THE HOWARD H. BAKER JR. CENTER for PUBLIC POLICY

The Economic Impact of Open Space on Residential Property Values in Tennessee

Report Prepared for the

Tennessee Advisory Commission on Intergovernmental Relations

by

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EXECUTIVE SUMMARY

Over 93 percent of Tennessee is classified as open space – public and private land with no buildings or other built structures. Individual values for many benefits produced by these open spaces are not reflected in markets. For example, Tennessee residents are unable to signal their value for a scenic view, wildlife habitat, or recreating in a forested area or along a greenway due to the absence of markets for these goods and services. The inability of markets to capture individual values for alternative land uses complicates local and state-level policy and planning decisions about zoning, restrictions and preferences on land use, government purchases of open space for preservation or other uses, and budget allocations for management and maintenance of municipal, state, and federal parks. This report provides estimates of the impact of these open spaces on nearby property values. These results provide insight on one cost of urban sprawl and also inform budget allocation decisions for publically protected open spaces such as state parks and wildlife management areas.

Over half of Tennessee's open space is covered in forest, over a third is agricultural land used as pasture and for growing crops, and the remainder is divided between developed open space, shrubland, and wetlands. The vast majority of open space in the state (approximately 96 percent) is privately owned with no form of protection from development. Less than 1 percent of this privately-owned open space has been protected from future development through a conservation easement, participation in the USDA's Conservation Reserve Program, or some other sale of development rights. Four percent of the open space is publically protected (lands administered by the state or federal government) as national parks, national recreation areas, wild and scenic rivers, state parks, state natural areas, state forests, and wildlife management areas.

Housing markets determine the amount of certain types of housing and the transaction prices for a house conveys the value people hold for the structural characteristics (for example number of bedrooms, square footage), neighborhood characteristics (for example distance to work), and environmental amenities in the area (for example amount and type of open space). If Tennessee residents value open space, they should be willing to pay more for homes near open space. Thus, the value that Tennessee residents have for open space is revealed through their home purchases.

Permanently protected open space in MSAs adds the largest value to nearby homes. In West Tennessee MSAs, a house located one kilometer closer to private protected open space is worth $1,371.20 more. In Middle Tennessee MSAs, a house located one kilometer closer to state protected open space is worth $1,061.47 more. Permanent protection likely provides the certainty needed to encourage larger housing premiums. Open space also tends to be less abundant in urban and suburban settings which explain the large open space impacts on home values in these areas. This study finds no evidence that Tennessee residents attempt to substitute publically provided open space with larger residential lots. This finding could reflect the relative abundance of open space across much of Tennessee.

Tennessee residents do not value all types of open space equally. Residents tend to prefer agricultural lands to developed open space such as golf courses and cemeteries. When averaging values across the state, an additional acre of pasture and cultivated crops increases home values by $3.38, but an additional acre of developed open space is associated with an average decrease in home values of $13.69. Values for open space also vary considerably across the state.

Residents in rural parts of the state value proximity to agricultural open space such as pastures and fields of cultivated crops but wish to locate further away from wetlands and developed open space such as golf courses and cemeteries. In contrast, residents of East Tennessee MSAs value proximity to wetlands and residents in Middle Tennessee MSAs value proximity to shrubland. In some areas of the state proximity to federal- and state-protected open space adds to home values while in neighboring areas it detracts from home values. These regional differences in open space values reflect the current supply of open space in these areas – in areas where open space is scarce there impacts on home values tend to be large. Efforts to control the development of open space should focus on cover types that are scarce in the region as these will likely be areas where the cost of development is high.

An evaluation of the relationship between home values and open space indicates the following:

- A 4,125 acre decrease in developed open space (1 acre in each Census Block Group in the state) increases home values by over $38 million. This results in an additional $384,300 in property tax revenues in the state.
- Forests have no impact on home values or property tax revenues. There is some evidence that certain types of forest add to home values and other types detract from home values.
- A 1 acre decrease in shrubland in each Census Block Group in the Nashville and Clarksville MSAs decreases home values by $179 million in these areas. This results in a $1.7 million decrease in property tax revenues.
- A 4,125 acre decrease in agricultural land (1 acre in each Census Block Group in the state) decreases home values by over $8 million. This results in a $94,000 loss in property tax revenues.

- A 4,125 acre decrease in wetlands (1 acre in each Census Block Group in the state) decreases home values by over $133 million in the Chattanooga, Cleveland, Johnson City, Kingsport, Knoxville, and Morristown MSAs but increases home values by nearly $694 million in other parts of the state. This results in a $5.5 million increase in property tax revenues in the state.

These results only indicate the impact of open space on home values and do not capture other impacts of open space such as tourism revenues and employment, recreational opportunities for state residents, increases in physical and mental health, wildlife habitat, and scenic views. A lack of data on municipal parks and greenways prevents a full accounting of the impacts of these open spaces on housing values.

1. INTRODUCTION

1.1 PURPOSE OF THE REPORT

Open space (public parks, farmland, forestland) in Tennessee provides a range of benefits to residents and visitors. This is especially important to state residents who see an enhanced quality of life. Parks and natural areas can be used for recreation; wetlands and forest supply wildlife habitat; farms and forest provide aesthetic benefits to surrounding residents; and bike and walking trails provide aesthetic value while improving health status. Many of these activities help support job creation and economic growth for the state.

Unlike the economic activity generated by the construction of new homes and businesses, the values associated with many open space benefits are not reflected in markets. For example, there is no market for a scenic view and many parks do not charge or otherwise restrict access. As a result, there is no direct mechanism to determine how individuals value such amenities. The inability of markets to capture valid economic values associated with open space complicates local and state-level policy and planning decisions about zoning, restrictions and preferences on land use, government purchases of open space for preservation or other uses, and budget allocations for management and maintenance of municipal, state, and federal parks. In practice, such decisions should be informed based on how individuals value alternative land uses. Decisions about how much and where land should be conserved require a careful weighing of the costs of these actions against the value residents and visitors place on open space benefits. For example, the excessive spatial growth of cities is, in part, a failure of local governments to account for the social value of open space when land is converted to urban use [1].

The need to value open space is of growing importance for two reasons. First, the state's urban and suburban population growth increases economic incentives to convert open space to other uses in the areas where open space is typically most valued. Between July 1, 2014 and July 1, 2015, Murfreesboro's population increased 4.4 percent making it the thirteenth fastest growing city in the United States.[1] This growth rate implies that Murfreesboro is growing by about 14 residents per day. Other fast growing Tennessee cities include

- Franklin: 2.8% or 6 new residents per day
- Clarksville: 1.7% or 7 new residents per day
- Nashville: 1.5% or 27 new residents per day
- Hendersonville: 1.5% or 2.2 new residents per day
- Chattanooga: 0.9% or 5 new residents per day
- Johnson City: 0.7% or 1 new resident per day
- Bartlett: 0.5% or 1 new resident per day
- Knoxville: 0.4% or 2 residents per day

Pressure to develop open space builds as resident in these fast growing cities spill further into suburban areas and commuting increases. Smart Growth America listed Nashville, Memphis, Chattanooga, Knoxville, Kingsport/Bristol, and Murfreesboro among the worst cities in the United State for urban sprawl. New residents in these cities and suburbs need housing but also likely value the open spaces in these areas which sharpens the need to balance costs and benefits of open space development and urban sprawl. A recent study at the Federal Reserve Bank of St. Louis estimated the costs of urban sprawl for Memphis.[2] These costs included lost labor income from commuting, costs of car operation, and the costs of running local Memphis area governments. This report provides estimates for another potential cost of urban sprawl in Tennessee – lost open space amenities.

[1] http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk
[2] https://www.stlouisfed.org/publications/bridges/winter-2000/the-cost-of-urban-sprawl-in-the-memphis-msa

Valuing open space in Tennessee is also of increasing importance due to the maintenance backlog at many state and municipal parks. Open space protected by the state of Tennessee is one of the state's most precious assets. For instance, Tennessee's State Parks were voted the best in the nation in 2007. Like state park systems in many parts of the country, the state's park system currently faces a $150 million maintenance backlog. A 2009 study by the University of Tennessee found that for every dollar spent from the State Park's budget allocation from the general fund ($41 million), it generates over $17 in direct expenditures and over $37 in economic impacts (total industry output) [2]. This report provides estimates for another potential economic impact of Tennessee's state parks – increases in nearby home values.

The report begins with a brief overview of the open space in Tennessee. The subsequent section details the various values associated with open space and describes the *hedonic pricing method* this study uses to estimate open space values. This section ends with a brief literature review that highlights estimates of open space values provided in previous research. The third section reports on the findings of this study. This section includes a detailed explanation of the data used, a technical description of the statistical methods employed, and finally the estimates of open space values. These estimates are reported as *marginal implicit prices* which indicate the impact on housing values from an additional acre of open space or from being one kilometer closer to open space. These estimates are then aggregated up to the county, regional, and state level. The report closes with a brief discussion and concluding remarks.

1.2 OVERVIEW OF OPEN SPACE IN TENNESSEE

Open space is any piece of public or private land that is undeveloped (has no buildings or other built structures). Based on this definition, 93 percent of the state of Tennessee (over 25 million acres) is open space. While the definition is quite broad, open space can be categorized along two key dimensions: cover type and ownership.

Cover type refers to the vegetation and land uses that describe a piece of open space. Figure 1 shows the distribution of cover types across the state of Tennessee. Over half of the 25 million acres of open space is covered in deciduous (for example oak, maple, and hickory) and evergreen (for example pine, cedar, and hemlock) forest. Over a third is agricultural land used as pasture and for growing crops. The remainder is divided between developed open space (parks, golf courses, cemeteries, and large residential lots), shrubland (more than 20% of total vegetation is less than 5 meters tall), and wetlands (areas where the soil or substrate is periodically saturated with or covered with water).

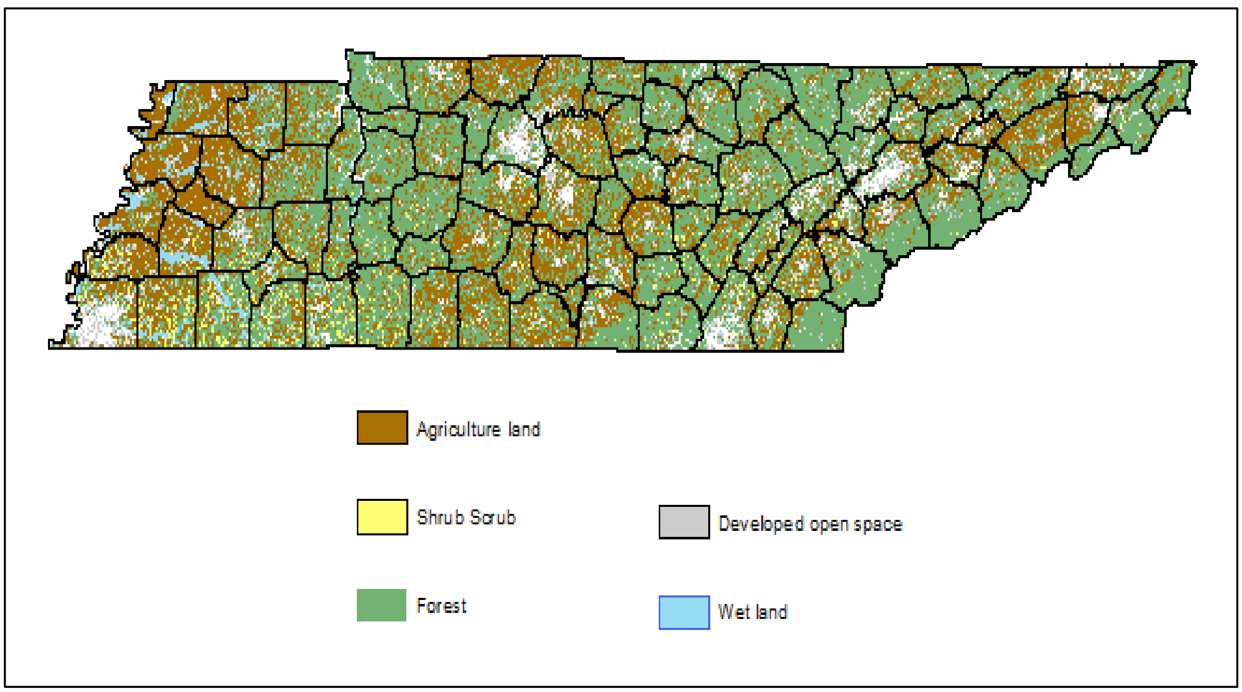

Figure 1. Open space cover types

Ownership refers to the balance of public versus private open space ownership. The vast majority of open space in the state (approximately 96 percent) is privately owned with no form of protection from development. Less than 1 percent of this privately-owned open space has been protected from future development through a conservation easement with a non-profit land trust such as the Nature Conservancy, participation in the USDA's Conservation Reserve Program, or some other sale of development rights. A diverse collection of properties fall in this category including Cruze Farm in Knox County[3], Mayfield Farm in McMinn County[4], Aubrey Preston Farm in Williamson County[5], Shelby Farms Park in Shelby County[6], and numerous private hunting preserves throughout the state. Figure 2 shows the organizations that own developments rights to private open space in Tennessee. Four percent of the open space is publically protected (lands administered by the state or federal government) as national parks, national recreation areas, wild and scenic rivers, state parks, state natural areas, state forests, and wildlife management areas. Many of these areas represent some of Tennessee's most prized natural assets and engines for tourism development. Prominent examples include the Great Smokey Mountain National Park in East Tennessee, Radnor Lake State Natural Area in Middle Tennessee, and Reelfoot Lake National Wildlife Refuge in West Tennessee. Figure 3 shows the government agencies responsible for the management of Tennessee's public open spaces. Figure 4 shows the distribution of public open space and privately held conservation lands.

[3] http://www.cruzefarm.com/
[4] http://www.mayfieldfarmandnursery.com/welcome/history
[5] http://visitfranklin.com/see-and-do/leipers-fork
[6] http://www.shelbyfarmspark.org/

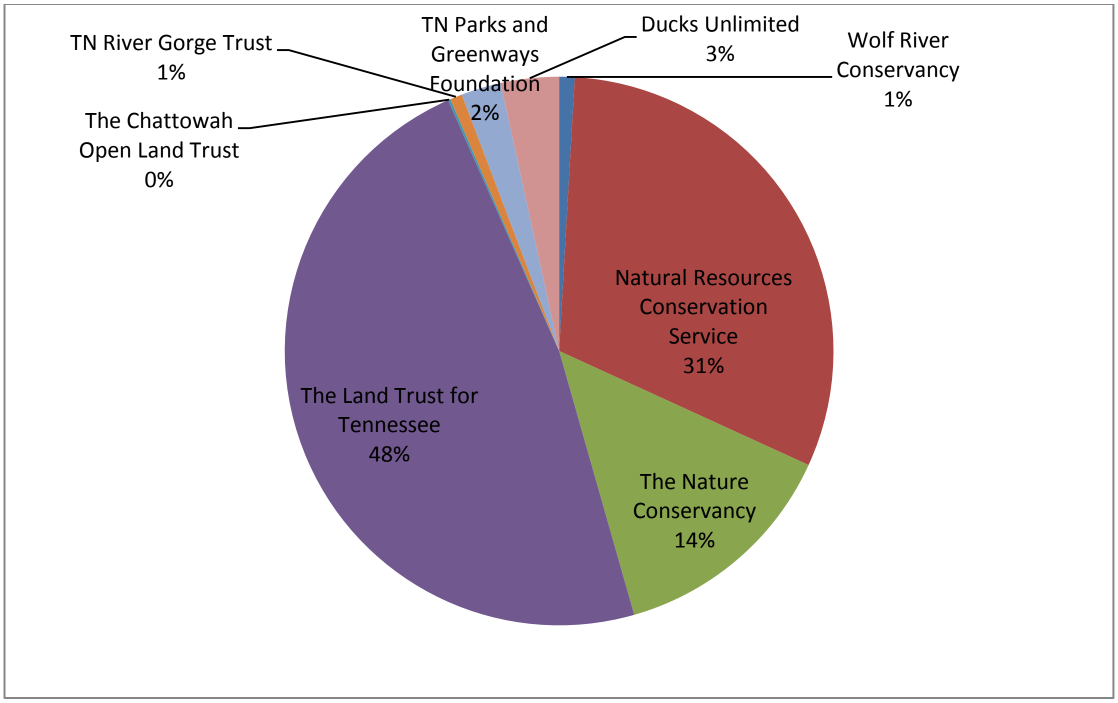

Figure 2. Organizations that own development rights to private open space in Tennessee

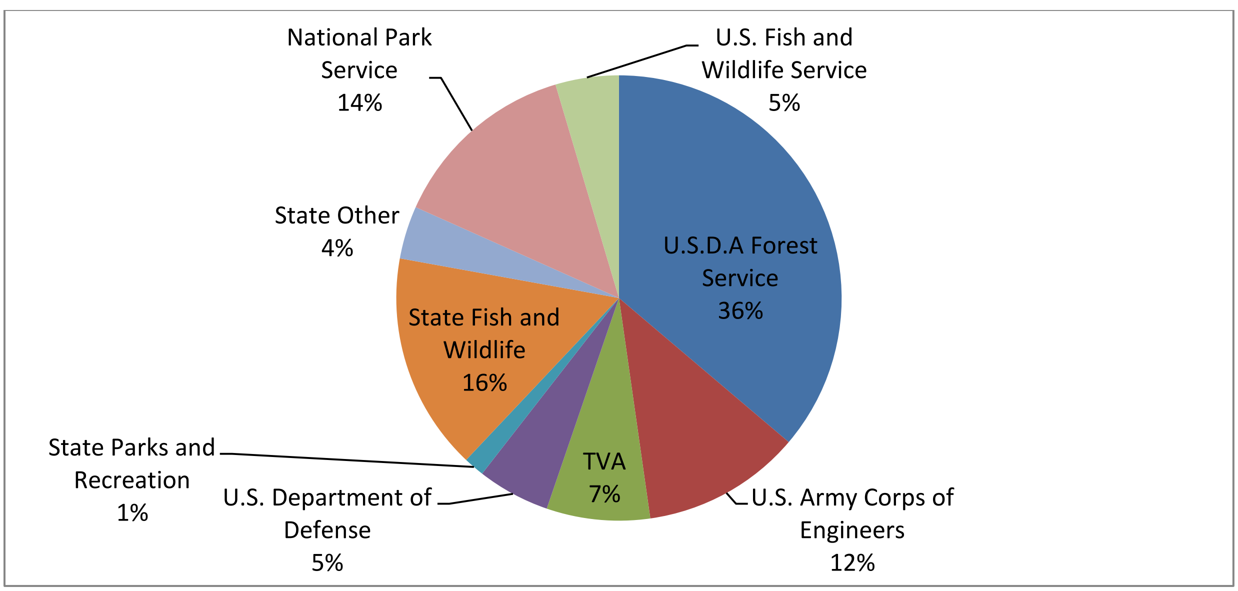

Figure 3. Federal and state government agencies responsible for open space in Tennessee

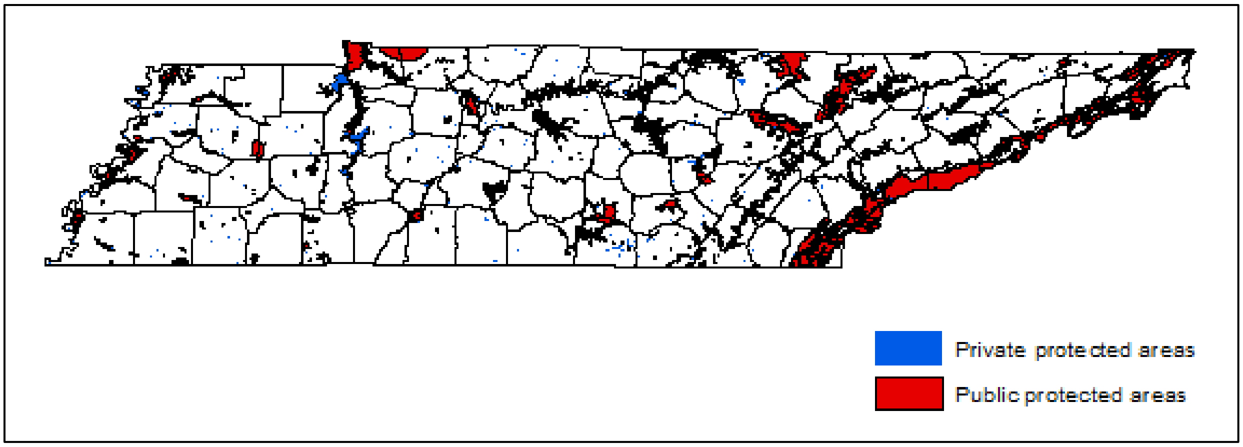

Figure 4. Federal, state, and privately held open space protected from development

2. MEASURING THE BENEFITS OF OPEN SPACE

The open space in Tennessee generates many services that are relatively easy to value because they are traded in markets. For example, the value of crops produced from agricultural lands and timber from forests can be easily valued based on the prices for these goods. This report focuses on benefits from Tennessee's open space that are not traded in markets. McConnell and Walls [3] provide a general survey of the literature estimating these types of non-market open space benefits. One category of non-market open space benefit is called *use value*. Use values are related to seeing or using the open space and include having a scenic view, experiencing improved water quality, or viewing wildlife. In contrast, *nonuse values* arise from simply knowing that open space exists. Residents of Nashville may derive nonuse value from knowing that farms on the periphery of the city have been there for generations even if they never plan to visit these farms. Residents throughout the state may value knowing that Tennessee is home to a national park even if they never plan to visit the Great Smokey Mountains National Park.

