, the other housing characteristics and the interactions. When we estimate the hedonic price equations with just lot size and the other housing characteristic variables and no interaction terms, they are all significant. Adding interaction terms can influence the coefficients and their significance for

individual variables. To determine if the interaction terms are significant as a group, we perform an F-test. In both counties, we reject the hypothesis that as a group they have no effect.<sup>12</sup>

The interaction terms are all significant except for sale year in Calvert County. Larger house size is associated with a slightly lower marginal value for an additional acre of lot size. Older houses have lower prices other things the same, but a bigger lot size has an offsetting effect of that age discount. In more recent years, lot size has had less of an effect on price in Montgomery County. To fully examine the effect of lot size on price, we calculate the marginal willingness to pay for additional private acreage by the partial derivatives of the price function with respect to each attribute, evaluated at various values of the relevant interaction variables. These results are shown at the bottom of Table 3.

**Table 3. Hedonic Regression Results, Calvert and Montgomery County, Maryland**

Dependent Variable is the natural log of house sale price		
	Calvert	Montgomery
	<i>Coeff. (Robust Std. Err.)</i>	<i>Coeff. (Robust Std. Err.)</i>
Lotsize	0.44581 (0.74301)	9.96370 (2.99716)**
Lotsize <sup>2</sup>	- 0.00028 (0.00040)	- 0.00603 (0.00416)
Gross floor area	0.00015 (0.00001)**	0.00015 (0.00001)**
Lotsize*Gross floor area	- 0.00001 (0.00000)**	- 0.00002 (0.00001)**
Age	- 0.00266 (0.00091)**	- 0.00501 (0.00162)**
Lotsize*Age	0.00012 (0.00006)*	0.00300 (0.00134)**
Lotsize*Sale year	- 0.00020 (0.00037)	- 0.00492 (0.00150)**
Constant	11.12193 (0.03609)**	11.45378 (0.02762)**
Adjusted R <sup>2</sup> :	0.8509	0.8809
Obs; Subdiv	3352; 89	22575; 1148
<b>Marginal effect with respect to lot size:</b>		
<i>Evaluated at mean values of all vars:</i>	0.022 (0.005)**	0.112 (0.022)**
<i>Evaluated at Sale year =</i>		
1985	0.023 (0.005)**	0.170 (0.029)**
2000	0.020 (0.006)**	0.096 (0.023)**
<i>Evaluated at house size =</i>		
2000 sq. ft.	0.022 (0.005)**	0.123 (0.023)**
3000 sq. ft.	0.014 (0.006)**	0.105 (0.022)**

Coefficients on the individual subdivision dummy variables and sale year dummy variables are not shown here but are available upon request. \*\* signifies significance at the 95% level; \* at the 90% level.

<sup>12</sup> For Calvert County, the F value is 56.16, and for Montgomery County it is 119.13.

Consistent with results of other hedonic studies including lot size variables (see Sirmans et al., 2006), households in both counties show a strong preference for larger lots. As shown in the elasticity estimates at the bottom of Table, evaluated at the sample mean of the relevant interaction variables, we find that a one acre increase in private lot size is associated with an approximately 2 percent and 11 percent increase in house price, all else equal, in Calvert and Montgomery, respectively. This suggests that for an average priced house in 2004 (about \$200,000 in Calvert County and \$350,000 in Montgomery County), an increase in lot size from 1 acre to 1.5 acres would increase price by about \$2,000 in Calvert and \$19,250 in Montgomery County. It is important to note that these marginal values should be interpreted not as the value of a 0.5 acre lot in these jurisdictions, but marginal value of adding another 0.5 acre to an existing developed lot. And these estimates abstract from the neighborhood or locational aspects of any particular lot; in this model those are captured separately in the fixed effects. The magnitude of these estimates of the value of lot size is robust across various specifications of the model, including one without interaction terms or with additional house characteristics in the Calvert regression.

Although the value of additional lot size is on average five times larger in Montgomery County than in Calvert County, its effect on price has fallen over the period under study. The significant interaction term between lot size and sale year in Montgomery indicates that marginal willingness to pay for lot size has decreased over time. As shown in Table 3, the marginal value of an additional acre fell from 17 percent in 1985 to 9.6 percent in 2000. In Calvert, the marginal effect remains around 2 percent over the sample period. The value of larger lot sizes appears to be falling in Montgomery County, and this may be indicative a declining interest in larger lots in suburban areas.

Finally, we find that the marginal willingness to pay for larger lot size is somewhat lower for larger houses in both counties. We look at house sizes of 2,000 square feet and 3,000 square feet, sizes that are around the mean size in both counties (see Table 2). Table 3 shows the elasticity of price with respect to lot size evaluated at these house sizes. This gives an indication of the rate at which homebuyers are willing to trade off lot size for house size—e.g., for a 1000

square foot increase in house size, the marginal value of an additional acre fell by 1 percent in Calvert and 2 percent in Montgomery.<sup>13</sup>

In summary, we find that households value additional acreage for their own lots, and as one might expect, these values are larger in urbanized Montgomery County where land values are higher and where most lot sizes are lower. However, we do find that the value of larger lots seems to be decreasing over time, at least in Montgomery County. Also, there is some indication of a willingness to trade off lot size for house size. In earlier work on Calvert County, we found additional evidence about household preferences with regard to lot size. We looked at whether residents of subdivisions would trade off lot size for more open space in their subdivision or for being adjacent to open space. We found evidence that of willingness to trade lot size for both of these amenities.

