SPATIAL VALUATION OF OPEN SPACE EXTERNALITIES IN BALTIMORE COUNTY, MARYLAND

A Thesis

by

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ABSTRACT

Different open space types are assumed to be valued in different ways by the public. This thesis analyzes four spatially explicit hedonic models of Baltimore County, Maryland to examine the effect of six different open spaces types on house value using 2007 sales data. The first model analyzes open space value using proximity measures of open spaces, while the other three models use percent area measures of open space at different neighborhood distance. Marginal monetary values of the open spaces are estimated. Additional eight hedonic models, four urban and four rural, are used to analyze the differences and similarities between the value placed on open space by urban dwellers and rural dwellers.

Among the open space types under study, storm water retention area is found to have the most prevalent influence on house value and in most instants this influence is found to be negative. Differences and similarities in urban and rural perspective on open space value are also discussed. Proximity to lakes without improvements has positive effect on house prices for both rural and urban area. Golf course area in urban neighborhood has negative influence on house prices, whereas in rural area its influence is seen to be positive.

To my loving Mother, my Inspiration

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1. INTRODUCTION

1.1 General Overview

Open spaces are considered key social and environmental resources that contribute to a higher quality of life (Chiesura, 2004). The benefits provided by open spaces are numerous and wide ranging. Wildlife habitat, biodiversity, and carbon sequestration are natural benefits provided by open spaces. Market goods and services like recreation and timber are also derived from open spaces. Chiesura (2004) suggests that open space provides social benefits that can be significant especially for urban dwellers and the sustainability of their communities. A study by Ulrich (1984) actually demonstrated the significance of psychological benefits provided by open spaces, where hospital patients with a view of trees and nature were recovering faster than the ones with a view of buildings or other developments.

The encroachment of development onto open spaces is well documented. From 1982 to 2007, approximately 11.12 million acres of cropland, 17.08 million acres of forested land, 6.84 million acres of pastureland, and 5.20 million acres of rangeland were converted to urban and other developed uses in the United States. In total, approximately 40.2 million acres of land were developed in this time frame (USDA, 2009). There is constant growth pressure on undeveloped open spaces especially in urban setting as opportunity cost increases with time (Irwin and Bockstael, 2001).

Loss of open spaces to urban sprawl and development has spurred major concern since the late 1990s in the United States (McConnell and Walls, 2005). Increasingly, people have been willing to invest public money for open space preservation purposes. As recently as the 2008 general elections, the voters approved 63 out of 89 state and local conservation finance measures, which generated $7.3 billion for open space purchase, preservation, and maintenance. An additional $2 billion in new funding was generated in the 2010 midterm election with the voters passing 30 out of 36 conservation funding measures (Trust for Public Land, 2011).

Although, it is apparent that the public values open spaces as they benefit from it in various ways, constant development pressures on open spaces exist. This can be partly attributed to the inability of planners and researchers to articulate their value in economic terms (More et al., 1988). Examination of both market value and non-market value are necessary for the understanding of complete value placed by people on open spaces. While valuation of market goods and services (e.g. timber) derived from open spaces can be estimated directly from market transactions, complication arises when the value of non-market benefits (positive externalities) associated with open space are in question. This paper specifically deals with the valuation of externalities associated with multiple open space types. There are several varying perspectives on the meaning of open space. Kaplan et al. (2004) revealed this phenomenon in their study where residents from the same township (but different subdivision type) had different notions of 'open space'. Residents in 'open space community' associated forest areas as open spaces whereas residents in conventional community perceived unobstructed landscape and view as open spaces. This research deals with six distinct open space types as will be discussed below.

1.2 Objective

This study uncovers the value placed by homeowners in Baltimore County, Maryland, on different open space types. The study focuses on the estimation of externalities associated with specific open space types using hedonic pricing of housing transactions. Most open space valuation studies have focused on one open space type. For this research, six open space types under study include: 1) parks, 2) playgrounds, 3) protected areas, 4) golf courses, 5) storm-water retention areas, and 6) lakes. Protected area in this case encompasses all open space areas that have development restriction and includes easements and public open spaces like parks.

Different open space types can be assumed to be valued in different ways and in varying degrees by homeowners. This study aims to understand these complex relations between house prices and different open space types using hedonic models. Proximity and proportional area (only within 800m) measures of open spaces are used to estimate their influence on housing price, thereby estimating their value to homeowners. In particular, the effects of various open space types on house price, in terms of marginal monetary value are estimated. The overall goal of this study is to understand the externalities of different open space types. Externalities of six open space types were under investigation. Specific objectives of this study were: 1) to estimate the externalities associated with open space types and, 2) to examine the differences or similarities between urban and rural valuation of open space types.

The remainder of the thesis is organized as follows. First, the literature on open space valuation is reviewed with an emphasis on hedonic pricing technique. Second, the research method begins with an explanation of hedonic theory followed by the discussion on the specification of the hedonic model used. Next, the study area and the data for the research is discussed after which, the results from the models are interpreted. Finally, the study is summarized and its prospective extension is explored in the conclusion.

2. LITERATURE REVIEW

Open space values have been estimated by measuring people's 'willingness to pay' or preferences using various approaches. These approaches can be categorized into two main types, stated preference and revealed preference. Contingent valuation is one of the important stated preference methods that have been used for open space valuation. The open space preferences of a study group are elicited using conditional (hypothetical) survey question in contingent valuation technique. Some reservation about the validity of this technique remains, mainly because expressed or stated attitudes of focus groups have known to be different from their behavior (Bishop and Heberleih, 1979). Another well known approach is the travel cost method, which falls under the revealed preference approach of open space valuation. This model inquires the distance traveled by users of the park and assumes that the benefit for the user is equal to the travel cost associated with it. Travel cost model are more suited for valuation of open spaces (state parks and natural reserves) that are situated some good distance from major human settlements where users travel different distances to enjoy its benefits. For valuation of neighborhood open spaces, travel cost method is understood to be lacking due to the very small variation in the travel cost accrued by users (More et al., 1988).

Hedonic modeling of house prices is the preferred method of open space valuation for this study. It falls under the revealed preference approach. Hedonic pricing models disaggregate the price of composite good, such as a house, into many contributing attributes. This makes it possible for the estimation of marginal value of each contributing attribute. Open space externality is one such attribute implicit to house prices. Therefore, hedonic modeling of house price has been extensively used to uncover the value of open space externalities in monetary terms.

Many of the earlier hedonic house pricing studies chose one specific open space type for valuation. Weicher and Zerbst (1973) investigated the value of neighborhood recreational parks in the City of Columbus, Ohio using hedonic pricing technique. Their study concludes that the City of Columbus was losing approximately $4,108 in tax revenues annually, from properties adjacent to the parks due to the lack of accounting of externalities associated with the parks by the assessors. The spatial orientation of the houses influenced the magnitude and direction of the externalities associated with the parks, i.e., houses facing the parks accrued positive externalities whereas, the ones facing the opposite direction accrued negative or no externalities. Correll et al. (1978) used a similar model to study the implicit value of greenbelts at Boulder, Colorado where it was observed that the proximity to greenbelts increased the value of homes. Do and Grudnitski (1995) examined the relationship between the selling price of single-family residential properties and golf courses in Rancho Bernardo, California, using the hedonic pricing model as well. A 7.6% increase in property price was determined for houses that abutted the golf course. Doss and Taff (1996) examined the value or preference of home owners to different wetland types where they found that in Ramsey County, MN, the value of lakes held more premiums compared to other wetland types like srcub-shrub, emergent vegetation and open water. Bin et al. (2009) used the hedonic pricing method to estimate the value of riparian buffer in the Neuse River Basin, North Carolina, where they found that riparian property generally commanded a higher premium.

More recently hedonic house pricing studies have been used to uncover the difference in valuation of open spaces in accordance to their future development status. Irwin & Bockstael (2001) and Geoghegan (2002) categorize open space in terms of their developable/non-developable status. Using hedonic pricing methods, Geoghegan (2002) estimated that local open spaces with development restriction increased the value of nearby residential land compared to "developable" open space by as much as three times in Howard county, Maryland. Irwin (2002), along the same vein of developable/non-developable status, analyzed open space with an added factor of ownership types for counties within central Maryland region. Her research determines a net increase in value of open space when it is converted from developable to non-developable land. In addition, a higher increase in value is seen when the developable land is converted to protected public land.