Economists have developed a number of approaches to value non-market open space amenities. These approaches can be grouped into two categories: *stated preference* approaches and *revealed preference* approaches. Stated preference methods make use of surveys that ask individuals directly about their preferences or willingness to pay for the preservation of a particular type of open space. Theoretically, these methods can capture both use and nonuse values associated with open space but in practice surveys must be carefully constructed to ensure responses accurately reflect the individual's values and are not biased.

In contrast, revealed preference approaches utilize information on behavior in markets associated with open space to infer the value of that open space. For example, many residents recognize the benefits that Tennessee's parks, farmland, forests and wetlands provide and pay a premium for real estate adjacent or in close proximity to these areas. Because these values are based on actual market transactions, they only capture use values but do not suffer from many of the biases that accompany stated preference methods. The most popular revealed preference approach to valuing open space is hedonic pricing models. This is the methodology employed in this study.

2.1 HEDONIC PRICING MODELS

Hedonic pricing models are based on the notion that a differentiated product can be viewed as a bundle of characteristics. The value people have for the differentiated product, such as an automobile, can be traced to the values people hold for the attributes embodied in the product [4]. The use of hedonic pricing models when valuing open space focuses on a specific differentiated product – houses. A house is a bundle of structural features (e.g., number of bedrooms, square footage) plus lot size, neighborhood characteristics (e.g., distance to work), and environmental amenities. Housing markets determine the amount of certain types of housing and the transaction prices for a house in a specific location conveys the value people hold for the structural characteristics, neighborhood characteristics, and environmental amenities in the area [5]. If Tennessee residents value open space, they should be willing to pay more for homes near open space. Thus, the value that Tennessee residents have for open space is revealed through their choice of house.

Estimation of a hedonic price model is predicated on three assumptions. First, the housing market is in equilibrium. If market forces are causing changes in prices and consumers have not yet fully adjusted to those changes, the housing price data may provide a misleading picture about the value of particular amenities. Second, homebuyers have accurate expectations of future amenity levels. Since a house's price should reflect expectations about future amenity levels, present levels of an amenity might give an inaccurate picture of the values of that amenity if homebuyers expected the future amenity levels to increase or decrease. This can be a particular problem for privately owned open space since this land may be developed in the future. It is difficult to know how homebuyers form expectations of the likelihood of future development. Third, a full range of houses with varying attributes is available for consumer to choose from. In many markets the range of choices is limited and consumers may be forced to settle for a house that does not accurately reflect the value they hold for the houses attributes.

2.2 VALUING OPEN SPACE WITH HEDONIC PRICING MODELS

There are many applications of hedonic pricing models to value open space. Applications of hedonic pricing models to open space first appeared in the late 1960s and early 1970s and primarily focused on urban and suburban parks. A recent meta-analysis of 12 hedonic studies uncovers a general trend in the hedonic pricing model literature: housing prices increased 0.137% when located 10 meters closer to open space [6]. However, this hides many nuances that are potentially important for informing government and private actions that shape land conversion decisions. Table 1 presents results from a small sample of studies selected to convey differences across types of open space and geographic areas.

Table 1. A sample of results from previous hedonic open space studies across the country

Study Area	Year	Open space change	Impact on median house price	Source
Central Maryland	2003	1% increase in	Private easement: $1,106 Private developable: -$768	[7]
New Haven County, CT	1995-1997	1% increase in	Open space: +$75	[8]
Research Triangle, NC	1995-1998	200 m closer to	Public open space: -$553	[9]
Portland, OR	1997	200 m closer to	Wetland: +$286	[10]
Ramsey County, MN	1996	200 m closer to	Forested wetland: -$960 Open-water wetland: +$1,980	[11]
Tucson, AZ	2000	200 m closer to	Natural areas: +$81 Wildlife habitat: +$150 Neighborhood park: -$568	[12]
Minneapolis-St. Paul, MN	1997	200 m closer to	Developed park: +$458 Natural park: +$600	[13]
Central Maryland	1995-1999	Conversion of 1 acre of pastureland to	Private protected: +$3,307 Public protected: +$994 Forest area: -$1,424	[14]
Roanoke, VA	1997-2006	100 ft^2 increase in	Size of urban park: +$80	[15]
Asheville & Winston, NC	2000	1% increase in	Forest patch density: -$1,011	[16]

Early hedonic pricing studies consistently find that house prices decrease the closer they are to a *busy* neighborhood park [17, 18]. Subsequent studies have expanded the definition of open space to consider golf courses [19], greenbelts [20, 21], forest areas [22], and wetlands [11, 23]. These studies find that proximity to certain types of open space generally increases a home's value while proximity to other types can decrease a home's value [7, 9, 12, 14, 24-26]. For example, Shultz and King [12] find a negative relationship between neighborhood parks and home prices consistent with the earlier research. But they also find that proximity to golf courses, large natural areas, and certain types of wildlife habitat increases home prices.

Several studies have looked at trade-offs between public open space and private backyards. Peiser and Schwann [27] look specifically at greenbelts. They find that an additional square foot of private backyard space was worth $384 (1985 dollars), but that the value of an additional foot of public open space between homes was worth less than $4. In a similar study, Thorsnes [28] concluded that forest preserves were, to some extent, a substitute for larger lot sizes. Santerre [29] concluded that if larger (smaller) quantities of residential land are used in the production of housing services, fewer (more) publicly provided substitutes may be demanded. Bates and Santerre [30] found that state and federal open space are substitutes for locally owned open space.

The simple concept underlying hedonic price models is that individuals should be willing to pay more to live closer to open space if they value that open space. But several studies have found that simple relationships between proximity to open space and housing values can be misleading. Geoghegan, Wainger, and Bockstael [31] find that the effect of open space becomes more negative the further you go from the open space. And recently, Dehring and Dunse [32] estimated price gradients between urban parks and densely populated neighborhoods. They found that housing prices increased near parks, but there were generally no price effects moving away from parks to lower density housing areas.

2.3 Previous Studies that Value Open Space in East Tennessee

East Tennessee's open space has been the subject of previous hedonic analyses (see

Table 2). Cho et al. [16] use hedonic analysis to value forested open space in the Southern Appalachian Highlands including much of east Tennessee. They find that accounting for the spatial configuration of forest area with a census block group (CBG) can lead to different conclusions. Specifically, an increase in average area of contiguous forest area decreases housing values in much of East Tennessee. But an increase in the density of forests (number of contiguous forest patches) increases house values in Knoxville but decreases house values around Johnson City, Tennessee. Based on these results, Knoxville residents appear to prefer more fragmented forests while residents of Johnson City prefer less fragmentation.

Cho et al. [33] find that the type of forest matters to Knoxville residents. Forested open space comprised of evergreen tree species (pines, hemlock, cedar) add to home values while forested open space comprised of deciduous species (oak, maple, hickory) detract from home values. Cho et al. [34] find that an additional quarter acre of open space in Knox County adds $42 to the value of a house. A look at regions within Knox County indicates that values for open space increase as you move from the eastern to western part of the county. Contrary to results in other areas of the country, Knox County residents do not appear to substitute public open space for large residential lots [35].

In summary, open space has been shown to add value to homes in Knox County and the size of a residential parcel has little bearing on the values that resident has for public open space. This report advances this previous work in two critical respects. First this report considers open space impacts on home values in other parts of the state. These estimates are needed given the rapid population growth in the Nashville and Clarksville metropolitan statistical areas (MSA). Second, it considers non-forested types of open space such as agricultural land, shrubland, and wetlands. Based on the estimates in Table 1, the values associated with forested open space may provide little information on resident values for other types of open space.

Table 2. Previous results relevant to Tennessee open space values

Study Area	Year	Open space change	Impact on median house price	Source
Southern Appalachian Highlands	2000	1% increase in	Forest patch size: -$193 Forest patch density: -$527	[16]
Greenville, SC; Knoxville, TN; Roanoke, VA; Greensboro, NC	2000	1% increase in	Forest patch density: +$950	[16]
Knoxville, TN and Farragut, TN	1998-2002	100 m closer to	Evergreen woodlot: +$692 Deciduous woodlot: -$589	[33]
Knox County, TN	1998-2002	Additional 0.25 acres of	Open space: +$47.62	[34]
Knox County, TN	1999-2001	1,000 ft closer to	Greenway: +$171 Park: +$180 Golf course: +$290 Water body: +$460	[35]

3. A STATEWIDE ANALYSIS OF OPEN SPACE VALUES

3.1 DATA SOURCES AND DESCRIPTION

This study focuses on 4,125 CBGs in the state of Tennessee as shown in Figure 5. A CBG is a cluster of Census blocks and generally contains between 600 and 3,000 persons. The population in each CBG is the aggregate of a cluster of census blocks. After removing observations with missing data, 3,993 CBGs were used in the analysis. The average size of the CBGs in the study area was 6,539 acres. The largest CBG was 136,113 acres and the smallest CBG was 23 acres. Focusing the analysis at the CBG level eliminates within-CBG spatial heterogeneity in the value of open space. However, any bias from aggregating open space value to the CBG level should be minimal because CBG data is created based on homogeneity in population characteristics and economic status (U.S. Census Bureau 2001). CBG-level data has been shown to be preferable to block- or tract-level aggregation when applied to hedonic pricing models [12].

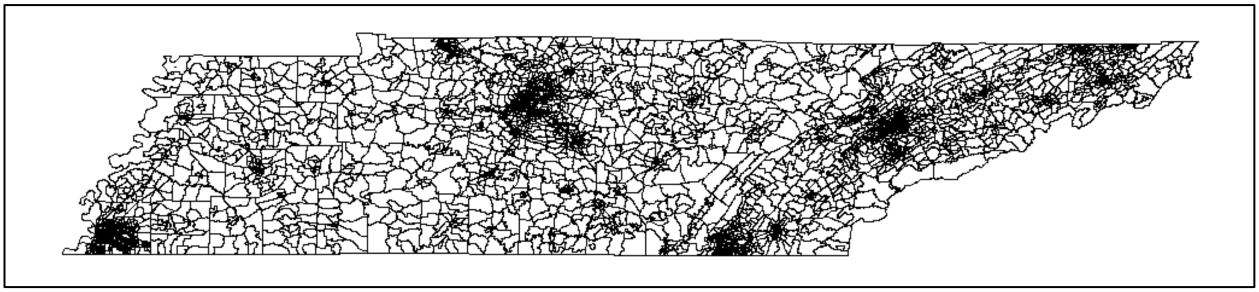

Figure 5. Census block groups for Tennessee

Our research draws from Census Bureau data, satellite imagery data, and environmental feature data all compiled and organized using ArcGIS software. The hedonic pricing model requires data on the median home value in each CBG as well as data on the structural characteristics of homes, socioeconomic characteristics in the area, neighborhood/location information, and quantity of open space. Table 3 provides the definition of each variable created for the analysis and its source. Table 4 shows summary statistics for each variable across the state of Tennessee. We use the 2010-2014 American Community Survey (ACS) for estimates of median home value and structural characteristics at the CBG level. The 2010-2014 ACS 5 year sample is a 5 in 100 national random sample of the population. It contains all households and persons from the 1% ACS samples for 2010, 2011, 2012, 2013, and 2014 identifiable by year. This dataset includes not only the basic short-form questions, but also detailed questions about population and housing characteristics to provide demographic, housing, social, and economic data every year. This dataset provides a respondent's estimate of how much the property (house and lot) would sell for if it were for sale in each CBG. ACS data is also our primary source for structural characteristics of the housing stock in the CBG (for example median number of rooms per house) and socioeconomic characteristics of the CBG (for example per capita income).

Table 3: Description of variables and sources

Variable	Description	Sources
Dependent variable		
$Value_i$ ($)	Median value of owner occupied housing units	2010-2014 ACS 5 year
Open space variables		
$DevOpen_i$ (acre)	Developed open space area	NLCD2011
$Forest_i$ (acre)	Sum of deciduous, evergreen and mixed forest area	NLCD2011
$Shrub_i$ (acre)	Shrub-Scrub area	NLCD2011
$Agland_i$ (acre)	Sum of grassland/herbaceous, pasture/hay and cultivated crops area	NLCD2011
$Wetland_i$ (acre)	Sum of woody wetlands and emergent herbaceous wetlands area	NLCD2011
$Feddist_i$ (km)	Distance from the centroid of CBG to the nearest federal protected area	PAD-US
$Statedist_i$ (km)	Distance from the centroid of CBG to the nearest state protected area	PAD-US
$Privatedist_i$ (km)	Distance from the centroid of CBG to the nearest private other area	PAD-US
Structural variables		
$Rooms_i$	Median number of rooms per house	2010-2014 ACS 5 year
Age_i (years)	Median age of houses	2010-2014 ACS 5 year
Gas_i (%)	Proportion of houses with gas heat	2010-2014 ACS 5 year
Bed_i (%)	Percentage of bedrooms more than three	2010-2014 ACS 5 year
$LotSize_i$ (acre)	Sum of developed low, medium and high intensity area per housing units	NLCD2011 and 2010-2014 ACS 5 year
Socioeconomic variables		
$Income_i$ ($)	Per capita income in the past 12 months	2010-2014 ACS 5 year
$Travel_i$ (%)	Proportion of population that travels more than 30 min to work	2010-2014 ACS 5 year
$Vacancy_i$ (%)	Proportion of houses that are vacant	2010-2014 ACS 5 year
$Unemploy_i$ (%)	Unemployment rate	2010-2014 ACS 5 year
Edu_i (%)	Proportion of the population with at least some college	2010-2014 ACS 5 year
$Stability_i$ (%)	Proportion of houses occupied continuously for at least 5 years	2010-2014 ACS 5 year
$Density_i$ (person/acre)	Number of people per acre	2010-2014 ACS 5 year
Locational variables		
$Interdist_i$ (km)	Distance from the centroid of CBG to the nearest interstate highway	2015 TIGER
$Lakedist_i$ (km)	Distance from the centroid of CBG to the nearest lake/reservoir	U.S. BGN
$Interface_i$	Dummy variable for interface (1 if CBG has mixed urban and rural area)	2015 TIGER
$EastMSA_i$	Dummy variable for East Tennessee MSA	2015 TIGER
$MiddleMSA_i$	Dummy variable for Middle Tennessee MSA	2015 TIGER
$WestMSA_i$	Dummy variable for West Tennessee MSA	2015 TIGER
Instrumental variables		
$Slope_i$ (degree)	Mean slope	USGS NED
$Vehicle_i$ (%)	Percentage of workers owning vehicle (%)	2010-2014 ACS 5 year
$Water_i$ (%)	Percentage of water area (%)	2010 U.S. Census
$MSAdist_i$ (km)	Distance from the centroid of CBG to the nearest MSA	2015 TIGER
$Elevation_i$ (m)	Mean elevation	USGS NED

Table 4: Summary statistics-Tennessee CBG

Variable	Mean	Std.Dev	Min	Max	Obs
Dependent variable					
$Value_i$ ($)	141,718.5	90,268.88	13,100	1,000,000	4,005
Open space variables					
$DevOpen_i$ (acre)	392.8624	397.8971	0	3,657.129	4,117
$Forest_i$ (acre)	3,242.608	7,628.413	0	11,7391.1	4,117
$Shrub_i$ (acre)	190.2074	674.9177	0	12,072.26	4,117
$Agland_i$ (acre)	2,103.258	4,118.275	0	94,116.14	4,117
$Wetland_i$ (acre)	192.4462	1,065.975	0	38,266.2	4,117
$Feddist_i$ (km)	51.39453	34.16665	0	152.4724	4,117
$Statedist_i$ (km)	7.218675	6.152381	0	36.43515	4,117
$Privatedist_i$ (km)	2.967813	3.162222	0	20.87205	4,117
Structural variables					
$Rooms_i$	5.675937	1.032064	1.3	9	4,081
Age_i (years)	36.61899	14.35381	7	75	4,076
Gas_i (%)	38.48591	23.05439	0	100	4,087
Bed_i (%)	63.9848	21.51806	0	100	4,117
$LotSize_i$ (acre)	0.47313	3.98609	0.016033	234.9089	4,090
Socioeconomic variables					
$Income_i$ ($)	24,111.81	12,530.18	466	129,768	4,099
$Travel_i$ (%)	32.63537	16.60629	0	100	4,094
$Vacancy_i$ (%)	12.41155	10.77343	0	100	4,090
$Unemploy_i$ (%)	39.45845	12.07867	0	100	4,102
Edu_i (%)	49.68194	19.18018	0	100	4,102
$Stability_i$ (%)	75.63896	14.30371	0	100	4,087
$Density_i$ (person/acre)	2.559903	3.96258	0	119.1	4,117
Locational variables					
$Interdist_i$ (km)	8.780525	12.3295	0	79.98759	4,117
$Lakedist_i$ (km)	2.685528	2.616201	0	21.47704	4,117
$Interface_i$	0.5321212	0.4990277	0	1	4,117
Instrumental variables					
$Slope_i$ (degree)	4.514089	3.392863	0.2189215	31.24327	4,110
$Vehicle_i$ (%)	96.39877	6.209612	0	100	4,045
$Water_i$ (%)	1.743439	5.847485	0	69.58105	4,117
$MSAdist_i$ (km)	0.62076	2.743601	0	29.74032	4,117
$Elevation_i$ (m)	238.5261	138.4807	0	1,185.914	4,117

Note: Upper bound of value of house in 2014 ACS 5 year estimates $1,000,000

Data on the type of land cover in each CBG is from the 2011 national land cover database (NLCD2011) from the Multi-Resolution Land Characteristics Consortium (MRLC 2011). NLCD2011 for Tennessee classifies all land cover not considered open water into 14 categories: developed open space, developed low intensity, developed medium intensity, developed high intensity, barren land, deciduous forest, evergreen forest, mixed forest, shrub/scrub, grassland/herbaceous, pasture/hay, cultivated crops, woody wetlands, and emergent herbaceous wetlands. Details on each category are provided in Table 5. Due to few observations in the state, the barren land category was eliminated from the analysis. We aggregate developed low intensity, developed medium intensity and developed high intensity areas and divide by number of housing units in the CBG to create a proxy for average lot size [16].

Table 5. 2011 National Land Cover Database Classification Descriptions

Developed, Open Space - areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20% of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.
Developed, Low Intensity - areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20% to 49% percent of total cover. These areas most commonly include single-family housing units.
Developed, Medium Intensity - areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50% to 79% of the total cover. These areas most commonly include single-family housing units.
Developed High Intensity -highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80% to 100% of the total cover.
Barren Land (Rock/Sand/Clay) - areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.
Deciduous Forest - areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species shed foliage simultaneously in response to seasonal change.
Evergreen Forest - areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species maintain their leaves all year. Canopy is never without green foliage.
Mixed Forest - areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75% of total tree cover.
Shrub/Scrub - areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.
Grassland/Herbaceous - areas dominated by gramanoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.
Pasture/Hay - areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20% of total vegetation.
Cultivated Crops - areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20% of total vegetation. This class also includes all land being actively tilled.
Woody Wetlands - areas where forest or shrubland vegetation accounts for greater than 20% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

Emergent Herbaceous Wetlands - Areas where perennial herbaceous vegetation accounts for greater than 80% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

In order to reduce multicollinearity between each land type in the regression analysis, we redefine the remaining 10 categories into 5 different open space categories: developed open space, forest (sum of deciduous, mixed, and evergreen forest), shrub, agriculture land (sum of grassland, pasture, and cultivated crops), and wetland (sum of woody and emergent herbaceous wetlands).

While these variables capture the variety of open space cover types, they do not indicate which of these open space areas are privately owned, privately owned land protected from future development through a conservation easement, or public lands protected from development. Data for private or public protected areas are from the protected areas database of the United States (PAD-US) of USGS. This database is available as a zipped national, regional, state, or Landscape Conservation Cooperative (LCC) geodatabase or shapefile, and provides geographic boundaries of public land ownership, standardized and original land owner, land manager and so on. We define protected areas as federal protected area if the owner type domain code is federal (01) or designation (04). This category includes the Great Smokey Mountains National Park, national forests (Cherokee, Daniel Boone, Chattahoochee-Oconee, George Washington and Jefferson), national wildlife refuges (for example Reelfoot, Chickasaw, Hatchie), national historic sites (Andrew Johnson and Cumberland Gap), the Obed Wild and Scenic River, and the Big South Fork National Recreation Area.