## 5. Conclusion

We find that average lot sizes are relatively large in urban areas, even in suburban counties that are close in to central cities. And, in many suburban areas, average lot size was trending upward during last 15 years, though maybe less that would have been expected. But large lot sizes do mean more land is taken from other uses for urban development. To the extent that communities want to slow the rate of growth of land used in development, and promote smart growth policies, there will need to be a move toward higher density. And it does not appear that zoning will be the most useful tool for achieving higher density. We find that zoning rules do not tend to establish density levels in most areas, except maybe in the lowest zoned ex urban areas. That is, in most areas, lot sizes are larger than would be allowed under zoning. An important contributor to this fact may be that people have preferences for space and larger lots. This remains a difficult challenge for achieving smart growth outcomes.

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<sup>13</sup> We also calculated the marginal value of house price with respect to age of the house and to house size (square footage). Evaluated at the sample means of the relevant interacted variables, in Calvert County the marginal effect of age on house price is -0.002 (0.001) in Calvert and -0.004 (0.001) in Montgomery, which means that house price would decrease 2% and 4%, respectively, for a house 10 years older. The marginal effect of house size on price is 0.00015 (0.00001) in both counties, meaning another 1,000 square feet would increase house value by 15%.

## References

- Arendt, R. 1992. 'Open Space' Zoning: What It Is and Why It Works. *Planning Commissioners Journal* 5 (July), <http://www.plannersweb.com/articles/are015.html>.
- Burchfield, Marcy, Henry G. Overman, Diego Puga, and Matthew A. Turner. 2006. Cause of Sprawl: A Portrait from Space. *Quarterly Journal of Economics* 121(2): 587–633.
- Fischel, William. 1999. Does the American Way of Zoning Cause the Suburbs of U.S. Metropolitan Areas to Be Too Spread Out? In *Governance and Opportunity in Metropolitan Areas*, edited by Alan Altshuler, William Morrill, Harold Wolman, and Faith Mitchell. Washington, DC: National Academy Press, 151–191.
- Fischel, William. 2004. An Economic History of Zoning and a Cure for Its Exclusionary Effects. *Urban Studies* 41(2): 317–340.
- Glaeser, Edward, Joseph Gyourko, Raven E. Saks. 2005. Why Have Housing Prices Gone Up? *American Economic Review Papers and Proceedings* 95(2): 329–333.
- Hammer, Roger B., Susan Stewart, Richelle Winkler, Volker Radeloff, and Paul Voss. 2004. Characterizing dynamic spatial and temporal residential density patterns from 1940–1990 across the North Central United States. *Landscape and Urban Planning* 69(2–3): 183–199.
- Irwin, Elena G., Nancy E. Bockstael, and Hyun Jin Cho. 2006. Measuring and modeling urban sprawl: Data, scale and spatial dependencies. Paper presented at the Regional Science Association Meetings, Toronto, Canada, November.
- Knaap, Gerrit-Jan, Yan Song, and Zorica Nedovic-Budie. 2007. Measuring Patterns of Urban Development: New Intelligence for the War on Sprawl. *Local Environment* 12(3): 239–257.
- Kopits, Elizabeth, Virginia McConnell, and Margaret Walls. 2008. Making Markets for Development Rights Work: What Determines Demand? *Land Economics* 84(2).
- Levine, Jonathan. 2006. *Zoned Out: Regulation, Markets, and Choices in Transportation and Metropolitan Land-Use*. Washington, DC: Resources for the Future.
- Maryland Department of Planning. 2005. Maryland Property View. <http://www.mdp.state.md.us/data/index.htm>.

- McConnell, Virginia and Margaret Walls. 2006. Markets for Preserving Farmland in Maryland: Making TDR Programs Work Better. Discussion Paper, Harry Hughes Center for Agroecology, University of Maryland.
- McConnell, Virginia, Elizabeth Kopits, and Margaret Walls, 2006. Using Markets for Land Preservation: Results of a TDR Program. *Journal of Environmental Planning and Management* 49(5): 631–51.
- McConnell, Virginia, Margaret Walls, and Elizabeth Kopits. 2006. Density, TDRs, and the Demand for Development. *Journal of Urban Economics* 59(3): 440–457.
- McDonald, J.F. 1989. Econometric Studies of Urban Population Density: A Survey. *Journal of Urban Economics* 26: 361–385.
- Sirmans, G. Lynn MacDonald, David Macpherson, and Emily Zietz. 2006. The Value of Housing Characteristics: A Meta Analysis. *The Journal of Real Estate Finance and Economics* 33(3): 215–240.