Bolitzer and Netusil (2000) studied four different open space types; public park, private park, golf course, and cemetery for the same dataset. Their empirical results from the city of Portland, Oregon suggested that private parks and cemetery did not have a significant effect on the home prices but houses within 1500 feet of parks and golf courses saw an increase of $2,262 and $3,400 in sales prices respectively. This study, like Bolitzer and Netusil's (2000) uses hedonic pricing technique to estimate the value of multiple open space types for the same dataset. More specifically, the externalities associated with six open space types are estimated for Baltimore County, Maryland.

In majority of the prior hedonic pricing studies, open space has been accounted in the models as proximity measures or percent neighborhood area measures. The proximity measures have been accounted mainly as straight line distance and as dummy variable representing presence or absence within certain buffer distance. Doss and Taff (1996) and Nicholls (2002) use straight line distance to measure the effect of open space on housing price. Transformation of straight line distance to open spaces, like squared of straight line distance (Doss and Taff, 1996) and log of the straight line distance can also be employed in hedonic models. Weicher and Zerbst (1973), Do and Grudnitski (1995), Bolitzer and Netusil (2000), Lutzenhiser and Netusil (2001), and Miller (2001) account for open space externalities using dummy variables that indicate the presence or absence of respective open spaces within a certain radius of houses.

As stated, percent open space area in the neighborhood has also been used (Irwin and Bockstael, 2001; Geoghegan, 2002; Irwin, 2002) to factor in open spaces into the hedonic model. Percent open space area measures within a neighborhood can be considered a more detailed variable compared to proximity measures, as it captures the areal dimension in addition to the proximity dimension of the surrounding open spaces. Although there is a caveat to this method, neighborhood designation which is necessary for the calculation of percent area, is an ambiguous term. In most studies, the choice of an arbitrary uniform distance around parcel centroids has been assumed as neighborhood. Irwin and Bockstael (2001) used 400 meter radius around the parcel centroid as a proxy for neighborhood. Geoghegan (2002) used 1600 meter radius instead, assuming this radial distance would encompass open spaces that can be seen in a 20 minute walk from the house parcel. Irwin (2002) relying on visual inspection of land use pattern around residential property assumes 400 meter radius to represent a neighborhood for her study. In a recent study estimating tree cover value, Sander et al. (2010) designated buffers around house parcels as neighborhood proxy instead of radius around parcel centroids to calculate percent neighborhood area.

In addition to distance and size, shapes of open space could also influence house prices. Geoghegan et al. (1997) used the spatial configuration indices (fragmentation index & diversity index) of surrounding land-use within 100 meters and 1000 meters radius of each house transaction, although these indices were not seen to have significant influence on the prices. They observed a positive influence by the proportion of open space on land value within 100m but negative effect within 1000m.

For this thesis, open spaces are accounted for by using both proximity measures and percent area measures but spatial configuration of open space is not considered. Straight line distance, dummy variables representing presence or absence of open spaces within certain distances and log transformation of straight line distance, has been used to account for open spaces in terms of proximity measures. As for percent area measures, buffer distances of 100 meters, 400 meters and 800 meters around house parcels are used as neighborhood proxies. Percent open space area is assumed to have effect on house prices only within close proximity; hence, for this study percent area is assumed to have significant influence only within 800 meters.

Different open space types are expected to influence house prices differently. Like Do and Grudnitski's (1995) study, golf courses are expected to have a positive effect on house prices within close proximity. Protected areas are also expected to have a positive influence on house prices due to their undevelopable status. Lakes are expected to increase house prices at least within close vicinity due to its recreational and aesthetic value. Storm water retention area is expected to have a negative influence on house prices due to its prevalent public perception as an eyesore. Playgrounds and parks are expected to have negative effect within close proximity due to possible congestion, noise, and loss of privacy, although their presence in the neighborhood is expected to have a positive impact. In addition to estimating the marginal value of open space types within the county, the difference between rural and urban valuation of open space is explored in this study.

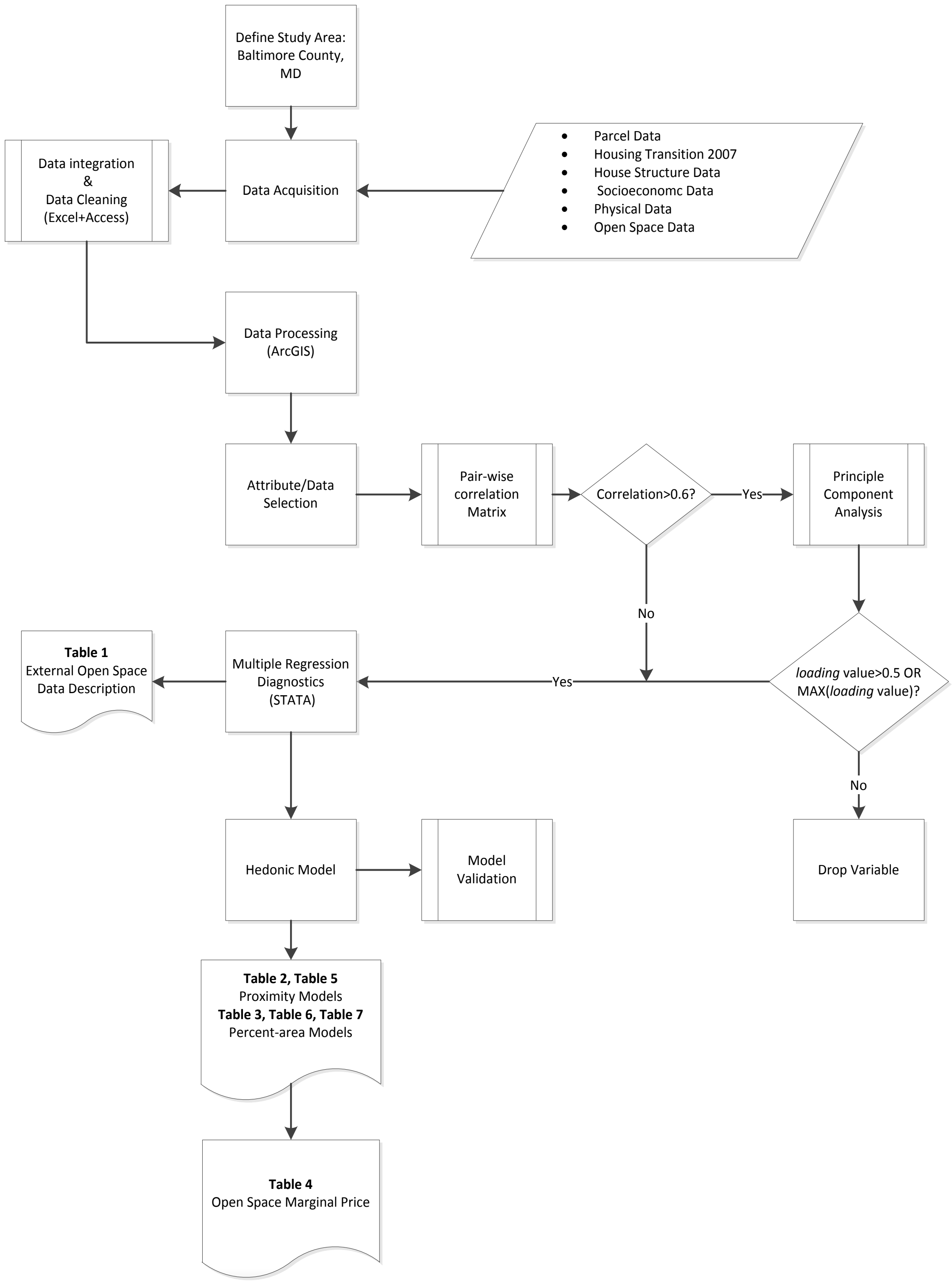

Figure 1. Overview of the Research Method

3. RESEARCH METHOD

3.1 Goal and Objective

The overall goal of this study is to understand the value of six open space types using hedonic pricing models. Specific objectives of this study are: 1) to estimate the externalities associated with open space types and, 2) to examine the differences or similarities between urban and rural valuation of open space types. Figure 1 gives a complete overview of the research method.