State protected areas include all parcels where the owner type domain code is state government (03). This category includes state natural areas (for example, Burgess Falls, House Mountain, and Montgomery Bell), state forests (for example Cedars of Lebanon and Lone

Mountain), state parks (for example Frozen Head, Cumberland Mountain, Johnson Mounds), state historic sites (for example Sgt. Alvin C. York, Davy Crockett Birthplace, Sycamore Shoals), and wildlife management areas (for example Royal Blue and Obion River). We define protected areas as private protected areas if the owner type domain code is local (05), jointly owned (08), non-governmental organization (06), or private (07). This category includes publically owned lands protected by a conservation easement (for example Shelby Farms Park), private lands with conservation easements held by organizations such as the Land Trust for Tennessee and the Nature Conservancy, and private lands enrolled in the USDA's Conservation Reserve Program. For the relatively few parcels with the owner type domain code unknown landowner (09), we turn to the management type domain code to allocate these parcels to federal, state or private areas.

Many of these protected areas may create impacts on home values that extend beyond the CBG in which they are located. For example, homes in CBGs adjacent to the Great Smokey Mountains National Park may have a premium even though the national park is not in the same CBG. To account for these open space spillovers, we construct three additional open space variables that reflect the distance to federal, state and private protected areas. Distance calculations are made using a raster system where all data are arranged in grid cells. Distances are measured as the Euclidean distance from the centroid of each CBG to the edge of the nearest protected area in the PAD-US database. These distance variables are logged to account for the declining influence of distance as a CBG moves further from a protected area [36].

A locational description of each CBG is created by considering distance to critical features and an interaction dummy variable that indicates whether a census block group has mixed urban and rural areas. Data for distance from interstate highways, metropolitan statistical areas, and lakes/reservoirs is measured as the Euclidean distance from the centroid of each CBG to the line of a feature in the 2015 topologically integrated geographic encoding and referencing (TIGER) geodatabases from U.S. Census and the U.S. Board on Geographic Names (BGN), respectively. Elevation and slope of each CBG in Tennessee are calculated using the USGS National Elevation Dataset (NED).

Previous studies using hedonic pricing models to value open space have found significant differences in open space values between urban and rural areas. For example, values for open space may differ between urban and rural CBGs because different types of public open space are found in urban areas (neighborhood parks instead of wildlife management areas). We also anticipate regional differences in open space values due to the variety of terrain and cover types across the state. For example, many parts of the mountainous eastern part of the state are covered in high-elevation forest species and relatively little agricultural land. In contrast, West Tennessee is characterized by large tracts of agricultural land with relatively little forested areas.

In order to examine potential differences in open space between urban and rural areas and in different regions of the state, we divide the sample by east Tennessee MSA, middle Tennessee MSA, west Tennessee MSA, and non MSA. The east Tennessee MSA includes the Chattanooga MSA (Hamilton, Marion, and Sequatchie Counties), Cleveland MSA (Bradley and Polk Counties), Johnson City MSA (Carter, Unicoi, Washington Counties), Kingsport MSA (Hawkins and Sullivan Counties), Knoxville MSA (Anderson, Blount, Campbell, Grainger, Knox, Loudon, Morgan, Roane, and Union Counties), and Morristown MSA (Hamblen and Jefferson Counties). The middle Tennessee MSA includes Clarksville MSA (Montgomery and Stewart Counties), and Nashville MSA (Cannon, Cheatham, Davidson, Dickson, Hickman, Macon, Maury, Robertson, Rutherford, Smith, Sumner, Trousdale, Williamson, and Wilson

Counties). The west Tennessee MSA includes Jackson MSA (Chester, Crockett, and Madison Counties) and Memphis MSA (Fayette, Shelby, and Tipton Counties). If the sample does not belong to any of the MSAs above, it is classified as Non MSA. Tables 6-9 show summary statistics for these regional MSA variables.

Table 6: Summary statistics-East Tennessee MSA CBG

Variable	Mean	Std.Dev	Min	Max	Obs
Dependent variable					
$Value_i$ ($)	142,556.6	69,286.85	14,500	564,900	1,200
Open space variables					
$DevOpen_i$ (acre)	334.7918	292.2282	0	2,562.926	1,214
$Forest_i$ (acre)	2,416.762	6,652.114	0	90,206.81	1,214
$Shrub_i$ (acre)	78.89797	348.2688	0	7,790.415	1,214
$Agland_i$ (acre)	978.1042	1,675.515	0	13,361.73	1,214
$Wetland_i$ (acre)	20.75364	54.06953	0	1,156.252	1,214
$Feddist_i$ (km)	32.24749	17.62937	0	91.06876	1,214
$Statedist_i$ (km)	7.826199	6.311149	0	27.651	1,214
$Privatedist_i$ (km)	2.802937	2.815125	0	18.8968	1,214
Structural variables					
$Rooms_i$	5.661494	0.9487504	1.3	9	1,205
Age_i (years)	37.30207	14.03999	10	75	1,205
Gas_i (%)	28.20131	20.07513	0	94.28224	1,206
Bed_i (%)	62.62804	19.49426	0	100	1,207
$LotSize_i$ (acre)	0.41118	0.67183	0.02173	15.3784	1,207
Socioeconomic variables					
$Income_i$ ($)	24,570.46	11,190.64	1,860	109,790	1,209
$Travel_i$ (%)	29.12089	15.97428	0	88.69258	1,209
$Vacancy_i$ (%)	11.24885	9.301904	0	100	1,207
$Unemploy_i$ (%)	41.33521	10.97761	0	100	1,210
Edu_i (%)	51.17809	18.16659	3.747535	100	1,210
$Stability_i$ (%)	77.07718	12.68521	0	100	1,206
$Density_i$ (person/acre)	2.089023	4.271515	0	119.1	1,214
Locational variables					
$Interdist_i$ (km)	5.231607	6.199857	0	44.06043	1,214
$Lakedist_i$ (km)	3.252313	2.851364	0	19.23801	1,214
$Interface_i$	0.5222405	0.499711	0	1	1,214
Instrumental variables					
$Slope_i$ (degree)	6.234598	3.51021	0.2189215	31.24327	1,214
$Vehicle_i$ (%)	96.59852	5.235582	0	100	1,203
$Water_i$ (%)	2.740607	7.14572	0	54.85965	1,214
$MSAdist_i$ (km)	0	0	0	0	1,214
$Elevation_i$ (m)	347.7101	120.0775	198.9795	1,185.914	1,214

Note: Upper bound of value of house in 2014 ACS 5 year estimates $1,000,000

Table 7: Summary Statistics-Middle Tennessee MSA CBG

Variable	Mean	Std.Dev	Min	Max	Obs
Dependent variable					
Value$_i$ ($)	188,196.8	122,733.5	13,200	1,000,000	1,061
Open space variables					
DevOpen$_i$ (acre)	293.257	307.377	0.444798	1,889.947	1,101
Forest$_i$ (acre)	2,004.619	4,952.335	0	55,904.88	1,101
Shrub$_i$ (acre)	47.37927	141.1441	0	1,825.229	1,101
Agland$_i$ (acre)	1,335.654	2,853.065	0	19,285.55	1,101
Wetland$_i$ (acre)	16.87425	65.87337	0	940.303	1,101
Feddist$_i$ (km)	85.45353	25.35607	5.307335	135.5025	1,101
Statedist$_i$ (km)	6.276383	5.446826	0	36.43515	1,101
Privatedist$_i$ (km)	1.936508	2.206701	0	14.86946	1,101
Structural variables					
Rooms$_i$	5.797064	1.246553	2.7	9	1,090
Age$_i$ (years)	34.87408	15.48569	8	75	1,088
Gas$_i$ (%)	37.29318	23.00365	0	100	1,093
Bed$_i$ (%)	64.18916	24.75601	0	100	1,093
LotSize$_i$ (acre)	0.34009	0.80991	0.01603	18.35647	1,093
Socioeconomic variables					
Income$_i$ ($)	27,924.08	15,114.9	1,881	129,768	1,098
Travel$_i$ (%)	36.88944	16.62641	0	88.96104	1,097
Vacancy$_i$ (%)	9.079465	7.954578	0	52.77778	1,093
Unemploy$_i$ (%)	33.64529	11.29803	0	100	1,099
Edu$_i$ (%)	56.75899	19.80449	0	100	1,099
Stability$_i$ (%)	71.94063	15.94052	0	100	1,093
Density$_i$ (person/acre)	3.247939	3.8458	0	31.22281	1,101
Locational variables					
Interdist$_i$ (km)	4.668079	6.373238	0	41.18487	1,101
Lakedist$_i$ (km)	2.982876	2.496218	0	17.15573	1,101
Interface$_i$	0.4069028	0.4914797	0	1	1,101
Instrumental variables					
Slope$_i$ (degree)	3.919438	2.53134	0.2712771	17.95638	1,094
Vehicle$_i$ (%)	97.29163	5.668896	25	100	1,077
Water$_i$ (%)	1.572154	6.117396	0	69.58105	1,101
MSAdist$_i$ (km)	0	0	0	0	1,101
Elevation$_i$ (m)	183.6106	35.34828	123.9223	349.2092	1,101

Note: Upper bound of value of house in 2014 ACS 5 year estimates $1,000,000

Table 8: Summary Statistics-West Tennessee MSA CBG

Variable	Mean	Std.Dev	Min	Max	Obs
Dependent variable					
$Value_i$ ($)	124,117.8	88,437.09	13,100	702,700	742
Open space variables					
$DevOpen_i$ (acre)	207.2103	288.4636	0.444798	1,846.356	787
$Forest_i$ (acre)	551.4317	1,983.693	0	17,789.92	787
$Shrub_i$ (acre)	175.4177	620.5644	0	5,755.019	787
$Agland_i$ (acre)	1,062.937	3,113.519	0	2,3062.33	787
$Wetland_i$ (acre)	175.4177	620.5644	0	5,755.019	787
$Feddist_i$ (km)	42.88515	12.76489	0	62.04552	787
$Statedist_i$ (km)	6.354836	3.903452	0	25.02262	787
$Privatedist_i$ (km)	4.77932	3.502948	0	15.50982	787
Structural variables					
$Rooms_i$	5.732564	1.246568	2.7	9	780
Age_i (years)	41.7426	16.53606	7	75	777
Gas_i (%)	58.97798	19.20225	0	98.0198	780
Bed_i (%)	64.72886	26.87609	0	100	780
$LotSize_i$ (acre)	0.44693	2.1425	0.04574	59.10518	780
Socioeconomic variables					
$Income_i$ ($)	23,441.54	14,507.15	3832	118,318	784
$Travel_i$ (%)	30.85557	16.56945	0	100	781
$Vacancy_i$ (%)	14.38865	12.67577	0	81.26888	780
$Unemploy_i$ (%)	36.91045	12.87208	1.470588	100	784
Edu_i (%)	52.7843	20.78924	8.311688	100	784
$Stability_i$ (%)	73.17266	16.25266	0	100	780
$Density_i$ (person/acre)	4.827869	4.386158	0	44.04628	787
Locational variables					
$Interdist_i$ (km)	4.009981	5.395172	0	31.12992	787
$Lakedist_i$ (km)	2.308278	1.758043	0	7.566656	787
$Interface_i$	0.2223634	0.4160984	0	1	787
Instrumental variables					
$Slope_i$ (degree)	1.857301	1.491923	0.3759128	20.83905	787
$Vehicle_i$ (%)	94.85185	8.732737	37.14286	100	758
$Water_i$ (%)	0.6796806	4.005058	0	60.3303	787
$MSAdist_i$ (km)	0	0	0	0	787
$Elevation_i$ (m)	94.46739	17.5902	62.06341	156.1258	787

Note: Upper bound of value of house in 2014 ACS 5 year estimates $1,000,000

Table 9: Summary Statistics-Non MSA CBG

Variable	Mean	Std.Dev	Min	Max	Obs
Dependent variable					
$Value_i$ ($)	104,533.3	34,616.54	30,900	300,000	1,002
Open space variables					
$DevOpen_i$ (acre)	710.8941	479.7331	20.23831	3,657.129	1,015
$Forest_i$ (acre)	7,659.91	11,224.51	0	117,391.1	1,015
$Shrub_i$ (acre)	489.3657	1,122.6 5	0	12,072.2 6	1,015
$Agland_i$ (acre)	5,088.286	6,101.374	0	94,116.14	1,015
$Wetland_i$ (acre)	573.4031	1,955.442	0	38,266.2	1,015
$Feddist_i$ (km)	43.94865	41.62699	0	152.4724	1,015
$Statedist_i$ (km)	8.183968	7.686782	0	35.9188	1,015
$Privatedist_i$ (km)	2.896804	3.549212	0	20.87205	1,015
Structural variables					
$Rooms_i$	5.518091	0.5603577	3.2	8.2	1,006
Age_i (years)	33.73062	9.810138	12	75	1,006
Gas_i (%)	36.22706	18.88682	0	100	1,008
Bed_i (%)	64.81044	14.06778	0	100	1,008
$LotSize_i$ (acre)	0.71137	7.71464	0.02093	234.9089	1,010
Socioeconomic variables					
$Income_i$ ($)	19,895.73	6,536.771	466	87,684	1,008
$Travel_i$ (%)	33.40562	16.02964	0	85.71429	1,007
$Vacancy_i$ (%)	15.79495	11.93554	0	100	1,010
$Unemploy_i$ (%)	45.57098	9.920964	0	100	1,009
Edu_i (%)	37.74685	11.52796	7.984791	100	1,009
$Stability_i$ (%)	79.78218	10.92559	30.41667	100	1,008
$Density_i$ (person/acre)	0.618259	1.551819	0	36.19064	1,015
Locational variables					
$Interdist_i$ (km)	21.19395	17.31883	0	79.98759	1,015
$Lakedist_i$ (km)	1.977585	2.794475	0	21.47704	1,015
$Interface_i$	0.9162562	0.2771398	0	1	1,015
Instrumental variables					
$Slope_i$ (degree)	5.157185	3.668505	0.3302773	21.78634	1,015
$Vehicle_i$ (%)	1.561371	4.748623	0	48.01135	1,015
$Water_i$ (%)	96.36964	5.271547	0	100	1,007
$MSAdist_i$ (km)	2.517928	5.076728	0	29.74032	1,015
$Elevation_i$ (m)	63.74392	26.06161	11.64117	130.8706	1,015

Note: Upper bound of value of house in 2014 ACS 5 year estimates $1,000,000

3.2 ECONOMETRIC METHODS

This section details the methods used to estimate the relationship between house value and open space variables. The primary objective when using hedonic pricing models to estimate the value for open space is to estimate the hedonic price function. The hedonic price function formally describes how the price of a house is related to its attributes. The most basic hedonic price function that could be used to examine the effect of open space on housing value is

$$Value_i = \beta_0 + \beta_1 DevOpen_i + \beta_2 Forest_i + \beta_3 Shrub_i + \beta_4 Agland_i + \beta_5 Wetland_i + \beta_6 Feddist_i + \beta_7 Statedist_i + \beta_8 Privatedist_i + \boldsymbol{\alpha X_i} + \varepsilon_i \qquad (1)$$

where *i* indicates census block group. $Value_i$, which is a dependent variable, is the median value of house, $DevOpen_i$ is developed open space, $Forest_i$ is forest, $Shrub\text{-}Scrub_i$ is shrub and scrub, $Agland_i$ is agriculture land, $Wetland_i$ is wet land, $Feddist_i$ is the distance to the nearest federal protected open space, $Statedist_i$ is the distance to the nearest state protected open space, $Privatedist_i$ is the distance to the nearest privately protected open space, $\boldsymbol{X_i}$ is vector of covariates including housing structure variables, households' socioeconomic variables, and CBGs' locational variables, and ε_i is the error term of the model.

Estimating equation (1) refers to the use of statistical analysis to determine how much a home price will change given a specific change in one of its attributes. This relationship between a home's attributes and its value is embodied in a set of coefficients depicted by the β's in equation (1). By carefully estimating the coefficients associated with open space (β_1 through β_8), we are able to determine how a change in each type of open space affects home values in Tennessee.

Estimating the coefficients associated with open space proceeds in four steps. The first step is to select the nature of the relationship between open space and home values. For example, equation (1) is a linear relationship. A linear relationship presumes that the 1000th acre of open space increases home values by the same amount as the 100th acre. Much of the existing literature indicates that the 1000th acre of open space will increase home values less than the 100th acre – what economists call diminishing returns. This is intuitive, since the further one is away from an amenity, the less value they may derive from it. To capture these diminishing returns many researchers have used a semi-log model (taking the natural log of home values in equation (1)) or a double-log model (taking the natural log of all variables in equation (1) that do not have a value between zero and one). Hedonic pricing models do not give guidance on the appropriate functional form. One of the commonly used approaches for selecting the functional form of the hedonic price function is to compare adjusted R^2 from alternative functional forms. The R^2 statistic indicates how much of the variation in house values can be explained by the various attributes included in the model. Adjusted R^2 from the double log model indicates that this specification for the hedonic price function is a better fit for the relationship between open space and housing values. This double-log specification for the hedonic price function is:

$$\begin{aligned} \ln(Value_i) = \beta_0 &+ \beta_1 \ln(DevOpen_i) + \beta_2 \ln(Forest_i) + \beta_3 \ln(Shrub_i) \\ &+ \beta_4 \ln(Agland_i) + \beta_5 \ln(Wetland_i) + \beta_6 \ln(Feddist_i) \qquad (2) \\ &+ \beta_7 \ln(Statedist_i) + \beta_8 \ln(Privatedist_i) + \boldsymbol{\alpha X_i} + \varepsilon_i \end{aligned}$$

In this double-log form, the coefficients $\beta_1 - \beta_8$ are elasticities which give the percentage increase in the median house price due to a one percentage increase in the open space variables.

The second step is to check for multicollinearity between variables that may lead to misleading conclusions. Multicollinearity arises when two or more of the variables used to predict a home's value in the hedonic price function are closely linked. If these predictor variables are too closely linked, conclusions about the influence of open space on home values can be misleading. Multicollinearity is often common among housing attributes. For example, homes with more bedrooms typically have more bathrooms – it is difficult to isolate the unique values of bedrooms versus bathrooms. Multicollinearity is particularly common in open space studies. Because the amount of land is fixed, an increase in one type of open space can be very closely linked to decreases in another type of open space. To test for multicollinearity, we calculate variance inflation factors (VIF) for each of the variables in our model. A VIF greater than 10 is often used as a threshold to indicate when multicollinearity becomes a concern. The largest VIF in our study is 8 which indicates a lack of severe multicollinearity in our model.

The third step is to account for the potential endogeneity of open space variables. Private open space that is not currently protected from development is endogenous in the hedonic pricing equation [14, 25]. When open space is privately held and developable, land parcels considered open space are part of the land market and thus affected by the same things that affect a location's residential value. This is not true with privately held open space that is protected from development and public open space. Identifying the relationship between house value and private open space that could be developed becomes more difficult. For example, a housing shortage in an area will cause home prices to rise on average but will also encourage more open space to be developed for houses. A hedonic analysis using equation (2) would incorrectly conclude that the value of open space had declined in this area.

We utilize a two stage least squares (2SLS) regression technique with an instrumental variable (IV) to control for the potential endogeneity associated with private developable open space. The 2SLS approach involves estimating a "first stage" regression where the open space variables are being predicted and a second stage regression that reflects the hedonic price function that accounts for the endogeneity of open space variables. In the first stage, we use ordinary least squares (OLS) to estimate the relationship between open space variables, IVs, and other housing structure, socioeconomic, and neighborhood variables. For consistent estimation from 2SLS, the IV should be correlated with endogenous open space variables in the model, but should not be correlated with the median value of the house which is the dependent variable.

Based on the previous literature, we exploit five different IVs for each open space variable. For developed open space, percentage of workers who own a private vehicle is used as an IV. For forest, we use mean slope of a CBG as an IV. Percentage of water area is an IV for shrub and scrub, and (log) distance from the centroid of CBG to the nearest MSA is an IV for agriculture land. Lastly, we exploit mean elevation of a CBG as an IV for wetlands. More specifically, for the first stage equation, we estimate following set of equations.

$$\ln(DevOpen_i) = \gamma_0 + \gamma_1 Vehicle_i + \gamma_2 X_i + \varepsilon_i^d \tag{3.1}$$

$$\ln(Forest_i) = \delta_0 + \delta_1 Slope_i + \delta_2 X_i + \varepsilon_i^f \tag{3.2}$$

$$\ln(Shrub_i) = \eta_0 + \eta_1 Water_i + \eta_2 X_i + \varepsilon_i^s \tag{3.3}$$

$$\ln(Agland_i) = \theta_0 + \theta_1 MSAdist_i + \theta_2 X_i + \varepsilon_i^a \tag{3.4}$$

$$\ln(Wetland_i) = \lambda_0 + \lambda_1 Elevation_i + \lambda_2 X_i + \varepsilon_i^w \tag{3.5}$$

where *Vehicle* is percentage of workers who own a private vehicle, *Slope* is mean slope of a CBG, *Water* is percentage of water area, *MSA* is log of distance from the centroid of the CBG to the nearest MSA, and *Elevation* is mean elevation of a CBG, respectively. From equation (3.1)-(3.5), we obtain the predicted value of each dependent variable. Replacing explanatory variables in equation (2) with the predicted values (denoted by a $\widehat{\ }$ above the variable), we can estimate a second stage hedonic price function that accounts for the endogeneity of open space.

$$\begin{aligned} \ln(Value_i) = \beta_0 &+ \beta_1 \ln\left(\widehat{DevOpen_i}\right) + \beta_2 \ln\left(\widehat{Forest_i}\right) + \beta_3 \ln\left(\widehat{Shrub_i}\right) \\ &+ \beta_4 \ln\left(\widehat{Agland_i}\right) + \beta_5 \ln\left(\widehat{Wetland_i}\right) + \beta_6 \ln(Feddist_i) \\ &+ \beta_7 \ln(Statedist_i) + \beta_8 \ln(Privatedist_i) + \boldsymbol{\alpha X_i} + \varepsilon_i \end{aligned} \tag{4}$$

Estimating equation (4) using OLS provides an unbiased estimate of β_1 through β_8. Appendix A shows the impact of correcting for endogeneity by comparing the coefficients (β's) that arise from estimating equation 2 (endogeneity not corrected) and equation 4 (endogeneity corrected).

Step 4 is to account for potential differences in open space values in different parts of the state. Equation (4) could be estimated to find the marginal implicit price of open space throughout the state but it could not identify differences in the marginal value of open space between urban and rural areas or regional differences in open space values across the mountainous eastern part of the state, the hills and plateaus of middle Tennessee and the lowland plains in the western part of the state. To examine heterogeneous effects of open space on home values we introduce regional MSA interaction terms. Specifically, dummy variables for east, middle, and west Tennessee MSAs are interacted with each open space variable and included in the 2SLS estimation procedure outlined above. IVs are interacted with the same regional MSA dummy variables to preserve the needed number of IVs to control for the endogeneity in each open space type in each regional MSA. This results in a final or "second stage" regression of the form:

$$\begin{aligned}\log(Value_i) = \beta_0 + \beta_1 \ln\left(\widehat{DevOpen_i}\right) + \beta_2\left(\ln\left(\widehat{DevOpen_i}\right) * EastMSA_i\right) \\ + \beta_3\left(\ln\left(\widehat{DevOpen_i}\right) * MiddleMSA_i\right) + +\beta_4\left(\ln\left(\widehat{DevOpen_i}\right) * WestMSA_i\right) \\ + \beta_5 \ln\left(\widehat{Forest_i}\right) + \beta_6\left(\ln\left(\widehat{Forest_i}\right) * EastMSA_i\right) + \cdots \\ + \beta_{20}(\ln\left(\widehat{Wetland_i}\right) * WestMSA_i) + \beta_{21} \ln(Feddist_i) \\ + \beta_{22} \ln(Statedist_i) + \beta_{23} \ln(Privatedist_i) + \boldsymbol{\alpha X_i} + \varepsilon_i\end{aligned} \tag{5}$$

where *EastMSA* is indicator of 1 if CBG is included in an east Tennessee MSA, *MiddleMSA* is indicator of 1 if CBG is included in a middle Tennessee MSA, and *WestMSA* is indicator of 1 if CBG is included in a west Tennessee MSA, respectively. Since the reference group in this equation is non-MSA, the coefficients of non-interacted open space variables (β_1, β_5, β_9 …) indicate the average effect of open space in a CBG located outside an MSA, and the coefficients of interaction terms represent the contribution of open space to housing values in each regional MSA (east, middle, and west Tennessee MSA) relative to a non-MSA CBG. Similar to equation (4), estimating equation (5) using OLS gives unbiased estimates of β_1 through β_{23}. Appendix B shows the impact of accounting to urban-rural differences in open space values in each part of the state.

3.3 RESULTS

The results of the hedonic pricing analysis consist of a series of regression results which provide estimates of the coefficients associated with open space variables (β_1 through β_{23}) as well as the other structural, socioeconomic, and locational variables. The complete set of second stage regression results for equation (5) are presented in Table 10. Results for the first stage regression are presented in Appendix C.

Table 10. Second stage regression results for hedonic price function

Variable	Coefficient estimate (standard error)
Constant	**5.5567*** (0.2432)**
Open space variables	
$DevOpen_i$	**-0.0302** (0.0137)**
$DevOpen_i$ EastMSA$_i$*	-0.0413 (0.0383)
$DevOpen_i$ MiddleMSA$_i$*	0.0002 (0.0249)
$DevOpen_i$ WestMSA$_i$*	0.0537 (0.0518)
$Forest_i$	0.0060 (0.0053)
$Forest_i$ EastMSA$_i$*	0.0040 (0.0182)
$Forest_i$ MiddleMSA$_i$*	0.0013 (0.0152)
$Forest_i$ WestMSA$_i$*	0.0336 (0.0484)
$Shrub_i$	-0.0032 (0.0072)
$Shrub_i$ EastMSA$_i$*	0.0078 (0.0264)
$Shrub_i$ MiddleMSA$_i$*	**0.0566** (0.0235)**
$Shrub_i$ WestMSA$_i$*	-0.0941 (0.0729)
$Agland_i$	**0.0151*** (0.0041)**
$Agland_i$ EastMSA$_i$*	-0.0078 (0.0093)
$Agland_i$ MiddleMSA$_i$*	-0.0163 (0.0114)
$Agland_i$ WestMSA$_i$*	**0.0610** (0.0276)**
$Wetland_i$	**-0.0199** (0.0086)**
$Wetland_i$ EastMSA$_i$*	**0.0427** (0.0193)**
$Wetland_i$ MiddleMSA$_i$*	**-0.0530** (0.0263)**
$Wetland_i$ WestMSA$_i$*	**-0.1072*** (0.0342)**

$Feddist_i$	**-0.0096* (0.0059)**
$Feddist_i$ EastMSA_i$*	**0.0265*** (0.0102)**
$Feddist_i$ MiddleMSA_i$*	-0.0082 (0.0417)
$Feddist_i$ WestMSA_i$*	0.0060 (0.0656)
$Statedist_i$	**0.0327*** (0.0099)**
$Statedist_i$ EastMSA_i$*	-0.0191 (0.0132)
$Statedist_i$ MiddleMSA_i$*	**-0.0681*** (0.0193)**
$Statedist_i$ WestMSA_i$*	-0.0103 (0.0460)
$Privatedist_i$	0.0007 (0.0104)
$Privatedist_i$ EastMSA_i$*	-0.0086 (0.0154)
$Privatedist_i$ MiddleMSA_i$*	-0.0241 (0.0204)
$Privatedist_i$ WestMSA_i$*	**-0.0528** (0.0242)**
Structural variables	
$Rooms_i$	**0.6067*** (0.0674)**
Age_i	**-0.1029*** (0.0172)**
Gas_i	-0.0003 (0.0003)
Bed_i	**-0.0010** (0.0005)**
$LotSize_i$	0.0106 (0.0337)
Socioeconomic variables	
$Income_i$	**0.5156*** (0.0217)**
$Travel_i$	-0.0003 (0.0005)
$Vacancy_i$	0.0007 (0.0006)
$Unemploy_i$	**0.0037*** (0.0006)**
Edu_i	**0.0079*** (0.0005)**
$Stability_i$	**-0.0031*** (0.0006)**
$Density_i$	**0.0822*** (0.0272)**
Locational variables	
$Interdist_i$	**-0.0142*** (0.0048)**
$Lakedist_i$	-0.0093 (0.0075)
$Interface_i$	**0.0587*** (0.0189)**
$EastMSA_i$	0.1840 (0.1395)
$MiddleMSA_i$	**0.3978* (0.2197)**
$WestMSA_i$	-0.3032 (0.3378)

Note: Number of observations 3,993. Adjusted R^2 = 0.752). Standard errors are clustered by census block group. * $p < 0.1$, **$p < 0.05$, *** $p < 0.01$

We first turn our attention to the structural, socioeconomic and location variables. Ensuring that the coefficients for these variables conform to intuition is a good way to gauge the overall fit of the hedonic pricing function and the accuracy of the open space coefficients. Among the structural variables, median number of rooms per house and median age of house are statistically significant at the 1% level. As expected, more rooms and a lower age adds value to houses. Percentage of housing units with more than three bedrooms is significant at the 5% level. The negative effect of having more than three bedrooms combined with the positive effect of having more rooms likely reflects the value gained by having more living space such as multiple living rooms and recreation rooms. The insignificance of residential area per household may be associated with not accurately recording low density residential development patterns in rural areas in the NLCD database [37].

Among the socioeconomic variables, greater per capita income, educational attainment, the proportion of houses occupied, and population density are statistically significant at the 1% level. As expected, more educated populations with higher per capita incomes in stable neighborhoods with high population density tend to support higher home values. Among the locational variables, home values are higher the closer the home is to an interstate. At the CBG level of the analysis, this likely reflects a desire among homebuyers to be close to an interstate but not immediately adjacent to an interstate. Homes in mixed urban-rural areas and in middle Tennessee MSAs are also more valuable.

The coefficients associated with open space are used to calculate the impact on housing values from an increase in open space area or distance to open space. A positive coefficient associated with open space area ($DevOpen_i$, $Forest_i$, $Shrub_i$, $Agland_i$, $Wetland_i$) suggests that an increase in open space adds value to homes within the same CBG. In contrast, a positive coefficient associated with open space distance ($Feddist_i$, $Statedist_i$, $Privatedist_i$) suggests that proximity to open space detracts from home values. If the coefficients associated with these variables are indicated with an asterisk, the impact of open space on home values in all parts of the state is significantly different from zero. If the coefficients associated with the open space interaction terms are indicated with an asterisk (for example $Shrub_i$* $MiddleMSA_i$ and $Wetland_i$* $EastMSA_i$), the impact of open space on home values differs in this area.

Table 11 shows the marginal implicit prices. The marginal implicit price reflects the premium added to home values to obtain more open space area or closer proximity to open space. Because the coefficients associated with open space are elasticities (percent change in home values resulting from a 1 percent change in open space), the marginal implicit prices fully capture variation in median home prices and the current supply of open space across the state.

Table 11. Marginal implicit prices for open space

Type of Open Space	Rural	Urban		
		Western MSAs	Middle MSAs	Eastern MSAs
Developed ($/acre)	-$4.44	-$18.09	-$19.38	-$12.86
Forest ($/acre)	$0	$0	$0	$0
Shrubland ($/acre)	$0	$0	$224.82	$0
Agricultural land ($/acre)	$0.31	$8.89	-$2.13	$2.20
Wetland ($/acre)	-$3.63	-$89.93	-$813.05	$156.61
Federal protected ($/km)	-$22.83	-$27.78	-$21.14	$74.71
State protected ($/km)	$417.68	$638.67	-$1,061.47	$595.64
Private protected ($/km)	$0	-$1,371.20	$0	$0

The coefficient associated with developed open space is negative and significant at the 5% level. Likewise, the regional MSA interaction terms associated with this type of open space are not significant. This suggests that developed open space (golf courses, neighborhood parks, cemeteries) detracts from home values and this negative effect is present in both urban and rural areas and in all parts of the state. In particular, a 1% increase in developed open space area decreases home values by 0.03% in rural areas and in all MSAs in the state. Because of regional differences in median home values across the state, this 1% increase manifests as a $43.05 decline in home values in rural areas to a $56.84 decline in home values in middle Tennessee MSAs. Because of regional differences in the current supply of developed open space, adding an additional acre of developed open space decreases home values by $4.44 in rural areas to $19.38 in middle Tennessee MSAs. It is important to remember that the developed open space cover type aggregates all areas where impervious surfaces are present but account for less than 20% of total cover. This result only indicates that the overall effect of this type of open space on home value is negative. Some types of open space that fall in this category. For example, golf courses could have positive impacts on home values [12] that are outweighed by negative effects generated by other types of developed open space such as busy neighborhood parks [17].

The coefficient associated with forested open space is insignificant in all areas of the state. This implies that increasing the amount of forest in Tennessee will not produce a statistically significant effect on home values in the state. This may be due to the values that Tennessee residents hold for different types of forested areas. Cho et al. [33] find that forested open space comprised of evergreen tree species (pines, hemlock, cedar) add to home values in Knox County while forested open space comprised of deciduous species (oak, maple, hickory) detract from home values.

The coefficient on shrubland is not significantly different than zero but the coefficient associated with the Middle Tennessee MSA interaction term is significant at the 5% level. This indicates that more shrubland adds value to homes but only in the Clarksville and Nashville

MSAs. Specifically, adding an additional acre of shrubland increases home values in these two MSAs by $224.82.

The coefficient on agricultural land is positive and significant at the 1% level indicating that pasture and cropland adds value to nearby homes. The coefficient on the interaction term with East Tennessee MSAs is not significant indicating that the impact of agricultural land on home values in East Tennessee MSAs does not significantly differ from other parts of the state. Due to differences in median home values and the quantity of agricultural open space acres in rural areas, East Tennessee MSAs, and Middle Tennessee MSAs, an additional acre of agricultural open space will increase home values by $0.31, $2.20, and $2.13 in these areas respectively. However, the coefficient on the interaction term with West Tennessee MSAs is significant. This indicates that the relationship between agricultural open space and home values found in urban and suburban areas in West Tennessee differs from other parts of the state. For example, the coefficient on West Tennessee MSAs is positive which indicates that agricultural open space adds more value ($8.89 per acre) to homes in urban and suburban parts of West Tennessee than it does in other parts of the state.

The coefficient on wetland area is negative and significant at the 5% level. Specifically, an additional acre of wetland lowers home values in rural parts of the state by -$3.63. The negative effect of wetland area is more pronounced in West and Middle Tennessee MSAs where an additional acre of wetland lowers home values by -$89.93 and -$813.05 respectively. This negative effect may be due to the odors and mosquitos that often accompany wetlands. Interestingly, the coefficient on the East Tennessee MSA interaction term is positive and larger than the coefficient on $Wetland_i$. This indicates that wetland open space adds to home values in the urban and suburban parts of East Tennessee. Specifically, an additional acre of wetland in the Chattanooga, Cleveland, Johnson City, Kingsport, Knoxville, and Morristown MSAs adds $156.61 to the value of nearby homes. This positive effect is likely due to the relative lack of wetlands in urban and suburban areas in the eastern part of the state.

The coefficient on distance to federal protected areas is negative and marginally significant at the 10% level. But the coefficient on the interaction term with East Tennessee MSAs is positive and significant at the 1 percent level. This indicates that proximity to open space protected by the federal government detracts from home values in East Tennessee MSAs but adds to home values in other parts of the state. Specifically, moving one kilometer closer to federally protected open space in rural areas, Middle Tennessee MSAs, and West Tennessee MSAs adds $22.83, $21.14, and $27.78 to home values respectively. However, moving one kilometer closer to federally protected open space in the Chattanooga, Cleveland, Johnson City, Kingsport, Knoxville, and Morristown MSAs lowers the value of homes by $74.71. This result is consistent with previous studies using hedonic pricing to value proximity to federally protected open space in East Tennessee [16].

Caution should be exercised when interpreting this result as evidence that federally protected open space detracts from home values in East Tennessee MSAs. Federal open space amenities such as the Great Smoky Mountains National Park and the Cherokee National Forest undoubtedly attractdoes residents to nearby cities like Knoxville, Chattanooga and Johnson City. Some evidence of this effect is found in the positive and relatively large coefficient on $EastMSA_i$ (although this coefficient is not significantly different from zero at the 10% level). The negative effect of $Feddist_i * EastMSA_i$ indicates that residents that chose to locate in these cities are not willing to pay to be closer to federally protected open spaces. Instead these residents are choosing to locate closer to other amenities or work and travel a few more miles to visit these federally protected areas.

It is also important to remember that this measure is calculated as distance to the *nearest* federally protected open space. Among East Tennessee MSAs, the average distance to a federally protected open space is 32 kilometers (less than 20 miles). However, larger federal protected open spaces such as the Great Smoky Mountains National Park and the Cherokee National Forest are located further than 20 miles from large portions of these MSAs. It is nearly 35 miles from Knoxville to Gatlinburg, one of the gateways to the Great Smoky Mountains National Park. It is nearly 42 miles from Chattanooga to Ocoee, TN, the main gateway to the southern part of the Cherokee National Forest. This negative effect is not capturing many efforts to locate closer to these larger federally protected areas.

The coefficient on distance to state protected open space is positive and significant at the 1 percent level. This indicates that proximity to open space protected by the state government detracts from home values in rural areas, East Tennessee MSAs, and West Tennessee MSAs. A home located one kilometer closer to state protected areas decreases home values by $417.68 in rural areas, $595.64 in East Tennessee MSAs, and $638.67 in West Tennessee MSAs. However, the coefficient associated with state protected area distance interacted with Middle Tennessee MSAs is negative and significant at the 1 percent level. Because the coefficient on the interaction term is larger than the coefficient on $Statedist_i$, proximity to state protected areas on net adds value to homes in Middle Tennessee MSAs. Specifically, a home located one kilometer closer to state protected open space in Clarksville and Nashville MSAs increase home values by $1,061.47.

Again, caution should be exercised when interpreting this result as evidence that state parks, forests, natural areas, historic sites, and wildlife management areas detract from home values in all areas except the Clarksville and Nashville MSAs. State protected areas are located in places with historic and natural amenities but also in areas where the opportunity costs of state designation are low. Figure 6 shows the location of state protected open space within each of the states MSAs. Locating state protected open space in neighborhoods with high housing values makes protecting these areas more expensive. As a result, state protected areas are often located in areas with lower housing values. For instance, the vast majority of state protected areas in the East Tennessee MSAs, where median home value is $142,556, are located in Morgan County (median value of $91,100) and Campbell County (median home value of $89,200). The majority of state protected open space in West Tennessee MSAs is located in northwestern Shelby County. This strategy lowers the cost of preserving open space but will not be expected to generate large impacts on nearby home values.

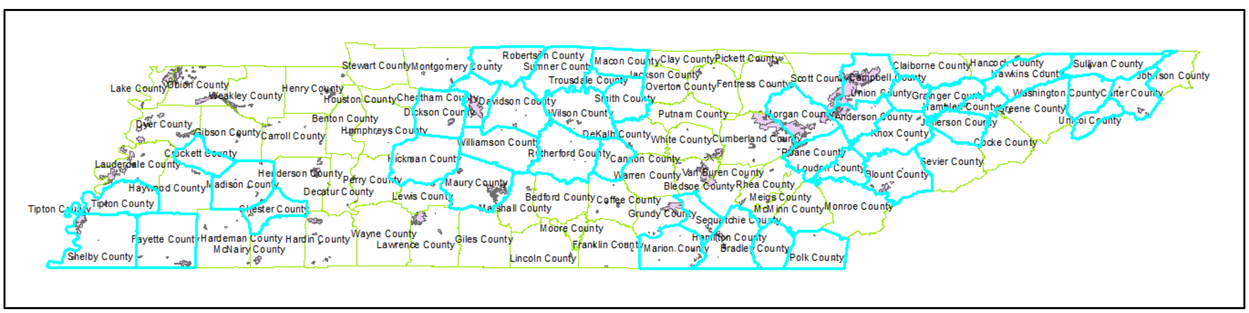

Figure 6. Location of state protected open space in rural counties (green) and MSA counties (blue)

The coefficient on distance to private protected areas is not significant but the interaction term with West Tennessee MSAs is negative and significant at the 5% level. This suggests that private conservation lands or open space lands owned by local governments only add to home values in West Tennessee MSAs. In these areas, being one kilometer closer to local government or private protected open space adds $1,371 to the value of a home. One notable example of this type of protected open space in a West Tennessee MSA is the 4,500 acre Shelby Farms Park located in east Memphis. This park is located approximately half way between the affluent suburban neighborhoods of Bartlett and Germantown.

4. DISCUSSION AND CONCLUDING REMARKS

An economic approach to land use weighs the benefits and costs of converting open space to other uses such as residential, commercial, and industrial properties. Cost-effective land use policies should strive to prevent development of open space when the costs of this development outweigh the benefits. The benefits of developing Tennessee's open space into residential, commercial, and industrial properties are typically captured by market forces making them relatively easy to estimate. The costs associated with open space development are far harder to estimate since many of the benefits open space provides are not captured by markets.