3.2 Theoretical Framework

This section describes hedonic theory, the underlying theoretical model of the research. It is then followed by the specification of the model used for this research.

The hedonic approach considers a good as a composite of many attributes. The value of a good, such as housing, is understood as a function of each of its contributing attributes (Hidano, 2002). Hedonic theory can be represented as follows:

$P = f(x_1, x_2, x_3 \ldots \ldots \ldots \ldots \ldots \ldots \ldots .. x_n)$, where P is the price of the house and x_i are the various attributes of the house.

Hence, house prices close to open spaces should vary in accordance to the negative or positive externalities associated with the open space, all else being equal (More et al., 1988). Hedonic price function follows the locus of equilibrium points that is the result of interactions of many buyers and sellers in the market. The marginal implicit price of the attributes associated with a good can be determined by differentiating the hedonic price function with respect to that attribute (Irwin, 2002). In particular open space externalities are implicit to house prices and their marginal price can be estimated by differentiating the hedonic price function with respect to open space attribute:

$\frac{\partial \hat{f}(x_i)}{\partial x_1} = \widehat{P}_1$, where $\widehat{P}_1$ is the estimated implicit marginal price of attribute x_1

Hedonic house pricing method lacks, in that, it is only able to estimate marginal price and is unable to capture the open space benefits accrued by non-residents. Nonetheless, the ‘willingness to pay’ by the home owners is a very important component of the general public’s perception of open space value.

Economic theory is unable to diagnose the best hedonic functional form. Semi-log form is chosen for the hedonic price function as similar studies (Bolitzer and Netusil, 2000; Irwin, 2002; Geoghegan, 2002, etc.) have successfully used this form. Also, simpler functional form like the semi-log is suggested by Cropper et al. (1998), for studies where variables may be missing or proxies have been used. Following previous hedonic pricing models (Freeman, 2003; Irwin, 2001; Geoghegan, 2002), the price of the houses is defined as a function of its structural characteristics, neighborhood characteristics, and environmental characteristics. The hedonic model specification for this paper is as follows:

$\ln(P) = \alpha + S\beta + N\gamma + O\tau + \varepsilon$

where P is $(n\times1)$ vector of housing prices; S is $(n\times a)$ matrix of structural attributes; N is $(n\times b)$ matrix of neighborhood attributes, neighborhood attributes includes socioeconomic and physical neighborhood characteristics; O is $(n\times c)$ matrix of open space type variables (proximity, and percent area); β, γ, τ are associated parameter vectors; α is the intercept; and ε is a $(n\times1)$ vector of random error terms.

3.3 Study Area

Baltimore County, the extent of this study, is located roughly at the center of Maryland. It spans from the City of Baltimore in the south, to the State of Pennsylvania in the north. It encompasses 612 square miles of land and an additional 28 square mile of water. The resident population of Baltimore County as of 2010 was 805,029. The population growth from 2000 to 2010 was recorded as 6.7 percent (www.baltimorecountymd.gov).

Baltimore County was chosen for the purpose of this study for two main reasons: 1) availability of very sound and detailed spatial and housing sales data which is crucial for the purposes of this study and, 2) the existence of the clear Urban Rural Demarcation Line (URDL) which provides an opportunity for inquiry into differing perspectives of rural and urban community on the value of open space types. URDL was established in 1967 as a part of the Smart Growth initiative. The main purpose of Smart Growth initiative is growth and development management, which encourages higher growth and development in urban areas but natural resource protection, agricultural land-use and low density housing in rural area (County, 2000). Figure 2 shows Baltimore County, Maryland with the location of the house sales for 2007, six open space types and the URDL.

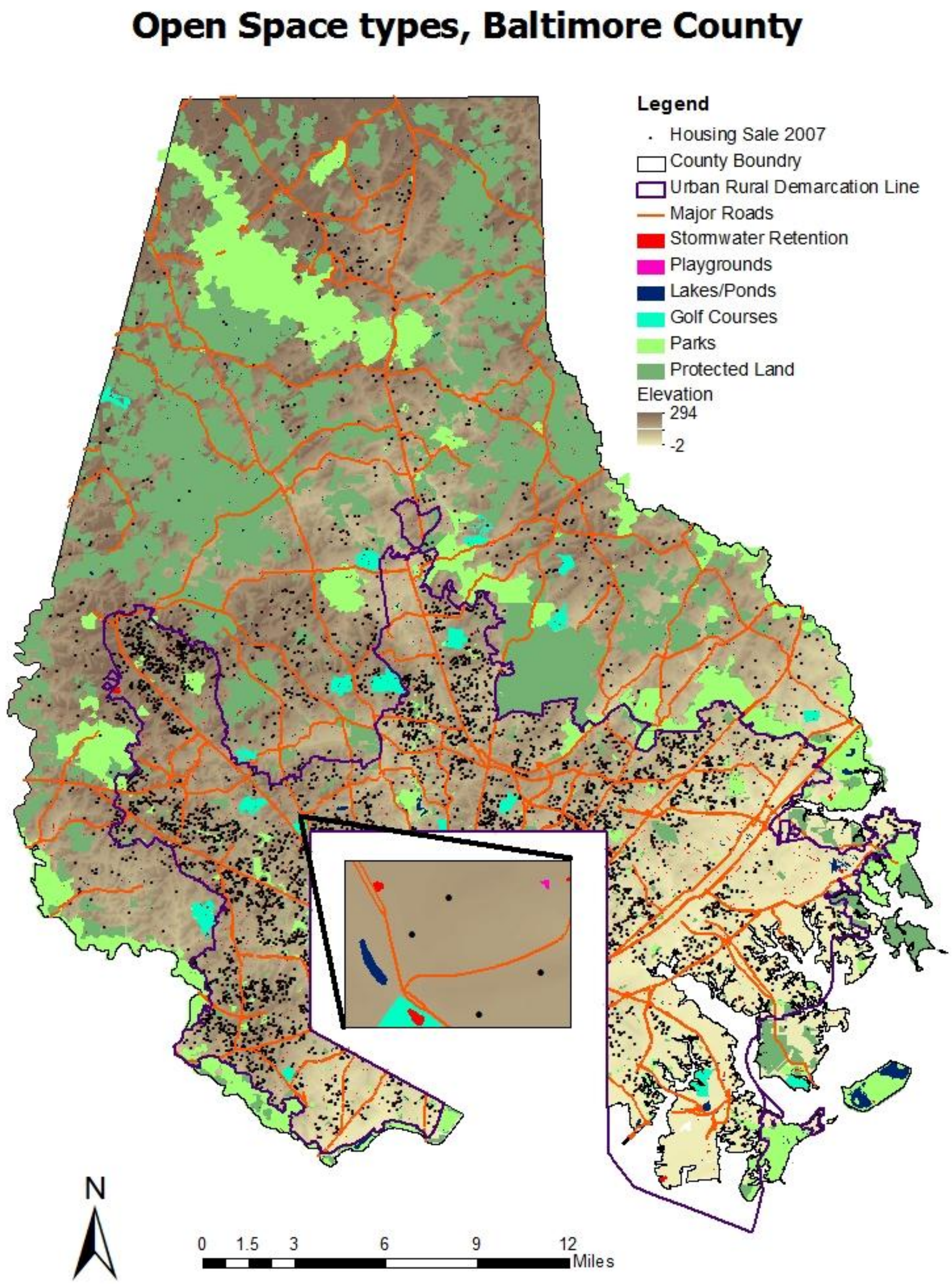

Figure 2. Baltimore County Open Space Types

Table 1
Definitions and descriptive statistics of variables used in the hedonic models

		COUNTY		URBAN		RURAL	
Variable	Definition	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
LNPRICE	Natural log of home sales price	12.73	0.49	12.74	0.49	12.65	0.48
	Structural variables						
STRUGRAD	Structural grade	3.94	0.93	3.97	0.94	3.80	0.86
AGE	Year home was built substracted from year sale	41.21	27.13	40.69	27.20	44.01	26.64
ENCLS	Enclosure area (sq. ft.)	1905.60	1020.07	1924.10	1031.10	1806.35	953.26
STRY	Number of storey	1.71	0.53	1.73	0.53	1.65	0.52
LOTSIZE	Parcel area (sq. ft.)	24053.01	40209.04	12391.69	15377.77	86622.76	66196.51
	Neighborhood variables						
POPDEN	Population density by block group	3452.58	2511.21	4019.95	2325.48	408.27	360.79
BLKPOP	Percentage of african americans by block group	17.37	25.87	19.63	27.08	5.30	12.43
COLLEGE	Percentage of adults with more than high school diploma by block group	61.91	17.71	60.25	17.94	70.80	13.26
DISTCITY	Euclidian distance to Baltimore city center line (m)	16656.52	6824.05	14771.77	4472.26	26769.31	8236.26
XDISTCOMM	Dummy variable(1 if within 1km of commercial parcel, 0 if not)	0.90	0.30	0.95	0.21	0.59	0.49
T100	Percent area of tree canopy cover within 100m buffer	40.37	17.65	37.79	15.36	54.18	22.14
	Open space:Distance						
DISTPRK	Euclidian distance to closest park (m)	2040.25	2037.79	1592.89	980.79	4440.61	3801.43
DISTPLY	Euclidian distance to closest playground (m)	2649.23	3191.48	1776.35	1119.65	7332.77	5667.08
YDISTPLY	Dummy variable(1 if within 1km of playgrounds, 0 if not)	0.46	0.50	0.54	0.50	0.06	0.24
DISTPRT	Euclidian distance to closest protected land area (m)	315.30	246.73	301.85	232.03	387.46	304.24
XDISTPRT	Dummy variable(1 if within 1km of protected land, 0 if not)	0.98	0.13	0.99	0.12	0.96	0.20
DISTSWRT	Euclidian distance to closest storm-water retention area (m)	1343.06	981.28	1290.37	958.07	1625.79	1054.02
DISTLKREC	Euclidian distance to closest lakes with piers or boat ramps(m)	9988.92	5969.13	10940.54	5900.09	4882.94	3017.95
DISTLKNO	Euclidian distance to closest lakes with no piers or boat ramps (m)	3842.10	2356.07	4120.01	2394.33	2350.98	1393.05
DISTGLF	Euclidian distance to closest private golf course (m)	5367.38	3454.84	5142.45	3020.11	6574.25	5033.81
XDISTGLF	Dummy variable(1 if within 1km of golf course, 0 if not)	0.06	0.23	0.05	0.22	0.09	0.28

(continued on next page)

Table 1 *(continued)*

Variable	Definition	COUNTY Mean	COUNTY Std. Dev.	URBAN Mean	URBAN Std. Dev.	RURAL Mean	RURAL Std. Dev.
	Open space:Area0_100						
GLF100	Percent area of golf courses within 100m buffer	0.1502	2.1150	0.1264	1.8337	0.2777	3.2288
PRK100	Percent area of parks within 100m buffer	0.9512	5.6415	0.9498	5.5603	0.9588	6.0619
PLY100	Percent area of playgrounds within 100m buffer	0.0176	0.1783	0.0200	0.1889	0.0049	0.1035
PRT100	Percent area of protected areas within 100m buffer	3.4937	10.9145	2.7229	8.1431	7.6293	19.5614
SWRT100	Percent area of storm-water retention areas within 100m buffer	0.3387	1.2240	0.3853	1.3145	0.0887	0.4380
	Open space:Area0_400						
GLF400	Percent area of golf courses within 400m buffer	0.4196	3.1804	0.3680	2.9751	0.6960	4.1019
PRK400	Percent area of parks within 400m buffer	2.4598	7.1030	2.4784	6.6926	2.3598	8.9951
PLY400	Percent area of playgrounds within 400m buffer	0.0409	0.0861	0.0476	0.0914	0.0051	0.0299
PRT400	Percent area of protected areas within 400m buffer	6.4176	11.4498	5.3295	8.6324	12.2564	19.8659
SWRT400	Percent area of storm-water retention areas within 400m buffer	0.3564	0.5143	0.3907	0.5365	0.1724	0.3154
	Open space:Area0_800						
GLF800	Percent area of golf courses within 800m buffer	0.7476	3.7841	0.6605	3.4717	1.2149	5.1238
PRK800	Percent area of parks within 800m buffer	3.7989	7.8169	3.7397	7.1643	4.1167	10.6570
PLY800	Percent area of playgrounds within 800m buffer	0.0434	0.0531	0.0504	0.0545	0.0059	0.0197
PRT800	Percent area of protected areas within 800m buffer	8.5494	11.9513	6.9853	9.2027	16.9415	19.2780
SWRT800	Percent area of storm-water retention areas within 800m buffer	0.3859	0.4463	0.4142	0.4231	0.2341	0.5298

3.4 Data

For this study, only 2007 housing sale data was used to control for time. While it reduced the amount of time for data processing, it also limited the sample size for rural area models, which could be the reason for -8.21% error associated with proximity rural model (Model 1.R). Some assumptions made for this study may have added biases in the estimations made in the hedonic models. It was assumed that the sample data belonged to one housing market that is at equilibrium, and the fluctuations in the housing market through 2007 were relatively small. Spatial autocorrelation, which often complicates hedonic model, was not accounted for in this study. Spatial autocorrelation occurs in hedonic models because in practice all the variables affecting housing price cannot be included in a model. The biggest assumption implicit to hedonic theory is that home buyers have all the information about house attributes, which is not true most of the time.

All hedonic models were run using robust regression in Stata, a data analysis and statistical software, to minimize the effect of outliers and account for heteroskedasticity. The main dataset for this study consists of 5067 house records. A record consists of all the variables associated with one particular house that was sold during the year 2007 in Baltimore County. Production of control variables like percent canopy within 100m buffer (T100) and all open space variables required processing, which was accomplished using ArGIS 10.0. Euclidian distance, zonal statistics, spatial join and model builder were some of the ArcGIS tools used. After screening for redundancy and missing data using Microsoft Access and Excel, 5067 out of 5168 house records remained.

An exhaustive list of attributes was considered in selecting the variables to be included in the models. Literature review and statistical techniques like pair-wise correlation matrix and principle component analysis (PCA) guided the screening out of variables that were found to be redundant (e.g. enclosure area and foundation area) or weakly correlated (e.g. mean slope, shortest distance to landfill) to house prices for this study site. PCA was instrumental in narrowing down the variables measuring the same attribute. For this study, the resultant components were not used as in conventional PCA. Instead, "the variables with the greatest *loading* (and value greater that 0.5) in each of the components with at least 75% of the cumulative variance were selected" (Batista et al., 2011). This alternative method is preferred because retaining the original variables will make for clearer interpretation of the models produced.

The data used for this research were collected from various sources. Table 1 consists of data description and summary statistics for the data used in the hedonic models. The parcel level land-use data, housing sales prices and structural attribute data were acquired from Maryland Property View, a GIS database created by the Maryland Office of Assessment and Taxation and, the Maryland Office of Planning. The University of Vermont Spatial Analysis Lab provided the classified land-use high-resolution NAIP (National Agriculture Imagery Program) imagery that was used for the tree canopy area calculation. The open space layers were acquired from Baltimore County Office of Information Technology. Socioeconomic neighborhood variables were derived from 1999 Census data which was acquired from the Social Explorer, an online database. The block group level census data was used as they were the most detailed data available.

The response variable is the house sales price, which only includes arms-length non-distressed (>$10,000) house sales price for the year 2007. A single year was chosen to control for temporal variation in housing price which allows the focus of the study on spatial variation in open space effect. The year 2007 was chosen because it was the closest date to the spatial data collected on open space types. It is assumed that the sample data belongs to one housing market which is at equilibrium and the fluctuations in the housing market through 2007 are relatively small.