This report provides estimates of one of the costs of open space development that is captured by markets – the housing premiums that arise due to proximity to open space. Houses located close to private open space in Tennessee may be more valuable due to the wildlife viewing and aesthetic views these private open spaces provide. Publicly accessible open space provides additional recreation opportunities for nearby homes. The premium that Tennessee residents are willing to pay to live near these areas provides one estimate of the values provided by Tennessee's public and private open spaces and, in turn, the costs of developing them into other uses. Overall, the housing premium estimates associated with open space reported here are similar in magnitude to results reports in other studies in East Tennessee and in other parts of the country.

This study finds that permanently protected open space in MSAs adds the largest value to nearby homes. In West Tennessee MSAs, a house located one kilometer closer to private protected open space is worth $1,371.20 more. Based on this analysis, this private protected open space is the most valuable in the state of Tennessee. After reviewing the local and private protected open spaces in this part of the state, we believe that much of this result is due to Shelby Farms Park. Shelby Farms is the nineteenth largest urban park in the United States. The park's 4,500 acres of publically owned open space is protected by a conservation easement and managed by a public-private partnership between Shelby Farms Park Conservancy and Shelby County Government. Shelby Farms provides for numerous activities not typically available in most urban parks such as horseback riding, mountain biking, ropes courses, lasertag and paintball, and a buffalo herd. Like many urban parks, residents can reach Shelby Farms by driving or by walking or biking along one of the city's greenways.

It is no surprise that proximity to this urban open space adds significant value to nearby homes thanks to public access to well-developed recreation facilities located in the heart of one of Tennessee's largest MSAs and greenway connections that increase the park's economic footprint. While the negative effect of developed open space on home values may suggest that municipal parks and greenways detract from home values, we strongly caution against this conclusion. Instead, many municipal parks and greenways like Shelby Farms likely add to nearby home values but these positive impacts are not being captured in the analysis due to their inclusion with other types of developed open space.

The second largest housing premium associated with open space is state protected open space in Middle Tennessee MSAs. In Middle Tennessee MSAs, a house located one kilometer closer to state protected open space is worth $1,061.47 more. The state protected open spaces in Middle Tennessee MSAs larger than 1000 acres include:

1. Cheatham Wildlife Management Area – Cheatham County
2. Yanahli Wildlife Management Area – Maury County
3. Montgomery Bell State Park – Dickson County
4. Duck River Complex State Natural Area – Maury County
5. Pea Ridge Wildlife Management Area – Cannon County
6. Williamsport Wildlife Management Area – Maury County
7. Radnor Lake State Natural Area – Davidson County
8. Montgomery Bell State Natural Area – Dickson County
9. Cedars of Lebanon State Forest – Wilson County

These state protected areas offer residents of the Clarksville and Nashville MSAs the opportunity to engage in recreational activities such as hunting, fishing, and camping that are not typically available so close to a major metropolitan area.

This study also uncovers two important general findings concerning open space in the state of Tennessee. First, Tennessee residents do not value all types of open space equally. Residents tend to prefer agricultural lands to developed open space such as golf courses and cemeteries. When averaging values across the state, an additional acre of pasture and cultivated crops increases home values by $3.38, but an additional acre of developed open space is associated with an average decrease in home values of $13.69. This result provides support for organizations like The Land Trust for Tennessee which has worked to preserve working farms in

Tennessee.[7] It also calls into question the common assertion that forested industrial parks and golf courses are substitutes for natural forests and grasslands.

Second, values for open space vary considerably across the state. Residents in rural parts of the state value proximity to agricultural open space such as pastures and fields of cultivated crops but wish to locate further away from wetlands and developed open space such as golf courses and cemeteries. In contrast, residents of East Tennessee MSAs value proximity to wetlands. Residents in Middle Tennessee MSAs value proximity to shrubland but values for shrubland in other parts of the state are not detected in the analysis. These regional differences in open space values reflect the current supply of open space in these areas. For instance, Middle Tennessee MSAs are characterized by a relatively low prevalence of shrubland partially explaining why residents in these areas value this type of open space when residents in other areas do not. Wetland values in East Tennessee MSAs may be due to wetlands being far less prevalent in this area compared to other parts of the state. Agricultural lands are far more prevalent in rural areas which are also where their impact on home values is lowest. This is what economists call scarcity value - the scarcer a type of open space is in a region, the more likely people will be willing to pay a premium to locate next to it. When a type of open space is abundant, it is easier for homeowners to capture the values provided by these types of open space by purchasing larger lots. Differences in geography and elevation across the state leads to considerable variation in the type of natural open space provided. Open space that is abundant in one area of the state may be rare in other parts of the state. Efforts to control the development of open space should focus on cover types that are scarce in the region as these will likely be areas where the cost of development is high.

[7] http://landtrusttn.org/category/our-projects/working-farms/

The marginal implicit prices in Table 11 indicate the average impact on a home in each region from a change in the stock of open space in that region. To find the total impact of an increase in open space area on housing values we multiply the marginal implicit prices by the number of homes in each county. Tables 12 through 15 show the total impact of a 1 acre increase in each type of open space (4,125 acre total) on housing values by county in each region. Variations in impacts reflect differences in the stock of open space, median home values across regions, and the number of housing units across counties. As expected, the largest impacts occur in MSAs due to the higher median house values and number of housing units in these areas. MSAs also tend to have lower acreage in each type of open space which makes the additional acre more valuable in these areas.

Table 12. Total impact on home values from a 1 acre increase in open space in each Census Block Group in East Tennessee Metropolitan Statistical Areas

County	Housing Units	Developed open space	Forest	Shrubland	Agricultural land	Wetland
Anderson	34,737	-$446,696	$0	$0	$76,449	$5,440,267
Blount	55,541	-$714,222	$0	$0	$122,234	$8,698,444
Bradley	41,928	-$539,167	$0	$0	$92,275	$6,566,471
Campbell	20,165	-$259,309	$0	$0	$44,379	$3,158,102
Carter	27,820	-$357,747	$0	$0	$61,226	$4,356,975
Grainger	10,870	-$139,781	$0	$0	$23,923	$1,702,384
Hamblen	27,004	-$347,254	$0	$0	$59,430	$4,229,178
Hamilton	152,697	-$1,963,586	$0	$0	$336,054	$23,914,340
Hawkins	26,819	-$344,875	$0	$0	$59,023	$4,200,205
Jefferson	23,583	-$303,262	$0	$0	$51,901	$3,693,405
Knox	196,985	-$2,533,102	$0	$0	$433,523	$30,850,418
Loudon	22,008	-$283,009	$0	$0	$48,435	$3,446,740
Marion	12,994	-$167,095	$0	$0	$28,597	$2,035,030
Morgan	8,909	-$114,564	$0	$0	$19,607	$1,395,265
Polk	8,181	-$105,202	$0	$0	$18,005	$1,281,251
Roane	25,658	-$329,946	$0	$0	$56,468	$4,018,377
Sequatchie	6,371	-$81,927	$0	$0	$14,021	$997,782
Sullivan	73,952	-$950,976	$0	$0	$162,753	$11,581,847
Unicoi	8,834	-$113,600	$0	$0	$19,442	$1,383,520
Union	9,043	-$116,287	$0	$0	$19,902	$1,416,252

Washington	58,045	-$746,422	$0	$0	$127,745	$9,090,603
Total	**852,144**	**-$10,958,029**	**$0**	**$0**	**$1,875,392**	**$133,456,855**

Table 13. Total impact on home values from a 1 acre increase in open space in each Census Block Group in Middle Tennessee Metropolitan Statistical Areas

County	Housing Units	Developed open space	Forest	Shrubland	Agricultural land	Wetland
Cannon	6,039	-$117,040	$0	$1,357,705	$12,849	-$4,909,987
Cheatham	15,767	-$305,576	$0	$3,544,781	$33,546	-$12,819,301
Davidson	287,824	-$5,578,248	$0	$64,709,390	$612,382	-$234,014,242
Dickson	20,938	-$405,794	$0	$4,707,339	$44,548	-$17,023,564
Hickman	10,280	-$199,234	$0	$2,311,178	$21,872	-$8,358,116
Macon	9,909	-$192,044	$0	$2,227,769	$21,083	-$8,056,476
Maury	35,566	-$689,296	$0	$7,996,047	$75,671	-$28,916,805
Montgomery	73,698	-$1,428,323	$0	$16,568,989	$156,802	-$59,919,887
Robertson	26,279	-$509,307	$0	$5,908,118	$55,912	-$21,366,044
Rutherford	105,662	-$2,047,810	$0	$23,755,224	$224,809	-$85,908,099
Smith	8,555	-$165,802	$0	$1,923,359	$18,202	-$6,955,611
Stewart	6,773	-$131,266	$0	$1,522,725	$14,410	-$5,506,763
Sumner	66,931	-$1,297,174	$0	$15,047,613	$142,404	-$54,418,003
Trousdale	3,387	-$65,643	$0	$761,475	$7,206	-$2,753,788
Williamson	70,861	-$1,373,340	$0	$15,931,167	$150,766	-$57,613,275
Wilson	47,166	-$914,113	$0	$10,603,991	$100,352	-$38,348,142
Total	**795,635**	**-$15,420,011**	**$0**	**$178,876,867**	**$1,692,813**	**-$646,888,102**

Table 14. Total impact on home values from a 1 acre increase in open space in each Census Block Group in West Tennessee Metropolitan Statistical Areas

County	Housing Units	Developed open space	Forest	Shrubland	Agricultural land	Wetland
Chester	7,006	-$126,736	$0	$0	$62,256	-$630,052
Crockett	6,427	-$116,262	$0	$0	$57,111	-$577,982
Fayette	15,938	-$288,313	$0	$0	$141,627	-$1,433,310
Madison	42,267	-$764,594	$0	$0	$375,589	-$3,801,085
Shelby	400,572	-$7,246,199	$0	$0	$3,559,523	-$36,023,574
Tipton	23,351	-$422,411	$0	$0	$207,499	-$2,099,963
Total	**495,561**	**-$8,964,515**	**$0**	**$0**	**$4,403,605**	**-$44,565,966**

Table 15. Total impact on home values from a 1 acre increase in open space in each Census Block Group in rural counties

County	Housing Units	Developed open space	Forest	Shrubland	Agricultural land	Wetland
Bedford	18,499	-$82,150	$0	$0	$5,739	-$67,111
Benton	8,973	-$39,847	$0	$0	$2,784	-$32,553
Bledsoe	5,704	-$25,330	$0	$0	$1,769	-$20,693
Carroll	13,182	-$58,538	$0	$0	$4,089	-$47,822
Claiborne	14,955	-$66,411	$0	$0	$4,639	-$54,254
Clay	4,271	-$18,966	$0	$0	$1,325	-$15,494
Cocke	17,406	-$77,296	$0	$0	$5,400	-$63,146
Coffee	23,481	-$104,273	$0	$0	$7,284	-$85,185
Cumberland	28,373	-$125,998	$0	$0	$8,802	-$102,933
Decatur	6,843	-$30,388	$0	$0	$2,123	-$24,825
DeKalb	9,411	-$41,792	$0	$0	$2,919	-$34,142
Dyer	16,744	-$74,356	$0	$0	$5,194	-$60,744
Fentress	8,952	-$39,754	$0	$0	$2,777	-$32,476
Franklin	18,841	-$83,668	$0	$0	$5,845	-$68,352
Gibson	22,198	-$98,576	$0	$0	$6,886	-$80,531
Giles	13,829	-$61,411	$0	$0	$4,290	-$50,169
Greene	32,076	-$142,442	$0	$0	$9,950	-$116,366
Grundy	6,387	-$28,363	$0	$0	$1,981	-$23,171
Hancock	3,616	-$16,058	$0	$0	$1,122	-$13,118
Hardeman	10,854	-$48,200	$0	$0	$3,367	-$39,377
Hardin	13,957	-$61,980	$0	$0	$4,330	-$50,634
Haywood	8,354	-$37,098	$0	$0	$2,592	-$30,307
Henderson	12,820	-$56,930	$0	$0	$3,977	-$46,509
Henry	17,030	-$75,626	$0	$0	$5,283	-$61,782
Houston	4,184	-$18,580	$0	$0	$1,298	-$15,179
Humphreys	8,880	-$39,434	$0	$0	$2,755	-$32,215
Jackson	5,823	-$25,859	$0	$0	$1,806	-$21,125
Johnson	8,940	-$39,700	$0	$0	$2,773	-$32,433
Lake	2,596	-$11,528	$0	$0	$805	-$9,418
Lauderdale	11,275	-$50,069	$0	$0	$3,498	-$40,904
Lawrence	18,165	-$80,666	$0	$0	$5,635	-$65,900
Lewis	5,456	-$24,229	$0	$0	$1,693	-$19,793
Lincoln	15,318	-$68,023	$0	$0	$4,752	-$55,571
McMinn	23,301	-$103,474	$0	$0	$7,228	-$84,532
McNairy	11,978	-$53,191	$0	$0	$3,716	-$43,454
Marshall	13,188	-$58,565	$0	$0	$4,091	-$47,844
Meigs	5,634	-$25,019	$0	$0	$1,748	-$20,439
Monroe	20,823	-$92,470	$0	$0	$6,460	-$75,542
Moore	2,934	-$13,029	$0	$0	$910	-$10,644
Obion	14,631	-$64,973	$0	$0	$4,539	-$53,079
Overton	10,285	-$45,673	$0	$0	$3,191	-$37,312
Perry	4,578	-$20,330	$0	$0	$1,420	-$16,608

Pickett	3,451	-$15,325	$0	$0	$1,071	-$12,520
Putnam	32,377	-$143,778	$0	$0	$10,044	-$117,458
Rhea	14,387	-$63,889	$0	$0	$4,463	-$52,194
Scott	9,891	-$43,923	$0	$0	$3,068	-$35,883
Sevier	56,136	-$249,286	$0	$0	$17,414	-$203,652
Van Buren	2,658	-$11,804	$0	$0	$825	-$9,643
Warren	17,813	-$79,103	$0	$0	$5,526	-$64,623
Wayne	7,272	-$32,293	$0	$0	$2,256	-$26,382
Weakley	15,512	-$68,885	$0	$0	$4,812	-$56,275
White	11,560	-$51,335	$0	$0	$3,586	-$41,938
Total	**695,802**	**-$3,089,885**	**$0**	**$0**	**$215,847**	**-$2,524,256**

These increases in home values also generate increases in property taxes provided these open space impacts are included in the appraised value of a home. To calculate the impact of an increase in open space on property tax revenues we multiply the change in home values in Tables 12 through 15 by 25 percent to calculate the impact of open space on assessed property values. We then multiply this change in assessed value by the average of city and county property tax rates in each county.[8] The impact of a 1 acre increase in open space in each CBG on property tax revenues is presented in Tables 16 through 19. Developed open space reduces property tax revenues by reducing nearby property values. Agricultural land increases property tax revenues by increasing nearby home values. Wetlands increase property tax revenues in East Tennessee MSAs but reduce property tax revenues in other parts of the state.

Many government programs incentivize open space preservation by providing property tax credits for certain types of open space. For example, Tennessee's Agricultural, Forest, and Open Space Act of 1976, (commonly referred to as the "Greenbelt Law") provides for the assessment of agriculture, forest, and open space lands for tax purposes based on present use value rather than on market value. Present use value means the value of land based on its current

[8] https://www.comptroller.tn.gov/pa/LR.asp?W=15

use as either agricultural, forest, or open space land and assuming that there is no possibility of the land being used for another purpose. The greenbelt program reduces the tax base likely leading to a combination of higher property tax rates and taxes on those property owners not enjoying greenbelt valuations. This report illustrates an additional channel through which the greenbelt program can impact local property tax revenues. For example, if the greenbelt program prevented 1 acre of agricultural land from being developed for residential use in each CBG in the state (a total of 4,125 acres maintained as agricultural land), this would generate nearly $94,000 in additional property tax revenues statewide due to the appreciation of nearby home values. This increase in property tax revenues must be compared to reductions in the property tax based to determine the full effect of greenbelt laws on property tax revenues. However, property tax revenues would not be increased if the greenbelt program prevented 1 acre of forest from being developed for residential use in each CBG in the state (a total of 4,125 acres maintained as forest).

Table 16. Total impact on property tax revenues from a 1 acre increase in open space in each Census Block Group in East Tennessee Metropolitan Statistical Areas

County	Average property tax rate	Developed open space	Forest	Shrubland	Agricultural land	Wetland
Anderson	0.0416	-$4,647	$0	$0	$795	$56,591
Blount	0.0385	-$6,868	$0	$0	$1,175	$83,650
Bradley	0.0247	-$3,324	$0	$0	$569	$40,484
Campbell	0.0425	-$2,755	$0	$0	$472	$33,555
Carter	0.0346	-$3,090	$0	$0	$529	$37,633
Grainger	0.0250	-$874	$0	$0	$150	$10,640
Hamblen	0.0260	-$2,258	$0	$0	$386	$27,504
Hamilton	0.0402	-$19,729	$0	$0	$3,376	$240,274
Hawkins	0.0361	-$3,116	$0	$0	$533	$37,949
Jefferson	0.0323	-$2,447	$0	$0	$419	$29,805
Knox	0.0323	-$20,446	$0	$0	$3,499	$249,007
Loudon	0.0250	-$1,767	$0	$0	$302	$21,526

Marion	0.0255	-$1,064	$0	$0	$182	$12,957
Morgan	0.0404	-$1,156	$0	$0	$198	$14,084
Polk	0.0303	-$797	$0	$0	$136	$9,706
Roane	0.0372	-$3,073	$0	$0	$526	$37,421
Sequatchie	0.0295	-$604	$0	$0	$103	$7,358
Sullivan	0.0407	-$9,675	$0	$0	$1,656	$117,828
Unicoi	0.0332	-$944	$0	$0	$162	$11,498
Union	0.0217	-$631	$0	$0	$108	$7,683
Washington	0.0286	-$5,341	$0	$0	$914	$65,053
Total		**-$94,607**	**$0**	**$0**	**$16,191**	**$1,152,205**

Table 17. Total impact on property tax revenues from a 1 acre increase in open space in each Census Block Group in Middle Tennessee Metropolitan Statistical Areas

County	Average property tax rate	Developed open space	Forest	Shrubland	Agricultural land	Wetland
Cannon	0.0321	-$939	$0	$10,896	$103	-$39,403
Cheatham	0.0318	-$2,431	$0	$28,198	$267	-$101,973
Davidson	0.0443	-$61,745	$0	$716,265	$6,778	-$2,590,292
Dickson	0.0329	-$3,342	$0	$38,763	$367	-$140,183
Hickman	0.0304	-$1,512	$0	$17,538	$166	-$63,423
Macon	0.0310	-$1,488	$0	$17,265	$163	-$62,438
Maury	0.0353	-$6,082	$0	$70,549	$668	-$255,131
Montgomery	0.0369	-$13,176	$0	$152,849	$1,446	-$552,761
Robertson	0.0386	-$4,911	$0	$56,973	$539	-$206,036
Rutherford	0.0344	-$17,605	$0	$204,221	$1,933	-$738,543
Smith	0.0305	-$1,264	$0	$14,659	$139	-$53,011
Stewart	0.0311	-$1,021	$0	$11,847	$112	-$42,844
Sumner	0.0339	-$10,988	$0	$127,460	$1,206	-$460,943
Trousdale	0.0367	-$602	$0	$6,986	$66	-$25,266
Williamson	0.0277	-$9,520	$0	$110,432	$1,045	-$399,364
Wilson	0.0312	-$7,140	$0	$82,823	$784	-$299,521
Total		**-$143,765**	**$0**	**$1,667,723**	**$15,783**	**-$6,031,132**

Table 18. Total impact on property tax revenues from a 1 acre increase in open space in each Census Block Group in West Tennessee Metropolitan Statistical Areas

County	Average property tax rate	Developed open space	Forest	Shrubland	Agricultural land	Wetland
Chester	0.0313	-$992	$0	$0	$487	-$4,930
Crockett	0.0372	-$1,081	$0	$0	$531	-$5,374
Fayette	0.0252	-$1,816	$0	$0	$892	-$9,028
Madison	0.0354	-$6,768	$0	$0	$3,324	-$33,644
Shelby	0.0597	-$108,172	$0	$0	$53,137	-$537,764
Tipton	0.0331	-$3,496	$0	$0	$1,717	-$17,382
Total		**-$122,325**	**$0**	**$0**	**$60,089**	**-$608,123**

Table 19. Total impact on property tax revenues from a 1 acre increase in open space in each Census Block Group in rural counties