The dependent variable in the hedonic models is the log transformation of housing sales price (LNPRICE). LNPRICE also accounts for the economic phenomenon of diminishing returns. All control variables, which consist of structural variables, socioeconomic neighborhood variables and physical neighborhood variables are identical for all models in this study. Structural variables used in the models include age of the house (AGE), square footage of the enclosure structures (ENCLS) and parcel size (LOTSIZE), number of stories (STRY), and an index variable that rates the structural grade on the scale of 0-9, with 9 being the highest grade (STRUGRAD). Like past studies, all of the aforementioned structural variables showed strong influence on house price. All structural variables had a significant positive influence on house prices except age, which had a significant but negative influence on house prices. However, unlike many past studies, enclosure structure area variable replaces foundation area variable because enclosure structure square footage is found to have a stronger relation to house price for this dataset, and also because these two variables are highly correlated.

Socioeconomic neighborhood variables derived from 1999 Census data include population density (POPDEN), percent black population (BLKPOP), and percentage of adults with more than high school diploma (COLLEGE). Like Irwin (2002), the house sales price is expected to decrease with increase in population percentage of African-Americans and population density. Educational attainment is represented by the variable COLLEGE. Median income, which is generally thought to be an indicator of neighborhood quality, was dropped due to high collinearity with the variable COLLEGE. Other socioeconomic neighborhood characteristics like crime statistics and public school quality were not readily available and therefore not used.

Physical neighborhood characteristic variables include distance (DISTCITY) to the center line of central business district (CBD) i.e. City of Baltimore, presence or absence of commercial parcels within 1 km (XDISTCOMM), and percent tree canopy within 100m buffer (T100). Due to the lack of official demarcation line for the City of Baltimore, the city center line was used as a proxy for CBD. Impervious surface area variable was not used as it showed a very strong correlation to tree canopy. Other physical neighborhood characteristic variables like mean elevation and slope; proximity to landfills, major roads, rivers, and industrial parcels had negligible relation to house price and were therefore dropped. In past studies, various transformations of the control variables like age (quadratic), lot size (natural log), distance to CBD (natural log), etc.

have been performed for best fit. The transformations of control variables are not used in order to retain the parsimony of the models.

Designation of neighborhoods for the investigation of open space effect on housing price is an unresolved issue. As discussed earlier, neighborhood is a subjective concept which can differ from household to household. In addition, the 'effective distance' or the 'distance of influence,' within which an open space has significant effect or influence on the house price can be assumed to vary with each open space type. For example, anecdotal information would suggest that effective neighborhood distance of influence of parks will not be same as that of smaller structures like storm water retention areas.

As previously discussed, both proximity and percent area measures of open space types are used for this study. Proximity measures of simple straight line distance (e.g. DISTPRK) to the closest subject open space type and dummy variables representing the presence or absence of open space types within 1 kilometer (e.g. XDISTPRT) and 1 mile (e.g. YDISTPLY) are used. To deal with the neighborhood determination problem for percent area calculation, open space effect are tested using three different treatments; open space types within 100 meters buffer (e.g. PRK100), 400 meters buffer (e.g. PRK400), and 800 meters buffer (e.g. PRK800) with an assumption that size of open space types are significant only within 800 meters buffer.

Table 2
County open space proximity model

	MODEL 1	
Variable	Coef.	t-value
Structural		
STRUGRAD	0.146808***	28.29
AGE	-0.0026957***	-20.03
ENCLS	0.0002099***	42.1
STRY	0.0685317***	11.14
LOTSIZE	0.00000193***	19
Neighborhood		
POPDEN	0.00000341*	2.29
BLKPOP	-0.0006682***	-5.13
COLLEGE	-0.0016313***	-7.77
DISTCITY	-0.0000038***	-6.22
XDISTCOMM	-0.0365223**	-3.17
T100	0.0008657***	4.36
Distance		
DISTPRK	0.000000	0.09
YDISTPLY	0.017782**	2.62
XDISTPRT	0.003753	0.02
LNDISTSWRT	0.019648***	5.08
DISTLKREC	-0.000001	-1.45
DISTLKNO	-0.000004**	-2.76
XDISTGLF	-0.032293*	-2.35
_cons	11.750650	248.46
Observations	5067	
R-squared	0.62	
Signif. Codes:	***0.001, **0.01, *0.05	

	Model Validation
Mean LNPRICE	12.7255
Mean Price	336206.22
Est. Mean LNPRICE	12.7365
Est. Mean Price	339916.10
Error	-1.10%

4. RESULTS AND DISCUSSION

This section is organized as follows: First, value of open space types for Baltimore County, Maryland, is discussed using the models represented in Table 2 and Table 3. Table 4 is used to summarize the marginal monetary value associated with open space types for the county. Second, differences and similarities between urban and rural valuation of the open space types are discussed using models represented in Table 5, Table 6, and Table 7.

4.1 County Models

For this section, all references are made to county models represented in Table 2, Table 3, and Table 4. Table 2 consists of a hedonic model that accounts for open space types within Baltimore County, Maryland, using only proximity variables. Table 3 contains three models that account for open space types as percent area within 100 m buffer, 400 m buffer, and 800 m buffer, respectively. Table 4 shows the marginal value associated with open space types. Sample size for all county models is 5067 housing transactions.

4.1.1 Proximity Model

Table 2 depicts the coefficients and t-statistics for independent variables, which belongs to Model 1. The R-squared value for Model 1 is 0.62. According to model validation -1.1% errors is seen to be associated with Model 1. All structural variables have expected signs and are significant at 1% level. Structural grade, enclosure area, number of storey and lot size all had expected positive effect on house price. Age as expected, have negative effect on house price at 1% level of significance. Age has been known to have quadratic relationship with prices of house, i.e., having negative influence at the beginning but positive effect after a certain age (historic properties), but to keep the models parsimonious linear relation was retained. Structural grade, which accounts for the quality of the house, is seen to have the maximum influence on the house prices among the structural variables.

All neighborhood variables, both socioeconomic and physical were significant. Black population percentage, straight line distance to Baltimore City, presence/absence of commercial parcels within 1km, and percent tree canopy cover within 100m buffers all had expected signs. Black population proportion is seen to have negative effect on house prices as expected. African American population proportion has been known to have negative effect on house prices. Houses with commercial parcels within 1 km saw negative effect to its value. Close presence of commercial parcels could decrease house price due to associated disamenity of high traffic and congestion. The increase in tree canopy at close ranges has been seen to increase property value in recent study (Sander et al., 2010). Increase in tree canopy within 100 m in this model shows positive effect on house price as expected. Within certain distance, a negative relation is understood to exist between house price and distance to CBD (Baltimore City), which holds true. Population density is seen to have a positive relation with house prices, which is unexpected. Education attainment represented as percentage of adults with more than high school diploma has a negative sign, which is also unexpected. With the increase in educational attainment better pay is expected and hence ownership of better and more expensive house is anticipated due to increased purchasing power.

As stated earlier, open space effect in Model 1 is accounted for as proximity measures. Parks do not have significant relation with the house price which is contrary to previous studies. Mean straight line distance to the closest park for the houses in the dataset is 2.04 km, which could partly explain the lack of significant relation of house price and park proximity. Playgrounds on the other hand are seen to have significant positive effect (at 1% level) on house price. Houses with playgrounds within 1 mile are seen to have 1.78% more value. Protected area contrary to expectation shows no significant effect on house price. Storm water retention area is seen to have significant (at 0.1% level) negative effect on house price, as expected. The log transformation of the straight line distance of house to the closest storm water retention area has the estimated coefficient of 0.0196. As the distance to the nearest storm water retention area increases by 1m, the price of the house also increases at the rate of 0.0196%; this effect diminishes with increasing distance. Storm water retention areas are generally smaller structures whose influence diminishes at an increasing rate with distance and hence log transformation of the straight line distance was expected *a priori* to have stronger effect on the house prices. This negative effect of storm water retention area seen on house price may be caused by the disamenity of foul smell and unappealing sight that has been known to be associated with storm water retention area. Lakes were categorized in terms of the presence or absences of piers or boat ramps which are assumed to be proxies for recreational amenity. Lakes were disaggregated due to the lack of significant relation with home prices when undifferentiated. Lakes with piers and boat ramps are seen to have no significant relation with house prices. On the other hand, lakes without such improvements are seen to have significant (at 1% level) positive effect on house prices. The preference of lakes without piers or boat ramps over the ones with these structures can be understood from the model. Increase of home price with lakes with no improvements, may be associated with the amenities (externalities) like pristine scenic vista and privacy. The absence of recreational activities could translate to absence of noise and traffic. As the distance between houses and lakes decreases by 1 m, house price increases by 0.0004%. Golf courses are seen to have significant (at 5% level) negative effect on house price. It is seen that houses with golf courses within 1 km saw drop in price by 3.2%.

Table 3

County open space percent area models

	MODEL 2			MODEL 3			MODEL 4	
Variable	Coef.	t-value	Variable	Coef.	t-value	Variable	Coef.	t-value
Structural								
STRUGRAD	0.146166***	28.28		0.146265***	28.46		0.147517***	28.66
AGE	-0.002691***	-20.04		-0.002735***	-20.4		-0.002732***	-20.29
ENCLS	0.000210***	41.94		0.000209***	42.05		0.000210***	41.98
STRY	0.069073***	11.17		0.068004***	11.03		0.068169***	11.03
LOTSIZE	0.000002***	19.25		0.000002***	19.07		0.000002***	19.05
Neighborhood								
POPDEN	0.000004**	2.57		0.000003*	2.14		0.000004*	2.27
BLKPOP	-0.000747***	-5.96		-0.000722***	-5.73		-0.000733***	-5.76
COLLEGE	-0.001776***	-8.84		-0.001571***	-7.64		-0.001623***	-7.8
DISTCITY	-0.000003***	-6		-0.000003***	-5.92		-0.000003***	-5.69
XDISTCOMM	-0.040981***	-3.62		-0.038659***	-3.41		-0.035183**	-3.05
T100	0.000958***	4.84		0.000726***	3.55		0.000908***	4.48
Area0_100			*Area0_400*			*Area0_800*		
GLF100	-0.000315	-0.22	GLF400	-0.001008	-1.04	GLF800	-0.001790*	-2.15
PRK100	0.000859	1.39	PRK400	0.000318	0.58	PRK800	0.000216	0.41
PLY100	-0.005924	-0.34	PLY400	0.027457	0.76	PLY800	0.014125	0.23
PRT100	-0.000227	-0.7	PRT400	0.000057	0.16	PRT800	-0.000050	-0.13
SWRT100	-0.009709***	-3.82	SWRT400	-0.03416***	-5.37	SWRT800	-0.020326**	-2.74
_cons	11.878370	365.87	_cons	11.885600	366.37	_cons	11.869210	365.29
Observations	5067			5067			5067	
R-squared	0.63			0.63			0.63	
Signif. Codes:	***0.001, **0.01, *0.05			***0.001, **0.01, *0.05			***0.001, **0.01, *0.05	
	Model Validation			Model Validation			Model Validation	
Mean LNPRICE	12.7255			12.7255			12.7255	
Mean Price	336206.22			336206.22			336206.22	
Est. Mean LNPRICE	12.7427			12.7402			12.7437	
Est. Mean Price	342036.23			341200.03			342399.69	
Error	-1.73%			-1.49%			-1.84%	

4.1.2 Percent Area Models

Table 3 depicts the coefficients and t-statistics for independent variables, which belongs to Model 2, Model 3, and Model 4. To reiterate Model 2, Model 3, and Model 4 accounts for open space types as percent area within 100 meters buffer, 400 meters buffer, and 800 meters buffer respectively. Each open space types have distinct characteristics and were expected to have significant effect on house prices at varying neighborhood distance. The three increasing buffer distances were used in an attempt to capture the effects of the multiple open space type under study. Lakes have not been included in these models as percent areas of lakes are assumed to have negligible effect on house prices. The R-squared value for Model 2, Model 3, and Model 4 are all approximately equal to 0.63. According to model validation -1.73%, -1.49%, and -1.84% error is associated with Model 2, Model 3, and Model 4, respectively.

The three models, Model 2, Model 3, and Model 4, which only differs from one another in the buffer distances used for open space percent-area calculations, are discussed together. The effects of control variables of all county percent-area models on house prices are very similar. As with Model 1, the proximity model, structural variables in all three percent-area models are significant at 1% level with expected sign. Structural grade, enclosure area, number of storey, and lot size all had expected positive effect on house price. Age has negative effect on house price at 1% level of significance. Structural grade have the maximum influence on the house prices among the structural variables like in Model 1.

For all percent-area models, neighborhood variables are seen to have significant effect on house price as well. Some neighborhood variables like black population percentage, straight line distance to Baltimore City, presence/absence of commercial parcels within 1km and percent tree canopy cover within 100m buffers have expected signs. Population density and education attainment are seen to have unexpected effect on house prices in all the percent-area models which was also the case in Model 1.

Golf course area within 100 m was expected to have a significant positive effect on house prices as per earlier studies (Do and Grudnitski, 1995; Nicholls, 2002). Percent golf course area within 100 m buffer around house parcels is seen to be insignificant in Model 2. Prior golf course externality valuation studies have determined significant positive value for houses adjacent to golf courses. Percent-area measure of golf course within 100 m buffer of house parcels does not account for their adjacency, which could explain the lack of its significant effect on house price. Percent-area of golf course area within 400 m as seen in Model 3 is not significant and also showed a negative tendency. Golf course area was only seen to have a significant effect on house prices in Model 4. It had negative effect on house prices within 800 m. With 1% increase of golf courses within 800 m, the house lost its value by 0.17% in Baltimore County. Parks percent-areas, though positive are not significant at any buffer distances. Within 100 m playgrounds have negative sign. Percent-area of playgrounds at close proximity was expected to have negative effect on price, which according to Model 2 is seen to be true, although the relationship is insignificant. Surprisingly, protected area in the neighborhood did not have expected significant influence on house prices. Storm water retention area was the only open space type with significant effect on house prices on all three percent-area models. All three models showed expected negative sign for storm water retention area. It also was the open space type that had the strongest effect on price. With 1% increase in storm water retention area within 100m, 400m, and 800m, house value decreased by 0.97%, 0.34% , and 2.03%, respectively. This finding aligns with the anecdotal evidence that storm water retention areas are perceived as an eye sore by homeowners.

Table 4

Monetary value of open space types

COUNTY		
Open Space Types	variables	Price($)
Proximity Model Estimation		
Park	DISTPRK	0.12
Playground	YDISTPLY	5978.41**
Protected	XDISTPRT	1261.78
Storm water retention	LNDISTSWRT	66.06***
Lakes	DISTLKREC	-0.28
	DISTLKNO	-1.34**
Golf courses	XDISTGLF	-10857.11*
Percent Area Models Estimation		
Park	PRK100	288.72
	PRK400	106.84
	PRK800	72.53
Playground	PLY100	-1991.84
	PLY400	9231.07
	PLY800	4749.07
Protected	PRT100	-76.49
	PRT400	19.22
	PRT800	-16.87
Storm water retention	SWRT100	-3264.23***
	SWRT400	-11484.80***
	SWRT800	-6833.73**
Golf courses	GLF100	-106.02
	GLF400	-338.95
	GLF800	-601.81*
Signif. Codes:	***0.001, **0.01, *0.05	

4.1.3 Monetary Value of Open Space Types

Table 4 enlists marginal monetary value associated with each open space types that are grouped according to proximity model estimation and percent area models estimation. Specific attention is given to significant estimations only.

Proximity to parks is seen to have no significant relation to house value. Houses with playgrounds within 1 mile have $5,978.41 premium compared to other houses. Like parks, protected area has no significant effect on houses in terms of proximity. Storm water retention areas have a strong negative externality associated with it. According to the proximity model, for every meter closer a storm water retention area gets, house value diminishes by $66.06 and this effect increases with increasing proximity. Lakes with recreational amenities did not have significant effect on house prices in terms of proximity. While lakes without any improvements are seen to be valued by homeowners, houses getting 1 meter closer to these lakes are seen to have the value go up by $1.34. Golf courses are seen to have significant negative effect on house value. Houses with golf courses within 1 km were seen to have $10,857.11 less value.

For percent-area models no significant relation is seen with park, playground, and protected area variables. As with proximity model, storm water retention areas have a significant negative externality. According to percent-area models, increase of storm water retention area by 1% within 100m, 400m, and 800m results in house price to decrease by $3,264.23, $11,484.80, and $6,833.73 respectively. Golf courses are seen to have negative effect on house value in all percent area models, while significant only for

800m percent-area model. Within 800m buffer, 1% increase on golf course area means the loss of house value by $601.81 in Baltimore County.