County	Average property tax rate	Developed open space	Forest	Shrubland	Agricultural land	Wetland
Bedford	0.0303	-$623	$0	$0	$43	-$509
Benton	0.0357	-$355	$0	$0	$25	-$290
Bledsoe	0.0264	-$167	$0	$0	$12	-$136
Carroll	0.0366	-$536	$0	$0	$37	-$438
Claiborne	0.0271	-$449	$0	$0	$31	-$367
Clay	0.0354	-$168	$0	$0	$12	-$137
Cocke	0.0403	-$779	$0	$0	$54	-$636
Coffee	0.0438	-$1,142	$0	$0	$80	-$933
Cumberland	0.0184	-$580	$0	$0	$41	-$474
Decatur	0.0265	-$201	$0	$0	$14	-$164
DeKalb	0.0219	-$228	$0	$0	$16	-$187
Dyer	0.0389	-$723	$0	$0	$51	-$591
Fentress	0.0234	-$233	$0	$0	$16	-$190
Franklin	0.0374	-$782	$0	$0	$55	-$638
Gibson	0.0412	-$1,014	$0	$0	$71	-$829
Giles	0.0315	-$484	$0	$0	$34	-$395
Greene	0.0287	-$1,024	$0	$0	$72	-$836
Grundy	0.0279	-$198	$0	$0	$14	-$162
Hancock	0.0222	-$89	$0	$0	$6	-$73
Hardeman	0.0315	-$379	$0	$0	$26	-$310
Hardin	0.0257	-$398	$0	$0	$28	-$326
Haywood	0.0357	-$331	$0	$0	$23	-$271
Henderson	0.0298	-$425	$0	$0	$30	-$347

Henry	0.0274	-$518	$0	$0	$36	-$423
Houston	0.0381	-$177	$0	$0	$12	-$144
Humphreys	0.0285	-$280	$0	$0	$20	-$229
Jackson	0.0311	-$201	$0	$0	$14	-$164
Johnson	0.0233	-$232	$0	$0	$16	-$189
Lake	0.0353	-$102	$0	$0	$7	-$83
Lauderdale	0.0440	-$551	$0	$0	$38	-$450
Lawrence	0.0365	-$736	$0	$0	$51	-$601
Lewis	0.0304	-$184	$0	$0	$13	-$151
Lincoln	0.0305	-$520	$0	$0	$36	-$424
McMinn	0.0261	-$676	$0	$0	$47	-$552
McNairy	0.0266	-$354	$0	$0	$25	-$289
Marshall	0.0425	-$623	$0	$0	$44	-$509
Meigs	0.0237	-$148	$0	$0	$10	-$121
Monroe	0.0268	-$620	$0	$0	$43	-$507
Moore	0.0245	-$80	$0	$0	$6	-$65
Obion	0.0339	-$551	$0	$0	$39	-$450
Overton	0.0288	-$329	$0	$0	$23	-$269
Perry	0.0275	-$140	$0	$0	$10	-$114
Pickett	0.0211	-$81	$0	$0	$6	-$66
Putnam	0.0365	-$1,310	$0	$0	$92	-$1,071
Rhea	0.0279	-$446	$0	$0	$31	-$365
Scott	0.0298	-$327	$0	$0	$23	-$267
Sevier	0.0218	-$1,361	$0	$0	$95	-$1,112
Van Buren	0.0193	-$57	$0	$0	$4	-$47
Warren	0.0270	-$533	$0	$0	$37	-$436
Wayne	0.0300	-$243	$0	$0	$17	-$198
Weakley	0.0339	-$584	$0	$0	$41	-$477
White	0.0258	-$330	$0	$0	$23	-$270
Total		**-$23,603**	**$0**	**$0**	**$1,649**	**-$19,282**

By accounting for multiple types of open space across the entire state, this study presents a general overview of one type of open space value in Tennessee – housing premiums associated with proximity to open space. It also highlights three critical areas of additional research that will greatly improve our understanding of the relationship between open space and home values in Tennessee. First, a theme that arises in our analysis is that proximity to federal and state protected areas lowers home values in some parts of the state. However, this study only captures the open space premium attached to home values and has limited capacity to capture the large recreational values and tourism impacts these protected areas generate. Residents may value the recreational opportunities these protected open spaces provide but do not want to live next to these areas due to increased traffic. A travel cost study is a better approach for estimating the recreation values these federal and state protected areas generate. For example, a travel cost study of just one user group (rock climbers) at the Obed Wild and Scenic River in Morgan County finds that the annual value of rock climbing recreational opportunities provided by this federally protected open space total nearly $400,000 [38].

A second area for additional research is a finer scale analysis of the state's major metropolitan statistical areas. Our analysis indicates that open space in these areas generates the largest impact on home values. But our analysis at the CBG level can only capture the average effect of open space in a CBG. For example, proximity to a municipal, state, or federal protected area may initially add value to homes. But for homes beyond a certain distance, the presence of these protected open spaces may begin to detract from home values. Another example is the value of forests. While our analysis at the CBG level finds that forests do not impact nearby home values, a parcel level analysis will likely find many instances where forests both increase and decrease home values. A hedonic pricing study using housing prices at the parcel level instead of the median of a CBG would be a better approach to capture these fine scale impacts. A parcel-level analysis would also allow for valuing open space fragmentation by comparing open space area and open space density. Fragmentation can be important for certain types of open space benefits such as wildlife habitat.

A third area for future research would be a more complete accounting of municipal parks and greenways. This study utilizes publically available datasets that only partially account for the impact of these areas. The National Land Cover Database lumps these areas in with other types of developed open space making it difficult to isolate the effect of these areas. The USGS protected area database (US-PAD) captures a handful of municipal parks and greenways that are permanently protected from development by a Landscape Conservation Cooperative. One prominent example is Shelby Farms which is largely responsible for the increase in home values near private protected areas in West Tennessee MSAs (1 km closer to a private protected area increases home values by nearly $1,400). A fuller accounting of these areas would require purchasing park and greenway boundary shapefiles from local governments. In many areas, these park boundary shapefile do not exist and would need to be created. However, this effort is likely to uncover large positive impacts from other municipal parks and greenways with characteristics similar to Shelby Farms. For example, Bays Mountain Park in Kingston, Warner Parks in Nashville, Steele Creek Park in Bristol, and Knoxville's Urban Wilderness all offer vast tracts of open space with multiple use trails and recreation facilities within city limits.

In conclusion, it is important to reiterate that the housing premiums created by open space do not fully account for all of the values created by open space in Tennessee. As mentioned previously, federal and state protected open space provides recreational values not captured in this hedonic pricing analysis. A travel cost study of these areas could be used to capture these recreational values. There is also increasing evidence that certain types of open space contribute to decreases in obesity and increases in mental health [39, 40]. This lowers health costs for residents and employers but also suggest quality of life improvements for Tennessee residents. This study does not fully capture these health benefits attributable to open space. This analysis also only considers use values created by open space. Permanently protected open spaces in Tennessee provide significant nonuse values as well. Many people outside the state place a value on knowing the Great Smokey Mountains National Park is permanently protected from development even if they never plan to visit the park. Many residents of Tennessee value knowing that the state's open spaces will be preserved for future generations. Neither of these open space values are captured by this analysis but could be captured through other survey-based approaches such as contingent valuation.

REFERENCES

[1] J.K. Brueckner, Urban sprawl: diagnosis and remedies, *International Regional Science Review*, **23** (2000) 160-171.

[2] J.M. Fly, B.C. English, R.J. Menard, K.L. Jensen, Estimated Economic Impacts of Tennessee's State Parks: An Executive Summary, in, University of Tennessee, 2010.

[3] V. McConnell, M.A. Walls, The value of open space: Evidence from studies of nonmarket benefits, Resources for the Future Washington, DC, 2005.

[4] K.J. Lancaster, A new approach to consumer theory, *The Journal of Political Economy*, (1966) 132-157.

[5] S. Rosen, Hedonic prices and implicit markets: product differentiation in pure competition, *Journal of Political Economy*, **82** (1974) 34-55.

[6] L.M. Brander, M.J. Koetse, The value of urban open space: Meta-analyses of contingent valuation and hedonic pricing results, *Journal of Environmental Management*, **92** (2011) 2763-2773.

[7] J. Geoghegan, L. Lynch, S. Bucholtz, Capitalization of open spaces into housing values and the residential property tax revenue impacts of agricultural easement programs, *Agricultural and Resource Economics Review*, **32** (2003) 33-45.

[8] G. Acharya, L.L. Bennett, Valuing open space and land-use patterns in urban watersheds, *The Journal of Real Estate Finance and Economics*, **22** (2001) 221-237.

[9] V.K. Smith, C. Poulos, H. Kim, Treating open space as an urban amenity, *Resource and Energy Economics*, **24** (2002) 107-129.

[10] B.L. Mahan, S. Polasky, R.M. Adams, Valuing urban wetlands: a property price approach, *Land Economics*, (2000) 100-113.

[11] C.R. Doss, S.J. Taff, The influence of wetland type and wetland proximity on residential property values, *Journal of Agricultural and Resource Economics*, (1996) 120-129.

[12] S.D. Shultz, D.A. King, The use of census data for hedonic price estimates of open-space amenities and land use, *The Journal of Real Estate Finance and Economics*, **22** (2001) 239-252.

[13] S.T. Anderson, S.E. West, Open space, residential property values, and spatial context, *Regional Science and Urban Economics*, **36** (2006) 773-789.

[14] E.G. Irwin, The effects of open space on residential property values, *Land Economics*, **78** (2002) 465-480.

[15] N.C. Poudyal, D.G. Hodges, C.D. Merrett, A hedonic analysis of the demand for and benefits of urban recreation parks, *Land Use Policy*, **26** (2009) 975-983.

[16] S.-H. Cho, S.G. Kim, R.K. Roberts, S. Jung, Amenity values of spatial configurations of forest landscapes over space and time in the Southern Appalachian Highlands, *Ecological Economics*, **68** (2009) 2646-2657.

[17] J.W. Kitchen, W.S. Hendon, Land values adjacent to an urban neighborhood park, *Land Economics*, **43** (1967) 357-360.

[18] J.C. Weigher, R.H. Zerbst, The externalities of neighborhood parks: an empirical investigation, *Land Economics*, **49** (1973) 99-105.

[19] A.Q. Do, G. Grudnitski, Golf courses and residential house prices: an empirical examination, *The Journal of Real Estate Finance and Economics*, **10** (1995) 261-270.

[20] M.R. Correll, J.H. Lillydahl, L.D. Singell, The effects of greenbelts on residential property values: some findings on the political economy of open space, *Land Economics*, **54** (1978) 207-217.

[21] C.M. Lee, P. Linneman, Dynamics of the greenbelt amenity effect on the land market—The Case of Seoul's greenbelt, *Real Estate Economics*, **26** (1998) 107-129.

[22] L. Tyrväinen, A. Miettinen, Property prices and urban forest amenities, *Journal of Environmental Economics and Management*, **39** (2000) 205-223.

[23] D. Earnhart, Combining revealed and stated preference methods to value environmental amenities at residential locations, *Land Economics*, **77** (2001) 12-29.

[24] M. Lutzenhiser, N.R. Netusil, The effect of open spaces on a home's sale price, *Contemporary Economic Policy*, **19** (2001) 291-298.

[25] E.G. Irwin, N.E. Bockstael, The problem of identifying land use spillovers: measuring the

effects of open space on residential property values, *American Journal of Agricultural Economics*, **83** (2001) 698-704.

[26] R. Walsh, Endogenous open space amenities in a locational equilibrium, *Journal of Urban Economics*, **61** (2007) 319-344.

[27] R.B. Peiser, G.M. Schwann, The private value of public open space within subdivisions, *Journal of Architectural and Planning Research*, (1993) 91-104.

[28] P. Thorsnes, The value of a suburban forest preserve: Estimates from sales of vacant residential building lots, *Land Economics*, **78** (2002) 426-441.

[29] R.E. Santerre, Spatial differences in the demands for local public goods, *Land Economics*, **61** (1985) 119-128.

[30] L.J. Bates, R.E. Santerre, The public demand for open space: the case of Connecticut communities, *Journal of Urban Economics*, **50** (2001) 97-111.

[31] J. Geoghegan, L.A. Wainger, N.E. Bockstael, Spatial landscape indices in a hedonic framework: an ecological economics analysis using GIS, *Ecological Economics*, **23** (1997) 251-264.

[32] C. Dehring, N. Dunse, Housing density and the effect of proximity to public open space in Aberdeen, Scotland, *Real Estate Economics*, **34** (2006) 553-566.

[33] S.-H. Cho, N.C. Poudyal, R.K. Roberts, Spatial analysis of the amenity value of green open space, *Ecological Economics*, **66** (2008) 403-416.

[34] S.-H. Cho, D.M. Lambert, R.K. Roberts, S.G. Kim, Demand for open space and urban sprawl: the case of Knox County, Tennessee, in: Progress in spatial analysis, Springer, 2010, pp. 171-193.

[35] S.-H. Cho, C.D. Clark, W.M. Park, S.G. Kim, Spatial and temporal variation in the housing market values of lot size and open space, *Land Economics*, **85** (2009) 51-73.

[36] O. Bin, S. Polasky, Effects of flood hazards on property values: evidence before and after Hurricane Floyd, *Land Economics*, **80** (2004) 490-500.

[37] E.G. Irwin, N.E. Bockstael, The evolution of urban sprawl: Evidence of spatial heterogeneity and increasing land fragmentation, *Proceedings of the National Academy of Sciences*, **104** (2007) 20672-20677.

[38] C. Sims, D.G. Hodges, Obed Wild and Scenic River Rock Climbing Survey Results, in: Final Report to the National Park Service, University of Tennessee, 2004.

[39] G.N. Bratman, J.P. Hamilton, K.S. Hahn, G.C. Daily, J.J. Gross, Nature experience reduces rumination and subgenual prefrontal cortex activation, *Proceedings of the National Academy of Sciences*, **112** (2015) 8567-8572.

[40] R. Ghimire, Green Space and Adult Obesity Prevalence in the United States, in: 2015 Annual Meeting, January 31-February 3, 2015, Atlanta, Georgia, Southern Agricultural Economics Association, 2015.

APPENDIX A: The Effect of Correcting for Endogeneity

When open space is privately held and developable, land parcels considered open space are part of the land market and thus affected by the same things that affect a location's residential value. Thus, an increase in housing prices creates an incentive to develop unprotected open space. Because housing prices tend to rise, failure to account for this endogenous effect has a tendency to underestimate the impact of open space on housing values. Table 20 shows the effect of correcting for unprotected open space endogeneity on our regression results.

Table 20. Effect of open space endogeneity on regression coefficient estimates

	No correction for endogenous open space	Correction for endogenous open space
$DevOpen_i$	-0.0269***	0.2385**
	(0.0090)	(0.0967)
$Forest_i$	0.0137***	-0.0011
	(0.0024)	(0.0091)
$Shrub_i$	0.0001	0.0142
	(0.0032)	(0.0452)
$Agland_i$	0.0072***	-0.0086
	(0.0020)	(0.0312)
$Wetland_i$	-0.0231***	-0.0687***
	(0.0026)	(0.0067)
$Feddist_i$	0.0235***	0.0261**
	(0.0043)	(0.0104)

$Statedist_i$	0.0067	-0.0068
	(0.0047)	(0.0112)
$Otherdist_i$	-0.0259***	-0.0381***
	(0.0057)	(0.0115)
Constant	5.139***	4.6205***
	(0.2250)	(1.2602)
N	4,000	3,993
R^2	0.722	0.725

APPENDIX B: The Effect of Accounting for Unobserved Regional Differences

The relationship between open space and housing values can be expected to differ considerably across the state. For instance, housing markets in rural parts of the state fundamentally differ from markets in urban and suburban areas due to property taxes and differing type and quantities of public goods. Urban housing markets in the state also differ based on the availability of the relative supply of open space and other public amenities. To account for these regional differences in open space on housing values we include regression variables that interact open space variables with CBG in MSAs in different parts of the state. Table 21 compares coefficient estimates using this approach to coefficient estimates that correct for endogenous open space but do not account for urban-rural differences across the state.

Table 21: Effect of regional interaction terms on regression coefficient estimates

	Correction for endogenous open space	Accounting for regional differences
$DevOpen_i$	0.2385**	-0.0302**
	(0.0967)	(0.0137)
*$DevOpen_i$*EastMSA*		-0.0413
		(0.0383)
*$DevOpen_i$*MiddleMSA*		0.0002
		(0.0249)
*$DevOpen_i$*WestMSA*		0.0537

		(0.0518)
$Forest_i$	-0.0011	0.0060
	(0.0091)	(0.0053)
$Forest_i$*EastMSA		0.0040
		(0.0182)
$Forest_i$*MiddleMSA		0.0013
		(0.0152)
$Forest_i$*WestMSA		0.0336
		(0.0484)
$Shrub_i$	0.0142	-0.0032
	(0.0452)	(0.0072)
$Shrub_i$ *EastMSA		0.0078
		(0.0264)
$Shrub_i$ *MiddleMSA		0.0566**
		(0.0235)
$Shrub_i$ *WestMSA		-0.0941
		(0.0729)
$Agland_i$	-0.0086	0.0151***
	(0.0312)	(0.0041)
$Agland_i$*EastMSA		-0.0078
		(0.0093)
$Agland_i$*MiddleMSA		-0.0163
		(0.0114)
$Agland_i$*WestMSA		0.0610**
		(0.0276)
$Wetland_i$	-0.0687***	-0.0199**
	(0.0067)	(0.0086)
$Wetland_i$*EastMSA		0.0427**
		(0.0193)
$Wetland_i$*MiddleMSA		-0.0530**
		(0.0263)
$Wetland_i$*WestMSA		-0.1072***
		(0.0342)
$Feddist_i$	0.0261**	-0.0096
	(0.0104)	(0.0059)
$Feddist_i$* $EastMSA_i$		0.0265***
		(0.0102)
$Feddist_i$* $MiddleMSA_i$		-0.0082
		(0.0417)
$Feddist_i$* $WestMSA_i$		0.0060
		(0.0656)
$Statedist_i$	-0.0068	0.0327***
	(0.0112)	(0.0099)
$Statedist_i$* $EastMSA_i$		-0.0191
		(0.0132)
$Statedist_i$* $MiddleMSA_i$		-0.0681***
		(0.0193)

$Statedist_i$ $WestMSA_i$*		-0.0103
		(0.0460)
$Otherdist_i$	-0.0381***	-0.0007
	(0.0115)	(0.0104)
$Otherdist_i$ $EastMSA_i$*		-0.0086
		(0.0154)
$Otherdist_i$ $MiddleMSA_i$*		-0.0241
		(0.0204)
$Otherdist_i$ $WestMSA_i$*		-0.0528**
		(0.0242)
Constant	4.6205***	5.5567***
	(1.2602)	(0.2432)
N	3,993	3,993
R^2	0.725	0.755

APPENDIX C: First Stage Regression Results for Hedonic Price Function

Correcting for the endogeneity of unprotected open space involves estimating a first state regression that accounts for the factors correlated with open space provision and a second stage regression that accounts for the relationship between open space and home values. First stage regression results are provided in tables 22 through 26. Second stage regression results are presented in Table 10.