Table 5

Urban and rural open space proximity models

	MODEL 1.U			MODEL 1.R	
Variable	Coef.	t-value	Variable	Coef.	t-value
Structural					
STRUGRAD	0.1526703***	27.04		0.1186711***	8.97
AGE	-0.0024585***	-16.72		-0.0043296***	-13.02
ENCLS	0.0002101***	38.95		0.0002107***	16.76
STRY	0.0751263***	11.25		0.024104	1.58
LOTSIZE	0.00000179***	15.57		0.00000262***	11.94
Neighborhood					
POPDEN	0.00000399*	2.48		0.000018	0.68
BLKPOP	-0.0007206***	-5.15		-0.000741	-1.05
COLLEGE	-0.0013787***	-5.9		-0.001373	-1.51
DISTCITY	-0.00000521***	-5.39		0.000000	-0.1
XDISTCOMM	-0.0529904**	-3.11		-0.013293	-0.86
T100	0.000659527**	2.67		0.00094003**	2.66
Distance			*Distance*		
DISTPRK	0.000000	-0.11	DISTPRK	-0.000001	-0.36
YDISTPLY	0.019715**	2.77	DISTPLY	0.000002	1.27
DISTPRT	-0.000002	-0.15	XDISTPRT	0.076488*	2.04
LNDISTSWRT	0.016523***	3.84	DISTSWRT	0.000017*	2.4
DISTLKREC	-0.000001	-1.36	DISTLKREC	-0.000002	-0.56
DISTLKNO	-0.000003*	-2.15	LNDISTLKNO	-0.028136*	-2.37
XDISTGLF	-0.049751**	-3.16	DISTGLF	0.000004	1.71
_cons	11.764220	234.42	_cons	12.133640	84.07
Observations	4271			796	
R-squared	0.62			0.60	
Signif. Codes:	***0.001, **0.01, *0.05			***0.001, **0.01, *0.05	
	Model Validation			Model Validation	
Mean LNPRICE	12.7387			12.6549	
Mean Price	340663.34			313279.17	
Est. Mean LNPRICE	12.7547			12.7337	
Est. Mean Price	346185.06			338984.79	
Error	-1.62%			-8.21%	

4.2 Urban and Rural Models

For this section, all references are made to urban and rural models represented in Table 5, Table 6, and Table 7. Table 5 consists of two hedonic models that accounts for open space types inside the URDL (urban) and outside the URDL (rural) using only proximity variables. Table 6 contains three models that account for open space types in urban area as percent area within 100 m buffer, 400 m buffer, and 800 m buffer respectively. Table 7 does the same, but for rural Baltimore County. Sample size for urban area is 4271, while for rural area it is 786. All urban models are found to be very similar to the corresponding county models. This similarity between county and urban models can be attributed to the fact that urban sample consists of 84.29% of the county sample dataset.

4.2.1 Proximity Models

Table 5 depicts Model 1.U and Model 1.R that account for proximity effect of open space types within urban area and rural area respectively. The R-squared value for Model 1.U is 0.62, while R-squared value for Model 1.R is 0.60. According to model validation -1.62% and -8.21% error is associated with Model 1.U and Model 1.R respectively. For Model 1.R, a very high error of -8.21% may be explained by its small sample size.

For urban area the coefficient estimates of all structural variables have expected signs and are significant at 1% level. All rural structural variables follows suite except for STRY variable which accounts for number of storey; it has expected positive sign but is found to have statistically insignificant effect on house prices. Number of storey for rural houses does not have as big of an influence on their prices compared to urban houses. This may be explained by the fact that rural parcels are larger and is not restricted to building multiple storey houses to accommodate residents. Mean rural parcel area for this dataset is 86,622.76 sq. ft. compared to 12,391.69 sq. ft. for urban parcels.

All neighborhood variables, both socioeconomic and physical, were significant for urban area. Black population percentage, straight line distance to Baltimore City, presence/absence of commercial parcels within 1km, and percent tree canopy cover within 100m buffers all had expected signs. As with county models the population density and education attainment variables were significant but with unexpected signs. For rural area only percent tree canopy within 100m buffer was significant with expected sign. Although insignificant, most rural neighborhood variables had the same sign as urban ones. Only straight line distance to CBD, Baltimore City, had opposite signs. Rural house price is definitely not affected by its proximity to Baltimore city as estimated coefficient of linear distance to CBD is zero. This may be explained by the fact that rural Baltimore County is considerably far from Baltimore City, and the rural house prices are well beyond the influence of Baltimore City in terms of proximity.

What follows is a discussion on the difference or similarity of open space type values between urban and rural area according to the proximity models in Table 4. For both areas proximity to parks is not significant to house price, which is unexpected more so for urban area. Playgrounds are seen to have significant influence on price for urban area, while no significant influence on rural house price. Urban houses with playgrounds within 1 mile radius cost 1.97% more than other urban houses. Protected area is seen to be significant for rural houses only. Rural area houses within 1 km of protected area were 7.6% more expensive compared to other rural houses. Proximity to storm water retention area was significant for both urban and rural houses. Storm water retention area, as expected had negative effect on both urban and rural house price, but in different ways. For every meter the storm water retention area gets closer, price of urban houses decreases 1.65%, this effect increases with increasing proximity. While for rural area, for every meter storm water retention area gets closer, house price decreases by 0.0017%. The preference of lakes without piers or boat ramps over ones with these structures is seen to be true, for both urban and rural areas. Distances to lakes with no recreational amenities like piers and boat ramps are significant (at 5% level) to house prices, for both urban and rural areas. For rural area, log of the shortest straight line distance to lakes with no improvements had the higher significance compared to linear distance variable, while linear relation is retained for urban area. Golf course proximity was significant to only urban houses. Urban houses with golf courses within 1 km had 4.9% less value. Although insignificant, increasing proximity of golf courses is seen to decrease rural house price as well.

Table 6

Urban open space percent area models

	MODEL 2.U			MODEL 3.U			MODEL 4.U	
Variable	Coef.	t-value	Variable	Coef.	t-value	Variable	Coef.	t-value
Structural								
STRUGRAD	0.151213***	27.03		0.151309***	27.19		0.153234***	27.52
AGE	-0.002454***	-16.72		-0.002497***	-17.07		-0.002492***	-16.97
ENCLS	0.000211***	38.95		0.000211***	39.03		0.000211***	38.96
STRY	0.075943***	11.32		0.074950***	11.21		0.074989***	11.19
LOTSIZE	0.000002***	15.87		0.000002***	15.65		0.000002***	15.55
Neighborhood								
POPDEN	0.000004**	2.88		0.000004*	2.43		0.000004**	2.6
BLKPOP	-0.000728***	-5.68		-0.000721***	-5.59		-0.000742***	-5.68
COLLEGE	-0.001516***	-6.79		-0.001339***	-5.9		-0.001299***	-5.62
DISTCITY	-0.000005***	-5.86		-0.000005***	-5.41		-0.000005***	-5.45
XDISTCOMM	-0.053113***	-3.18		-0.055203***	-3.31		-0.047574**	-2.84
T100	0.000730**	2.94		0.000491	1.93		0.000647*	2.54
Area0_100			*Area0_400*			*Area0_800*		
GLF100	-0.001434	-0.78	GLF400	-0.002453*	-2.17	GLF800	-0.003526***	-3.54
PRK100	0.000467	0.61	PRK400	-0.000297	-0.38	PRK800	-0.000218	-0.26
PLY100	-0.001086	-0.06	PLY400	0.035852	0.97	PLY800	0.064840	1.02
PRT100	0.000147	0.27	PRT400	0.000638	1.03	PRT800	0.000137	0.21
SWRT100	-0.009946***	-3.81	SWRT400	-0.03253***	-4.7	SWRT800	-0.015918	-1.69
_cons	11.861130	316.52	_cons	11.870140	317.13	_cons	11.846120	316.8
Observations	4271			4271			4271	
R-squared	0.63			0.63			0.63	
Signif. Codes:	***0.001, **0.01, *0.05			***0.001, **0.01, *0.05			***0.001, **0.01, *0.05	