Table 22: First stage regression results for developed open space cover type

	Dependent Variables			
	$DevOpen_i$	*$DevOpen_i$ * $EastMSA_i$*	*$DevOpen_i$ * $MiddleMSA_i$*	*$DevOpen_i$ * $WestMSA_i$*
Explanatory Variables				
$Vehicle_i$	0.000632 (0.000464)			
*$Vehicle_i$ *$EastMSA_i$*		0.00434*** (0.00108)		
*$Vehicle_i$ *$MiddleMSA_i$*			0.00621*** (0.00120)	
*$Vehicle_i$ *$WestMSA_i$*				0.00314*** (0.00080)
$DevOpen_i$		0.709*** (0.0212)	0.716*** (0.0178)	0.699 *** (0.0197)

DevOpen$_i$ * *EastMSA*$_i$	0.987*** (0.00287)		-0.720*** (0.0175)	-0.701*** (0.0196)
DevOpen$_i$ * *MiddleMSA*$_i$	0.991*** (0.00267)	-0.716*** (0.0213)		-0.710*** (0.0195)
DevOpen$_i$ * *WestMSA*$_i$	0.989*** (0.00308)	-0.714*** (0.0216)	-0.726*** (0.0176)	-0.0770*** (0.00480)
Forest$_i$	0.106*** (0.00612)	-0.0756*** (0.00506)	-0.0756*** (0.00483)	
Forest$_i$* *EastMSA*$_i$	-0.105*** (0.00614)	0.124*** (0.00492)	0.0745*** (0.00483)	0.0726*** (0.00483)
Forest$_i$* *MiddleMSA*$_i$	-0.106*** (0.00614)	0.0756*** (0.00490)	0.0984*** (0.00507)	0.0728*** (0.00485)
Forest$_i$* *WestMSA*$_i$	-0.104*** (0.00637)	0.0750*** (0.00514)	0.0747*** (0.00501)	0.127*** (0.00661)
Shrub$_i$	-0.0378*** (0.0103)	0.0277*** (0.00742)	0.0272*** (0.00746)	0.0289*** (0.00731)
Shrub$_i$* *EastMSA*$_i$	0.0388*** (0.0103)	-0.0495*** (0.00839)	-0.0251*** (0.00753)	-0.0260*** (0.00738)
Shrub$_i$* *MiddleMSA*$_i$	0.0354*** (0.0104)	-0.0265*** (0.00748)	-0.00311 (0.00881)	-0.0263*** (0.00742)
Shrub$_i$* *WestMSA*$_i$	0.0328*** (0.0107)	-0.0254*** (0.00770)	-0.0245*** (0.00779)	-0.0612*** (0.0110)
Agland$_i$	0.0502*** (0.00523)	-0.0361*** (0.00399)	-0.0367*** (0.00391)	-0.0386*** (0.00383)
Agland$_i$* *EastMSA*$_i$	-0.0500*** (0.00523)	0.0443*** (0.00414)	0.0376*** (0.00389)	0.0357*** (0.00384)
Agland$_i$* *MiddleMSA*$_i$	-0.0494*** (0.00530)	0.0373*** (0.00394)	0.0580*** (0.00433)	0.0366*** (0.00390)
Agland$_i$* *WestMSA*$_i$	-0.0501*** (0.00532)	0.0366*** (0.00397)	0.0378*** (0.00398)	0.0483*** (0.00541)
Wetland$_i$	0.0516*** (0.00729)	-0.0365*** (0.00536)	-0.0377*** (0.00533)	-0.0363*** (0.00526)
Wetland$_i$* *EastMSA*$_i$	-0.0563*** (0.00750)	0.0460*** (0.00626)	0.0403*** (0.00551)	0.0401*** (0.00543)
Wetland$_i$* *MiddleMSA*$_i$	-0.0492*** (0.00737)	0.0361*** (0.00543)	0.0342*** (0.00719)	0.0367*** (0.00535)
Wetland$_i$* *WestMSA*$_i$	-0.0529*** (0.00755)	0.0394*** (0.00552)	0.0392*** (0.00558)	0.0573*** (0.00865)
Rooms$_i$	-0.0199 (0.0310)	0.0738** (0.0307)	0.0959*** (0.0323)	0.135*** (0.0327)
Age$_i$	-0.00733 (0.00826)	-0.0000963 (0.00777)	0.00705 (0.00941)	-0.00380 (0.00759)
LotSize$_i$	0.113*** (0.0271)	-0.0531** (0.0214)	-0.0693** (0.0213)	-0.0753*** (0.0235)
Gas$_i$	-0.000114 (0.000188)	0.0000718 (0.000160)	0.000436** (0.000159)	-0.000147 (0.000163)
Bed$_i$	0.000426	-0.000258	-0.000344	-0.000505*

	(0.000276)	(0.000243)	(0.000259)	(0.000268)
$EastMSA_i$	-4.316*** (0.0742)	3.808*** (0.119)	3.152*** (0.0933)	3.074*** (0.101)
$MiddleMSA_i$	-4.306*** (0.0757)	3.118*** (0.110)	3.606*** (0.136)	3.118*** (0.101)
$WestMSA_i$	-4.290*** (0.0755)	3.095*** (0.107)	3.145*** (0.0939)	3.997*** (0.113)
$Density_i$	0.00672 (0.0118)	-0.0108 (0.0137)	-0.0395*** (0.0127)	-0.0713*** (0.0116)
$Income_i$	0.0417*** (0.0131)	-0.00668 (0.0119)	-0.0267 ** (0.0123)	-0.0356 *** (0.0116)
$Vacancy_i$	0.00101** (0.000492)	-0.000455 (0.000390)	-0.000942** (0.000379)	-0.00123*** (0.000406)
$Unemploy_i$	-0.000118 (0.000372)	-0.000164 (0.000339)	0.000140 (0.000328)	-0.0000116 (0.000327)
Edu_i	-0.000155 (0.000273)	-0.000254 (0.000283)	0.000228 (0.000250)	0.000234 (0.000253)
$Stability_i$	0.000192 (0.000299)	-0.00000802 (0.000267)	-0.000219 (0.000284)	-0.000108 (0.000284)
$Travel_i$	0.000362 (0.000269)	-0.000347 (0.000214)	-0.000323 (0.000284)	-0.000412* (0.000222)
$Interdist_i$	-0.0193*** (0.00387)	0.0123*** (0.00305)	0.0154*** (0.00302)	0.0140*** (0.00297)
$Lakedist_i$	-0.00878* (0.00510)	0.00656 (0.00421)	0.0124*** (0.00416)	0.00543 (0.00398)
$Interface_i$	0.00493 (0.0110)	-0.0280*** (0.0101)	-0.0455*** (0.00992)	-0.0300 *** (0.00943)
$Feddist_i$	0.00794 (0.00945)	-0.00636 (0.00683)	-0.00664 (0.00688)	-0.00437 (0.00672)
$Feddist_{i*}$ $EastMSA_i$	-0.0132 (0.00941)	0.00274 (0.00821)	0.00837 (0.00687)	0.00715 (0.00674)
$Feddist_{i*}$ $MiddleMSA_i$	-0.0245** (0.01000)	0.0118 (0.00731)	0.00654 (0.0137)	0.0115 (0.00744)
$Feddist_{i*}$ $WestMSA_i$	-0.0221** (0.0102)	0.0104 (0.00742)	0.0129* (0.00761)	-0.0000970 (0.0143)
$Statedist_i$	-0.0311*** (0.0135)	0.0227*** (0.00967)	0.0239** (0.00974)	0.0216** (0.00954)
$Statedist_{i*}$ $EastMSA_i$	0.0223 (0.0136)	-0.0145 (0.0109)	-0.0203** (0.00984)	-0.0180* (0.00962)
$Statedist_{i*}$ $MiddleMSA_i$	0.0382*** (0.0136)	-0.0278*** (0.00978)	-0.00485 (0.0118)	-0.0256*** (0.00971)
$Statedist_{i*}$ $WestMSA_i$	0.0169 (0.0139)	-0.0154 (0.00997)	-0.0125 (0.0101)	-0.0324** (0.0161)
$Otherdist_i$	-0.00920 (0.0145)	0.00778 (0.0104)	0.00620 (0.00105)	0.00519 (0.00103)
$Otherdist_{i*}$ $EastMSA_i$	0.0151 (0.0146)	-0.00183 (0.0121)	-0.00927 (0.0106)	-0.00667 (0.0103)

Otherdist$_i$ MiddleMSA$_i$*	0.0113 (0.0147)	-0.00716 (0.0105)	0.00999 (0.0130)	-0.00348 (0.0104)
Otherdist$_i$ WestMSA$_i$*	0.0201 (0.0148)	-0.00875 (0.0107)	-0.00984 (0.0109)	-0.0123 (0.0153)
Constant	3.934*** (0.157)	-3.104*** (0.149)	-2.995*** (0.157)	-2.755*** (0.154)
N	4,036	4,036	4,036	4,036
R^2	0.974	0.996	0.995	0.993
F-statistics	67,433.53	43,890.33	30,169.70	11,983.35

Note: Standard errors in parentheses. Standard errors are clustered by census block group. * p < 0.1, **p < 0.05, *** p < 0.01

Table 23: First stage regression results for forest cover type

	Dependent Variables			
	Forest$_i$	*Forest$_i$* EastMSA$_i$*	*Forest$_i$* MiddleMSA$_i$*	*Forest$_i$* WestMSA$_i$*
Explanatory Variables				
Slope$_i$	0.0576*** (0.00657)			
*Slope$_i$ *EastMSA$_i$*		0.0643*** (0.0108)		
*Slope$_i$ *MiddleMSA$_i$*			0.115*** (0.0152)	
*Slope$_i$ *WestMSA$_i$*				0.0171 (0.0293)
Forest$_i$		0.527*** (0.0196)	0.543*** (0.0193)	0.296*** (0.0194)
Forest$_i$ EastMSA$_i$*	0.914*** (0.00862)		-0.550*** (0.0193)	-0.285*** (0.0192)
Forest$_i$ MiddleMSA$_i$*	0.920*** (0.00780)	-0.535*** (0.0193)		-0.287*** (0.0192)
Forest$_i$ WestMSA$_i$*	0.966*** (0.00842)	-0.526*** (0.0202)	-0.543*** (0.0200)	
DevOpen$_i$	2.413*** (0.122)	-1.366*** (0.0884)	-1.430*** (0.0892)	-0.733*** (0.0639)
*DevOpen$_i$ * EastMSA$_i$*	-2.417*** (0.123)	2.229*** (0.0839)	1.412*** (0.0897)	0.741*** (0.0638)
*DevOpen$_i$ * MiddleMSA$_i$*	-2.406*** (0.124)	1.348*** (0.0893)	1.862*** (0.0871)	0.735*** (0.0639)
*DevOpen$_i$ * WestMSA$_i$*	-2.476*** (0.123)	1.338*** (0.0896)	1.381*** (0.0905)	1.225*** (0.0713)
Shrub$_i$	0.895***	-0.498***	-0.513***	-0.271***

	(0.0350)	(0.0272)	(0.0277)	(0.0212)
$Shrub_i$ $EastMSA_i$*	-0.893*** (0.0359)	0.864*** (0.0306)	0.519*** (0.0278)	0.278*** (0.0215)
$Shrub_i$ $MiddleMSA_i$*	-0.882*** (0.0363)	0.505*** (0.0274)	0.786*** (0.0340)	0.270*** (0.0216)
$Shrub_i$ $WestMSA_i$*	-0.901*** (0.0372)	0.494*** (0.0283)	0.504*** (0.0288)	0.943*** (0.0506)
$Agland_i$	0.115*** (0.0241)	-0.0919*** (0.0141)	-0.0946*** (0.0144)	-0.0404*** (0.00809)
$Agland_i$ $EastMSA_i$*	-0.161*** (0.0242)	0.190*** (0.0177)	0.0910*** (0.0143)	0.0476*** (0.00800)
$Agland_i$ $MiddleMSA_i$*	-0.168*** (0.0244)	0.0777*** (0.0142)	0.299*** (0.0189)	0.0523*** (0.00826)
$Agland_i$ $WestMSA_i$*	-0.161*** (0.0246)	0.0784*** (0.0143)	0.0955*** (0.0146)	0.191*** (0.0303)
$Wetland_i$	-0.431*** (0.0320)	0.246*** (0.0200)	0.257*** (0.0205)	0.136*** (0.0133)
$Wetland_i$ $EastMSA_i$*	0.476*** (0.0340)	-0.102*** (0.0300)	-0.261*** (0.0213)	-0.132*** (0.0139)
$Wetland_i$ $MiddleMSA_i$*	0.446*** (0.0331)	-0.240*** (0.0204)	-0.270*** (0.0335)	-0.136*** (0.0136)
$Wetland_i$ $WestMSA_i$*	0.419*** (0.0346)	-0.249*** (0.0210)	-0.265*** (0.0216)	0.0547 (0.0549)
$Rooms_i$	0.351** (0.154)	-0.159 (0.124)	-0.0322 (0.121)	-0.192* (0.112)
Age_i	-0.323*** (0.0421)	0.0163 (0.0319)	0.181*** (0.0352)	0.0917*** (0.0261)
$LotSize_i$	-0.640*** (0.132)	0.0400 (0.0732)	-0.0567 (0.0684)	-0.0873 (0.061)
Gas_i	-0.00452*** (0.000988)	0.00345*** (0.000716)	0.00194*** (0.000725)	0.000393 (0.000511)
Bed_i	-0.00178 (0.00124)	0.00214** (0.000928)	0.00287*** (0.00103)	0.00187** (0.000946)
$EastMSA_i$	6.060*** (0.676)	-5.729*** (0.458)	-3.509*** (0.424)	-1.924*** (0.249)
$MiddleMSA_i$	6.115*** (0.684)	-3.117*** (0.424)	-2.624*** (0.591)	-2.023*** (0.255)
$WestMSA_i$	6.608*** (0.678)	-3.350*** (0.417)	-3.563*** (0.426)	-4.702*** (0.467)
$Density_i$	-0.625*** (0.0662)	-0.113** (0.0494)	-0.140*** (0.0453)	0.0224 (0.0363)
$Income_i$	-0.150*** (0.0550)	-0.0758 (0.0413)	-0.0504 (0.0417)	0.00978 (0.0330)
$Vacancy_i$	0.00734 *** (0.00207)	-0.00565*** (0.00138)	-0.00600*** (0.00134)	-0.00218** (0.00100)
$Unemploy_i$	0.000359 (0.00145)	-0.000953 (0.00115)	-0.00147 (0.00114)	0.00188* (0.000960)

Edu_i	0.00213 (0.00132)	0.000102 (0.00107)	-0.000696 (0.00100)	0.000460 (0.000771)
$Stability_i$	0.00456*** (0.00152)	-0.00391*** (0.00112)	-0.00313*** (0.00117)	-0.00312*** (0.000960)
$Travel_i$	0.00319*** (0.00114)	-0.00143* (0.000808)	0.000375 (0.000845)	-0.00419*** (0.000685)
$Interdist_i$	0.0286 (0.0182)	0.0116 (0.0126)	-0.0446*** (0.0130)	-0.0173** (0.00863)
$Lakedist_i$	-0.0222 (0.0231)	-0.0303* (0.0181)	-0.0711*** (0.0177)	0.00828 (0.0115)
$Interface_i$	0.0932* (0.0544)	0.155*** (0.0467)	0.0305 (0.0464)	-0.0416 (0.0334)
$Feddist_i$	-0.201*** (0.0460)	0.148*** (0.0275)	0.155*** (0.0283)	0.0794*** (0.0158)
$Feddist_{i*}$ $EastMSA_i$	0.293*** (0.0455)	-0.0946** (0.0400)	-0.168*** (0.0280)	-0.0778*** (0.0159)
$Feddist_{i*}$ $MiddleMSA_i$	0.321*** (0.0501)	-0.166*** (0.0294)	-0.590*** (0.0846)	-0.0490*** (0.0187)
$Feddist_{i*}$ $WestMSA_i$	0.253*** (0.0528)	-0.118*** (0.0302)	-0.133*** (0.0313)	0.465*** (0.0998)
$Statedist_i$	-0.125** (0.0566)	0.0579* (0.0328)	0.0558* (0.0337)	0.0279 (0.0180)
$Statedist_{i*}$ $EastMSA_i$	0.142** (0.0581)	-0.0713 (0.0438)	-0.0580* (0.0345)	-0.0250 (0.0187)
$Statedist_{i*}$ $MiddleMSA_i$	0.112* (0.0577)	-0.0464 (0.0330)	0.0710 (0.0525)	-0.0101 (0.0184)
$Statedist_{i*}$ $WestMSA_i$	0.211*** (0.0628)	-0.0696* (0.0358)	-0.0644* (0.0367)	-0.448*** (0.0712)
$Otherdist_i$	-0.327*** (0.0704)	0.173*** (0.0408)	0.187*** (0.0420)	0.0975*** (0.0228)
$Otherdist_{i*}$ $EastMSA_i$	0.374*** (0.0718)	-0.341*** (0.0532)	-0.186*** (0.0423)	-0.104*** (0.0232)
$Otherdist_{i*}$ $MiddleMSA_i$	0.333*** (0.0719)	-0.181*** (0.0414)	-0.451*** (0.0597)	-0.104*** (0.0234)
$Otherdist_{i*}$ $WestMSA_i$	0.269*** (0.0732)	-0.154*** (0.0423)	-0.183*** (0.0435)	0.0501 (0.0649)
Constant	-3.491*** (0.869)	4.625*** (0.562)	4.073*** (0.590)	1.825*** (0.436)
N	4,069	4,069	4,069	4,069
R^2	0.975	0.981	0.974	0.961
F-statistics	20,704.98	4,354.65	2,652.91	599.76

Note: Standard errors in parentheses. Standard errors are clustered by census block group. * p < 0.1, **p < 0.05, *** p < 0.01

Table 24: First stage regression results for shrubland cover type

	Dependent Variables			
	$Shrub_i$	$Shrub_i$* $EastMSA_i$	$Shrub_i$* $MiddleMSA_i$	$Shrub_i$* $WestMSA_i$
Explanatory Variables				
$Water_i$	-0.00453* (0.00234)			
$Water_i$ *$EastMSA_i$		0.00169 (0.00305)		
$Water_i$ *$MiddleMSA_i$			-0.00951*** (0.00285)	
$Water_i$ *$WestMSA_i$				0.0287*** (0.00329)
$Shrub_i$		0.458*** (0.0196)	0.444*** (0.0198)	0.226*** (0.0210)
$Shrub_i$* $EastMSA_i$	0.991*** (0.00351)		-0.439*** (0.0200)	-0.228*** (0.0210)
$Shrub_i$* $MiddleMSA_i$	0.998*** (0.00295)	-0.458*** (0.0197)		-0.225*** (0.0214)
$Shrub_i$* $WestMSA_i$	0.991*** (0.00697)	-0.461*** (0.0198)	-0.439*** (0.0200)	
$DevOpen_i$	-0.406*** (0.104)	0.189*** (0.0502)	0.168*** (0.0485)	0.0791*** (0.0265)
$DevOpen_i$ * $EastMSA_i$	0.419*** (0.103)	-0.343*** (0.0540)	-0.175*** (0.0483)	-0.0888*** (0.0267)
$DevOpen_i$ * $MiddleMSA_i$	0.414*** (0.104)	-0.171*** (0.0505)	-0.0436 (0.0553)	-0.0866*** (0.0268)
$DevOpen_i$ * $WestMSA_i$	0.436*** (0.104)	-0.177*** (0.0504)	-0.174*** (0.0485)	-0.195*** (0.0378)
$Forest_i$	0.413*** (0.0168)	-0.192*** (0.0116)	-0.182*** (0.0115)	-0.0942*** (0.00954)
$Forest_i$* $EastMSA_i$	-0.400*** (0.0169)	0.318*** (0.0116)	0.179*** (0.0115)	0.0913*** (0.00967)
$Forest_i$* $MiddleMSA_i$	-0.399*** (0.0171)	0.187*** (0.0117)	0.273*** (0.0124)	0.0905*** (0.00963)
$Forest_i$* $WestMSA_i$	-0.401*** (0.0173)	0.189*** (0.0117)	0.177*** (0.0117)	0.326*** (0.0198)
$Agland_i$	0.0718*** (0.0169)	-0.0294*** (0.00807)	-0.0285*** (0.00775)	-0.0159*** (0.00429)
$Agland_i$* $EastMSA_i$	-0.0558*** (0.0167)	0.115*** (0.0105)	0.0238*** (0.00760)	0.0137*** (0.00423)
$Agland_i$* $MiddleMSA_i$	-0.0626*** (0.0168)	0.0246*** (0.00806)	0.0609*** (0.0112)	0.0130*** (0.00436)
$Agland_i$* $WestMSA_i$	-0.0613*** (0.0169)	0.0261*** (0.00807)	0.0225*** (0.00782)	0.144*** (0.0189)

$Wetland_i$	0.202*** (0.0234)	-0.0952*** (0.0116)	-0.0860*** (0.0113)	-0.0446*** (0.00677)
$Wetland_i$* $EastMSA_i$	-0.210*** (0.0237)	0.105*** (0.0179)	0.0885*** (0.0115)	0.0416*** (0.00690)
$Wetland_i$* $MiddleMSA_i$	-0.200*** (0.0239)	0.0950*** (0.0117)	0.209*** (0.0222)	0.0452*** (0.00701)
$Wetland_i$* $WestMSA_i$	-0.208*** (0.0238)	0.0932*** (0.0119)	0.0940*** (0.0117)	0.0593* (0.0341)
$Rooms_i$	-0.179* (0.0966)	-0.0418 (0.0744)	0.147** (0.0737)	0.0541 (0.0582)
Age_i	0.0140 (0.0251)	-0.0134 (0.0196)	-0.0675*** (0.0210)	-0.0286* (0.0148)
$LotSize_i$	0.0815 (0.0653)	-0.0555 (0.0410)	0.0320 (0.0382)	0.0745** (0.0379)
Gas_i	0.00288*** (0.000632)	-0.000822* (0.000429)	-0.00140*** (0.000422)	-0.0000878 (0.000270)
Bed_i	-0.000266 (0.000799)	-0.0000309 (0.000558)	-0.00142** (0.000593)	0.00000503 (0.000466)
$EastMSA_i$	0.374 (0.514)	0.504* (0.271)	-0.228 (0.234)	-0.0842 (0.125)
$MiddleMSA_i$	0.360 (0.509)	-0.296 (0.245)	-3.581*** (0.398)	-0.0442 (0.127)
$WestMSA_i$	0.219 (0.516)	-0.254 (0.245)	-0.125 (0.235)	0.678** (0.283)
$Density_i$	0.110*** (0.0310)	-0.0194 (0.0209)	0.00841 (0.0235)	0.00292 (0.0191)
$Income_i$	-0.0194 (0.0382)	0.0156 (0.0237)	0.0538** (0.0248)	0.00944 (0.0185)
$Vacancy_i$	-0.00185 (0.00133)	0.00197** (0.000784)	0.00138* (0.000736)	-0.0000122 (0.000549)
$Unemploy_i$	0.000752 (0.000952)	-0.000515 (0.000687)	0.000286 (0.000658)	-0.000663 (0.000543)
Edu_i	-0.00111 (0.000893)	-0.000294 (0.000619)	0.000678 (0.000576)	-0.0000948 (0.000446)
$Stability_i$	-0.000340 (0.000958)	0.000173 (0.000642)	0.000371 (0.000656)	0.000490 (0.000458)
$Travel_i$	0.00157* (0.000815)	0.000910* (0.000491)	-0.000892* (0.000528)	0.00218*** (0.000411)
$Interdist_i$	0.00243 (0.0127)	-0.00169 (0.00783)	-0.00290 (0.00775)	-0.000882 (0.00514)
$Lakedist_i$	0.00208 (0.0163)	-0.0255** (0.0111)	0.0102 (0.0108)	-0.0182** (0.00721)
$Interface_i$	-0.109*** (0.0337)	0.0234 (0.0285)	0.0612** (0.0282)	0.00677 (0.0178)
$Feddist_i$	0.116*** (0.0277)	-0.0536*** (0.0134)	-0.0529*** (0.0129)	-0.0286*** (0.00723)
$Feddist_{i*}$	-0.119***	-0.00437	0.0530***	0.0217***

$EastMSA_i$	(0.0275)	(0.0224)	(0.0130)	(0.00711)
$Feddist_i$* $MiddleMSA_i$	-0.122*** (0.0296)	0.0611*** (0.0147)	0.687*** (0.0685)	0.00530 (0.00853)
$Feddist_i$* $WestMSA_i$	-0.114*** (0.0293)	0.0574*** (0.0147)	0.0324** (0.0148)	-0.171*** (0.0596)
$Statedist_i$	0.145*** (0.0399)	-0.0659*** (0.0187)	-0.0660*** (0.0181)	-0.0305*** (0.00984)
$Statedist_i$* $EastMSA_i$	-0.138*** (0.0402)	-0.00427 (0.0291)	0.0563*** (0.0185)	0.0235** (0.00992)
$Statedist_i$* $MiddleMSA_i$	-0.147*** (0.0395)	0.0657*** (0.0188)	-0.0395 (0.0335)	0.0258** (0.0101)
$Statedist_i$* $WestMSA_i$	-0.145*** (0.0415)	0.0696*** (0.0198)	0.0523*** (0.0195)	0.123** (0.0492)
$Otherdist_i$	0.0387 (0.0511)	-0.0194 (0.0238)	-0.0161 (0.0228)	-0.00856 (0.0120)
$Otherdist_i$* $EastMSA_i$	-0.0699 (0.0514)	-0.107*** (0.0346)	0.0250 (0.0229)	0.0125 (0.0121)
$Otherdist_i$* $MiddleMSA_i$	-0.0542 (0.0514)	0.0201 (0.0240)	0.0356 (0.0354)	0.0120 (0.0123)
$Otherdist_i$* $WestMSA_i$	-0.0556 (0.0517)	0.0155 (0.0245)	0.0388 (0.0237)	0.0285 (0.0425)
Constant	-0.232 (0.615)	0.264 (0.332)	-0.240 (0.331)	0.0572 (0.231)
N	4,076	4,076	4,076	4,076
R^2	0.936	0.918	0.898	0.942
F-statistics	47,483.20	531.13	359.51	311.87

Note: Standard errors in parentheses. Standard errors are clustered by census block group. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 25: First stage regression results for agricultural land cover type

	Dependent Variables			
	$Agland_i$	$Agland_i$* $EastMSA_i$	$Agland_i$* $MiddleMSA_i$	$Agland_i$* $WestMSA_i$
Explanatory Variables				
$MSAdist_i$	0.175*** (0.0671)			
$MSAdist_i$ *$EastMSA_i$				
$MSAdist_i$ *$MiddleMSA_i$				
$MSAdist_i$ *$WestMSA_i$				
$Agland_i$		0.500***	0.472***	0.265***

		(0.0196)	(0.0197)	(0.0196)
$Agland_i$* $EastMSA_i$	0.916*** (0.00783)		-0.498*** (0.0191)	-0.272*** (0.0198)
$Agland_i$* $MiddleMSA_i$	0.923*** (0.00877)	-0.529*** (0.0195)		-0.281*** (0.0203)
$Agland_i$* $WestMSA_i$	0.929*** (0.00923)	-0.519*** (0.0196)	-0.503*** (0.0195)	
$DevOpen_i$	1.872*** (0.176)	-0.975*** (0.104)	-0.899*** (0.101)	-0.515*** (0.0649)
$DevOpen_i$ * $EastMSA_i$	-1.901*** (0.178)	1.204*** (0.113)	0.955*** (0.101)	0.526*** (0.0655)
$DevOpen_i$ * $MiddleMSA_i$	-1.913*** (0.177)	1.015*** (0.105)	1.404*** (0.113)	0.537*** (0.0662)
$DevOpen_i$ * $WestMSA_i$	-2.039*** (0.179)	0.997*** (0.105)	0.965*** (0.101)	0.704*** (0.0892)
$Forest_i$	0.161*** (0.0369)	-0.142*** (0.0206)	-0.138*** (0.0197)	-0.0698*** (0.0120)
$Forest_i$* $EastMSA_i$	-0.244*** (0.0368)	0.268*** (0.0246)	0.107*** (0.0199)	0.0608*** (0.0118)
$Forest_i$* $MiddleMSA_i$	-0.245*** (0.0366)	0.133*** (0.0205)	0.385*** (0.0232)	0.0721*** (0.0119)
$Forest_i$* $WestMSA_i$	-0.196*** (0.0374)	0.131*** (0.0207)	0.135*** (0.0202)	0.276*** (0.0462)
$Shrub_i$	0.246*** (0.0596)	-0.104*** (0.0320)	-0.107*** (0.0303)	-0.0594*** (0.0173)
$Shrub_i$* $EastMSA_i$	-0.215*** (0.0603)	0.463*** (0.0445)	0.0931*** (0.0309)	0.0551*** (0.0175)
$Shrub_i$* $MiddleMSA_i$	-0.214*** (0.0602)	0.101*** (0.0323)	0.256*** (0.0442)	0.0500*** (0.0176)
$Shrub_i$* $WestMSA_i$	-0.246*** (0.0622)	0.108*** (0.0331)	0.0977*** (0.0320)	0.592*** (0.0910)
$Wetland_i$	0.606*** (0.0379)	-0.330*** (0.0235)	-0.318*** (0.0226)	-0.177*** (0.0168)
$Wetland_i$* $EastMSA_i$	-0.577*** (0.0394)	0.517*** (0.0347)	0.313*** (0.0235)	0.174*** (0.0174)
$Wetland_i$* $MiddleMSA_i$	-0.590*** (0.0389)	0.327*** (0.0237)	0.677*** (0.0394)	0.180*** (0.0170)
$Wetland_i$* $WestMSA_i$	-0.602*** (0.0397)	0.329*** (0.0243)	0.294*** (0.0243)	0.761*** (0.0627)
$Rooms_i$	0.237 (0.186)	-0.0760 (0.142)	-0.201 (0.153)	0.0677 (0.138)
Age_i	-0.0708 (0.0509)	-0.179*** (0.0405)	-0.335*** (0.0439)	-0.188*** (0.0321)
$LotSize_i$	-0.499 *** (0.132)	-0.0918 (0.0854)	0.0554 (0.0827)	0.104* (0.0599)
Gas_i	-0.00309**	-0.00352***	0.000578	0.000612

	(0.00120)	(0.000879)	(0.000836)	(0.000601)
Bed$_i$	0.00310* (0.00161)	0.00184 (0.00115)	0.000780 (0.00121)	-0.00308*** (0.00115)
EastMSA$_i$	8.408*** (0.870)	-4.446*** (0.557)	-3.675*** (0.483)	-2.057*** (0.300)
MiddleMSA$_i$	8.716*** (0.867)	-4.190*** (0.504)	-6.113*** (0.698)	-2.078*** (0.306)
WestMSA$_i$	8.617*** (0.871)	-3.980*** (0.502)	-3.782*** (0.489)	-0.713 (0.652)
Density$_i$	-0.815*** (0.0748)	-0.0216 (0.0433)	-0.0675 (0.0528)	0.0727* (0.0406)
Income$_i$	-0.180** (0.0769)	0.0425 (0.0518)	-0.137* (0.0560)	0.0590 (0.0402)
Vacancy$_i$	-0.0163*** (0.00296)	0.00492*** (0.00179)	0.00793*** (0.00163)	0.00239* (0.00122)
Unemploy$_i$	-0.00594*** (0.00205)	0.00435*** (0.00140)	0.00337** (0.00143)	-0.000396 (0.00119)
Edu$_i$	-0.00112 (0.00183)	-0.000557 (0.00128)	-0.00101 (0.00127)	-0.00158* (0.000936)
Stability$_i$	-0.00260 (0.00175)	0.00128 (0.00130)	0.00000663 (0.00137)	0.00234** (0.00113)
Travel$_i$	-0.00138 (0.00157)	0.00110 (0.00108)	0.00173* (0.00104)	0.000381 (0.000810)
Interdist$_i$	-0.0108 (0.0231)	0.00973 (0.0161)	0.0446*** (0.0151)	0.0317*** (0.0107)
Lakedist$_i$	-0.0943*** (0.0322)	0.0485** (0.0238)	0.0383* (0.0217)	0.00462 (0.0140)
Interface$_i$	0.470*** (0.0723)	0.188*** (0.0565)	0.282*** (0.0567)	0.165*** (0.0415)
Feddist$_i$	0.345*** (0.0525)	-0.152*** (0.0290)	-0.142*** (0.0275)	-0.0846*** (0.0163)
Feddist$_{i*}$ *EastMSA*$_i$	-0.333*** (0.0541)	0.00461 (0.0516)	0.176*** (0.0282)	0.0878*** (0.0168)
Feddist$_{i*}$ *MiddleMSA*$_i$	-0.365*** (0.0621)	0.192*** (0.0336)	0.166 (0.108)	0.0751*** (0.0203)
Feddist$_{i*}$ *WestMSA*$_i$	-0.254*** (0.0611)	0.156*** (0.0323)	0.175*** (0.0334)	-0.783*** (0.130)
Statedist$_i$	0.0889 (0.0780)	-0.0769* (0.0416)	-0.0565 (0.0388)	-0.0321 (0.0221)
Statedist$_{i*}$ *EastMSA*$_i$	-0.0965 (0.0788)	0.0738 (0.0564)	0.0717* (0.0396)	0.0321 (0.0227)
Statedist$_{i*}$ *MiddleMSA*$_i$	-0.0733 (0.0794)	0.0596 (0.0421)	0.203*** (0.0625)	0.0222 (0.0226)
Statedist$_{i*}$ *WestMSA*$_i$	-0.0711 (0.0808)	0.0947** (0.0426)	0.0945** (0.0413)	0.535*** (0.0941)
Otherdist$_i$	0.0768 (0.0931)	-0.0541 (0.0500)	-0.0571 (0.0470)	-0.0340 (0.0266)

Otherdist$_i$ EastMSA$_i$*	-0.0589 (0.0944)	0.236*** (0.0672)	0.0554 (0.0477)	0.0356 (0.0270)
Otherdist$_i$ MiddleMSA$_i$*	-0.0902 (0.0953)	0.0493 (0.0512)	0.329*** (0.0701)	0.0336 (0.0275)
Otherdist$_i$ WestMSA$_i$*	-0.0380 (0.0961)	0.0337 (0.0516)	-0.00437 (0.0494)	0.0545 (0.0840)
Constant	-4.164*** (1.163)	4.043*** (0.712)	6.092*** (0.722)	1.899*** (0.514)
N	4,076	4,076	4,076	4,076
R^2	0.962	0.943	0.957	0.954
F-statistics	20,146.63	843.32	1,421.36	579.92

Note: Standard errors in parentheses. Standard errors are clustered by census block group. * p < 0.1, **p < 0.05, *** p < 0.01

Table 26: First stage regression results for wetland cover type

	Dependent Variables			
	Wetland$_i$	*Wetland$_i$ * EastMSA$_i$*	*Wetland$_i$ * MiddleMSA$_i$*	*Wetland$_i$ * WestMSA$_i$*
Explanatory Variables				
Elevation$_i$	-1.496*** (0.0731)			
*Elevation$_i$ *EastMSA$_i$*		-1.201*** (0.0984)		
*Elevation$_i$ *MiddleMSA$_i$*			-1.663*** (0.188)	
*Elevation$_i$ *WestMSA$_i$*				-2.196*** (0.210)
Wetland$_i$		0.370*** (0.0158)	0.265*** (0.0162)	0.172*** (0.0138)
*Wetland$_i$ * EastMSA$_i$*	0.922*** (0.00876)		-0.268*** (0.0163)	-0.179*** (0.0146)
*Wetland$_i$ * MiddleMSA$_i$*	0.933*** (0.00777)	-0.371*** (0.0162)		-0.175*** (0.0140)
*Wetland$_i$ * WestMSA$_i$*	0.905*** (0.0116)	-0.385*** (0.0165)	-0.266*** (0.0164)	
DevOpen$_i$	0.796*** (0.108)	-0.359*** (0.0500)	-0.229*** (0.0376)	-0.157*** (0.0266)
*DevOpen$_i$ * EastMSA$_i$*	-0.751*** (0.110)	0.440*** (0.0582)	0.237*** (0.0375)	0.159*** (0.0267)
*DevOpen$_i$ * MiddleMSA$_i$*	-0.780*** (0.109)	0.368*** (0.0502)	0.231*** (0.0474)	0.159*** (0.0269)
*DevOpen$_i$ * WestMSA$_i$*	-0.801*** (0.109)	0.368*** (0.0504)	0.241*** (0.0379)	0.221*** (0.0412)

Forest$_i$	-0.196*** (0.0221)	0.133*** (0.0110)	0.0946*** (0.00895)	0.0607*** (0.00656)
Forest$_i$ EastMSA$_i$*	0.209*** (0.0222)	-0.0353** (0.0157)	-0.0899*** (0.00885)	-0.0609*** (0.00667)
Forest$_i$ MiddleMSA$_i$*	0.191*** (0.0223)	-0.126*** (0.0111)	-0.0844*** (0.0145)	-0.0591*** (0.00659)
Forest$_i$ WestMSA$_i$*	0.244*** (0.0223)	-0.120*** (0.0116)	-0.0899*** (0.00905)	0.113*** (0.0245)
Shrub$_i$	0.308*** (0.0326)	-0.131*** (0.0158)	-0.0929*** (0.0123)	-0.0612*** (0.00863)
Shrub$_i$ EastMSA$_i$*	-0.375*** (0.0338)	0.0905*** (0.0261)	0.0934*** (0.0122)	0.0619*** (0.00863)
Shrub$_i$ MiddleMSA$_i$*	-0.265*** (0.0338)	0.124*** (0.0162)	0.246*** (0.0247)	0.0615*** (0.00884)
Shrub$_i$ WestMSA$_i$*	-0.354*** (0.0348)	0.114*** (0.0170)	0.0888*** (0.0126)	-0.00251 (0.0442)
Agland$_i$	0.199*** (0.0171)	-0.109*** (0.00893)	-0.0815*** (0.00743)	-0.0537*** (0.00562)
*Agland$_i$ * EastMSA$_i$*	-0.193*** (0.0175)	0.184*** (0.0122)	0.0805*** (0.00731)	0.0526*** (0.00533)
*Agland$_i$ * MiddleMSA$_i$*	-0.194*** (0.0173)	0.110*** (0.00909)	0.195*** (0.0116)	0.0499*** (0.00534)
*Agland$_i$ * WestMSA$_i$*	-0.178*** (0.0183)	0.110*** (0.00909)	0.0824*** (0.00756)	0.278*** (0.0179)
Rooms$_i$	0.177 (0.116)	0.0206 (0.0909)	0.0162 (0.0741)	-0.0515 (0.0873)
Age$_i$	-0.0106 (0.0315)	-0.00109 (0.0233)	0.0251 (0.0228)	0.0116 (0.0185)
LotSize$_i$	-0.280*** (0.0779)	0.317*** (0.0645)	0.122*** (0.0401)	0.155*** (0.0486)
Gas$_i$	-0.00156** (0.000710)	0.000239 (0.000499)	-0.00107*** (0.000389)	-0.0000798 (0.000337)
Bed$_i$	-0.00263*** (0.000950)	-0.00123* (0.000666)	0.000356 (0.000578)	0.000688 (0.000693)
EastMSA$_i$	2.511*** (0.547)	6.212*** (0.680)	-0.311* (0.173)	-0.178 (0.115)
MiddleMSA$_i$	0.475 (0.543)	-0.361 (0.244)	10.22*** (1.017)	-0.114 (0.118)
WestMSA$_i$	-0.0864 (0.549)	-0.393 (0.245)	-0.254 (0.175)	9.993*** (0.990)
Density$_i$	-0.167*** (0.0376)	0.0954*** (0.0265)	0.0901*** (0.0254)	-0.000312 (0.0244)
Income$_i$	-0.0444 (0.0449)	0.0509* (0.0293)	0.00943 (0.0252)	-0.0264 (0.0229)
Vacancy$_i$	0.00410 (0.00141)	-0.00111 (0.000879)	-0.00119* (0.000676)	0.000164 (0.000625)
Unemploy$_i$	0.000144	0.00216**	0.000224	0.000183

	(0.00120)	(0.000811)	(0.000629)	(0.000764)
Edu_i	0.000580 (0.00112)	-0.000943 (0.000754)	-0.000253 (0.000591)	0.000384 (0.000540)
$Stability_i$	0.00287*** (0.00106)	0.000293 (0.000741)	-0.000270 (0.000634)	-0.000242 (0.000590)
$Travel_i$	-0.000526 (0.000950)	0.00243*** (0.000605)	0.00105** (0.000504)	0.000724 (0.000454)
$Interdist_i$	0.0819*** (0.0147)	-0.0636*** (0.00892)	-0.0135* (0.00726)	-0.00617 (0.00588)
$Lakedist_i$	-0.0630*** (0.0197)	0.0264** (0.0132)	0.0184 (0.0121)	0.0203*** (0.00743)
$Interface_i$	-0.0254 (0.0363)	0.0793** (0.0333)	0.0643** (0.0282)	0.0308 (0.0244)
$Feddist_i$	-0.138*** (0.0322)	0.0736*** (0.0147)	0.0520*** (0.0106)	0.0347*** (0.00724)
$Feddist_i$ $EastMSA_i$*	-0.131*** (0.0392)	-0.182*** (0.0323)	-0.0517*** (0.0108)	-0.0326*** (0.00735)
$Feddist_i$ $MiddleMSA_i$*	0.222*** (0.0364)	-0.30*** (0.0178)	-0.379*** (0.0646)	-0.0463*** (0.00950)
$Feddist_i$ $WestMSA_i$*	0.174*** (0.0387)	-0.103*** (0.0183)	-0.0613*** (0.0121)	0.00890 (0.0704)
$Statedist_i$	-0.402*** (0.0457)	0.173*** (0.0220)	0.119*** (0.0170)	0.0808*** (0.0119)
$Statedist_i$ $EastMSA_i$*	0.416*** (0.0472)	-0.213*** (0.0340)	-0.122*** (0.0172)	-0.0805*** (0.0121)
$Statedist_i$ $MiddleMSA_i$*	0.384*** (0.0472)	-0.159*** (0.0227)	-0.461*** (0.0343)	-0.0788*** (0.0120)
$Statedist_i$ $WestMSA_i$*	0.450*** (0.0481)	-0.208*** (0.0241)	-0.133*** (0.0177)	-0.225*** (0.0567)
$Otherdist_i$	-0.273*** (0.0555)	0.146*** (0.0247)	0.0989*** (0.0186)	0.0667*** (0.0128)
$Otherdist_i$ $EastMSA_i$*	0.298*** (0.0567)	-0.160*** (0.0389)	-0.100*** (0.0186)	-0.0684*** (0.0129)
$Otherdist_i$ $MiddleMSA_i$*	0.413*** (0.0563)	-0.159*** (0.0254)	-0.242*** (0.0391)	-0.0689*** (0.0131)
$Otherdist_i$ $WestMSA_i$*	0.243*** (0.0579)	-0.147*** (0.0269)	-0.0954*** (0.0195)	-0.314*** (0.0480)
Constant	7.182*** (0.787)	-0.275 (0.370)	-0.108 (0.308)	0.337 (0.265)
N	4,076	4,076	4,076	4,076
R^2	0.905	0.822	0.794	0.929
F-statistics	4,069.53	169.70	70.94	257.72

Note: Standard errors in parentheses. Standard errors are clustered by census block group. * p < 0.1, **p < 0.05, *** p < 0.01