	Model Validation	Model Validation	Model Validation
Mean LNPRICE	12.7387	12.7387	12.7387
Mean Price	340663.34	340663.34	340663.34
Est. Mean LNPRICE	12.7497	12.7503	12.7515
Est. Mean Price	344459.53	344651.97	345074.30
Error	-1.11%	-1.17%	-1.29%

Table 7
Rural open space percent area models

Variable	MODEL 2.R Coef.	t-value	Variable	MODEL 3.R Coef.	t-value	Variable	MODEL 4.R Coef.	t-value
Structural								
STRUGRAD	0.119099***	8.93		0.117566***	8.83		0.119165***	8.93
AGE	-0.004246***	-12.73		-0.004237***	-12.7		-0.004256***	-12.74
ENCLS	0.000206***	16.08		0.000207***	16.27		0.000206***	16.11
STRY	0.023960	1.55		0.023199	1.5		0.024107	1.56
LOTSIZE	0.000002***	11.12		0.000002***	11.1		0.000002***	11.29
Neighborhood								
POPDEN	0.000031	1.22		0.000028	1.11		0.000030	1.18
BLKPOP	-0.001243	-1.78		-0.001139	-1.63		-0.001029	-1.45
COLLEGE	-0.003314***	-4.56		-0.003027***	-4.11		-0.003034***	-4.11
DISTCITY	-0.000004**	-3.16		-0.000003**	-2.86		-0.000003**	-2.71
XDISTCOMM	-0.023761	-1.52		-0.022463	-1.41		-0.018812	-1.16
T100	0.001095**	3.08		0.000954**	2.66		0.001008**	2.85
Area0_100			*Area0_400*			*Area0_800*		
GLF100	0.003067	1.33	GLF400	0.003910*	2.12	GLF800	0.002272	1.49
PRK100	0.003244*	2.5	PRK400	0.001026	1.12	PRK800	0.001228	1.57
PLY100	-0.156031*	-2.15	PLY400	0.090505	0.36	PLY800	-0.480648	-1.24
PRT100	-0.000418	-1.04	PRT400	-0.000149	-0.35	PRT800	-0.000029	-0.06
SWRT100	0.020706	1.22	SWRT400	-0.026074	-1.09	SWRT800	-0.008110	-0.57
_cons	12.216460	129.58	_cons	12.202340	129.19	_cons	12.185010	128.04
Observations	796			796			796	
R-squared	0.62			0.61			0.61	
Signif. Codes:	***0.001, **0.01, *0.05			***0.001, **0.01, *0.05			***0.001, **0.01, *0.05	
	Model Validation			Model Validation			Model Validation	
Mean LNPRICE	12.6549			12.6549			12.6549	
Mean Price	313279.17			313279.17			313279.17	
Est. Mean LNPRICE	12.6497			12.6677			12.6646	
Est. Mean Price	311668.41			317323.77			316344.15	
Error	0.51%			-1.29%			-0.98%	

4.2.2 Percent Area Models

Table 6 and Table 7 depict three percent area models each for urban and rural area, respectively. Table 6 contains urban area models, Model 2.U, Model 3.U, and Model 4.U, which accounts for open space types as percent area within 100 m buffer, 400 m buffer, and 800 m buffer respectively. Table 7 contains corresponding rural area models, Model 2.R, Model 3.R, and Model 4.R. Like the county percent area models R-squared value for Model 2.U, Model 3.U, and Model 4.U are all approximately equal to

0.63, while R-squared value for Model 2.R, Model 3.R and Model 4.R are equal to 0.62, 0.61, and 0.61 respectively. According to model validation, the errors for urban percent area models range from -1.29% to -1.11%, while for rural percent area models range from -1.29% to 0.51%.

All corresponding control variables, excluding percent tree canopy, for each urban percent area models (Model 2.U, Model 3.U, and Model 4.U) have similar effect on house prices. All structural variables are significant with expected signs. The neighborhood variables are significant also, except tree canopy area within 100 m in Model 3.U. Like in county models population density and education attainment are seen to have unexpected signs. For each rural percent area models (Model 2.R, Model 3.R, and Model 4.R) the structural variables except number of storey are significant with expected sign. While for neighborhood attributes, only educational attainment, distance to CBD and percent tree canopy within 100 m are significant.

What follows is a discussion on the differences or similarities of open space type values between urban and rural area according to the percent area models in Table 6 and Table 7. Golf course area in the urban neighborhood is seen to have negative effect on home prices. Golf course area within 100 m buffer is insignificant, while for percent golf course area within 400m and 800m the negative relation are significant. Unlike urban areas, golf courses are seen to have positive effect to house prices in rural areas, although it is significant only within 400 m buffer. Golf courses in rural area may not be associated with the same magnitude of traffic and congestion as urban golf courses, which could explain the differing perspective on values of golf courses noted above. The effect of parks on house price is seen to be significant (at 5% level) only for rural houses within 100m of the parks. The magnitude of significant coefficient of percent area within 100 m in rural area is 0.03244. This translates to 3.24% increase in marginal house price with 1% increase in park area within 100m buffer for rural houses. Parks are thought to be more valuable to urban dwellers due to the limited open space available in urban areas compared to rural setting, but urban parks are also known to be associated with negative externalities like crime and reduced privacy due to increased traffic (Troy and Grove 2008). Moreover, for Baltimore County the parks within urban areas are scattered and smaller in size compared to large contiguous parks in the rural areas. The mean size of parks within urban area is 6.26 acres whereas; the rural parks have a mean size of 319.46 acres, which could in-part, explain this difference in perception between urban and rural resident on parks. Like the parks, playground areas in the neighborhood are seen to have a significant effect on rural area only. For rural parts of the county, playgrounds are seen to have a significant (5% level) negative impact on the value of houses when they are at close proximity of 100m. The house prices drop by 15.6% for 1% increase in playground area within 100m area surrounding the house parcel. The recreational amenity that playgrounds provide is likely overridden by the associated disamenities of noise and loss of privacy. Protected open space includes easements, parks, and other public lands. All protected areas are undevelopable lands. Contrary to prior studies (Irwin, 2002; Geoghegan, 2002), undevelopable areas i.e. protected area in the neighborhood did not show expected significant influence on both urban and rural house value. Two models, Model 2.U and Model 3.U, detected significant storm water area influence on house prices for urban area, while no percent-area model did for rural. Storm water retention area had negative effect on urban house prices. For each of the chosen buffer distances the mean percent storm water area in urban area are higher compared rural area, which suggests that storm water retention area are more prevalent within the URLD. The higher presence of storm water retention area in urban area neighborhood may explain its significant negative effect on house price, which is missing for rural houses.

5. SUMMARY

The paper achieves the objective of estimating the values of different open space types using hedonic pricing method. Different proximity treatments (presence/absence within 1km, presence/absence within 1 mile, and straight line distance) were modeled to detect the effect on house prices in Baltimore County. Percent area of these open space types within close proximity of 100m, 400m, and 800m were also modeled assuming the changes in their area would be important within 800m only. Monetary values of open space types for the county were estimated. The assumption that reaction of house values to each open space types being distinct is reaffirmed. Furthermore, the differences and similarities in perception of open space between rural and urban homeowners in Baltimore County are clearly demonstrated using urban and rural models. For house prices, storm water retention areas can be argued to be the most pervasive influence, especially in urban areas. It was significantly reactive in all urban models and had negative sign in all the models. This reaffirms the existence of the negative perception that people have on storm water retention area.

Increasing the sample size by using data from multiple years would definitely improve this study. Inclusion of spatial configuration indices (fragmentation index & diversity index) like Geoghegan et al. (1997) for neighborhood open space types could be an added dimension to gain better insight on open space value. Also, using proximity measured as street network distance, in addition to euclidian distance could add more to this study. Studies focusing on single open space types that were most reactive in the 12 models studied, like storm water retention area and lakes without developments, seem to be an obvious extension to this study for Baltimore County. Studies dealing with single open space type decrease the complexity of dealing with multiple open space types and hence a more detailed investigation on the value of particular open spaces can be done.

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