THE EFFECT OF OPEN SPACES ON A HOME'S SALE PRICE

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The relationship between a home's sale price and its proximity to different open spaces types is explored using a data set comprised of single-family home sales in the city of Portland, within Multnomah County, between 1990 and 1992. Homes located within 1,500 feet of a natural area park, where more than 50% of the park is preserved in native and/or natural vegetation, are found to experience, on average, the largest increase in sale price. The open space size that maximizes a home's sale price is calculated for each open space type. Natural area parks require the largest acreage to maximize sale price, and specialty parks are found to have the largest potential effect on a home's sale price. A zonal approach is used to examine the relationship between a home's sale price and its distance to an open space. Natural area parks and specialty parks are found to have a positive and statistically significant effect on a home's sale price for each zone studied. Homes located adjacent to golf courses (within 200 feet) are estimated to experience the largest increase in sale price due to open space proximity although the effect drops off quickly as distance from the golf course increases. (*JEL* Q2, R14)

I. INTRODUCTION

Throughout the United States, local, state, and federal government agencies are proposing and implementing plans to preserve open spaces. In 1998, voters in 26 states approved 124 open space ballot measures, raising more than $5 billion (Pritchard, 2000). In 1995, residents of Portland, Oregon, passed a ballot measure that raised $135.6 million to purchase open spaces. To date, almost 6,000 acres have been acquired.

Open spaces can include parks, golf courses, and cemeteries. The characteristics of these areas, such as the breadth of recreation opportunities and acreage, can vary dramatically both within and across open space types. This article seeks to estimate the effect on a home's sale price resulting from proximity to different open space types. Additionally, the size of each open space type that maximizes the sale price of a home is also determined.

Numerous studies use the hedonic price technique (Mahan et al., 2000; Bolitzer and Netusil, 2000; Do and Grudnitski, 1995; Frech and Lafferty, 1984; Correll et al., 1978; Weicher and Zerbst, 1973) to investigate the relationship between a home's sale price, or assessed value, and its proximity to an open space.

Frech and Lafferty (1984) estimate that actions taken by the California Coastal Commission to preserve open spaces raised home values in their study area by at least $990 and in some cases by as much as $5,043 (1975 dollars). Do and Grudnitski (1995) conclude that homes abutting a golf course experience an increase in sale price of 7.6%. Bolitzer and Netusil (2000), focusing on Portland, Oregon, estimate that homes located within 1,500 feet of a public park sell for $2,262 more than homes located more than 1,500 feet from any open space; the effect for homes within 1,500 feet of a golf course is estimated to be $3,400 (1990 dollars).

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Mahan et al. (2000) present a detailed analysis of the relationship between a home's sale price and wetlands in Portland, Oregon. The authors estimate that increasing the size of the nearest wetland by one acre increases a home's sale price by $24 (1994 dollars) and reducing the distance to the nearest wetland by 1,000 feet increases a home's sale price by $436. Wetland type is not found to have a statistically significant effect on a home's sale price.

Studies have also found a negative relationship between open spaces and a home's sale price. Weicher and Zerbst (1973), focusing on five parks in Columbus, Ohio, find that homes facing a heavily used recreation area in one park sold for $1,150 less than properties one block away from the park. Negative externalities due to open space proximity are also discussed in Li and Brown (1980).

This article extends the existing literature by breaking apart the catch-all "park" category into three new categories—urban park, natural area park, and specialty park/facility—that are based on a park's characteristics. The determination of the open space size that maximizes a home's sale price, and how this varies across open space types reflects an additional contribution. Authors commonly include a measure of the open space size in the regression equation but not in a quadratic form. The study by Rosenberger and Walsh (1997) that values Western valley ranchland using contingent valuation represents an exception.

The estimates presented in this article reflect the benefit of preserving open spaces as transmitted through the housing market, that is, the authors are able to capture "private" benefits using the statistical technique presented herein. Benefits from preserving open spaces that have strong "public good" elements, such as reduced soil erosion, wildlife habitat, and improved water quality, will not be captured using this technique.

The next section provides an overview of hedonic price theory and the functional form used in the statistical analysis. An overview of the study area and data is presented in section III. Results are discussed in section IV; conclusions are in section V.

II. HEDONIC PRICE THEORY AND FUNCTIONAL FORM

Hedonic price theory views a home as a bundle of attributes, primarily, its structural and environmental characteristics as well as the attributes of the surrounding neighborhood (Freeman, 1993). These attributes, in combination, determine the sale price of a home.

Assuming a single competitive housing market, the relationship between a home's sale price and its attributes can be represented by the hedonic price function

$$P_i = P(S_i, Q_i, N_i), \tag{1}$$

where P_i represents the price of the ith home, S_i is a vector of structural characteristics, Q_i is a vector of environmental characteristics, and N_i is a vector of neighborhood characteristics. The partial derivative of the hedonic price function with respect to a specific attribute represents the marginal implicit price of that attribute holding all other factors constant.

Economic theory provides no guidance on an appropriate functional form for the hedonic price function, although it is generally acknowledged that the equation should be nonlinear (Freeman, 1993). The Box-Cox transformation yields an implicit attribute price that depends on the attribute's level as well as the level of other attributes.

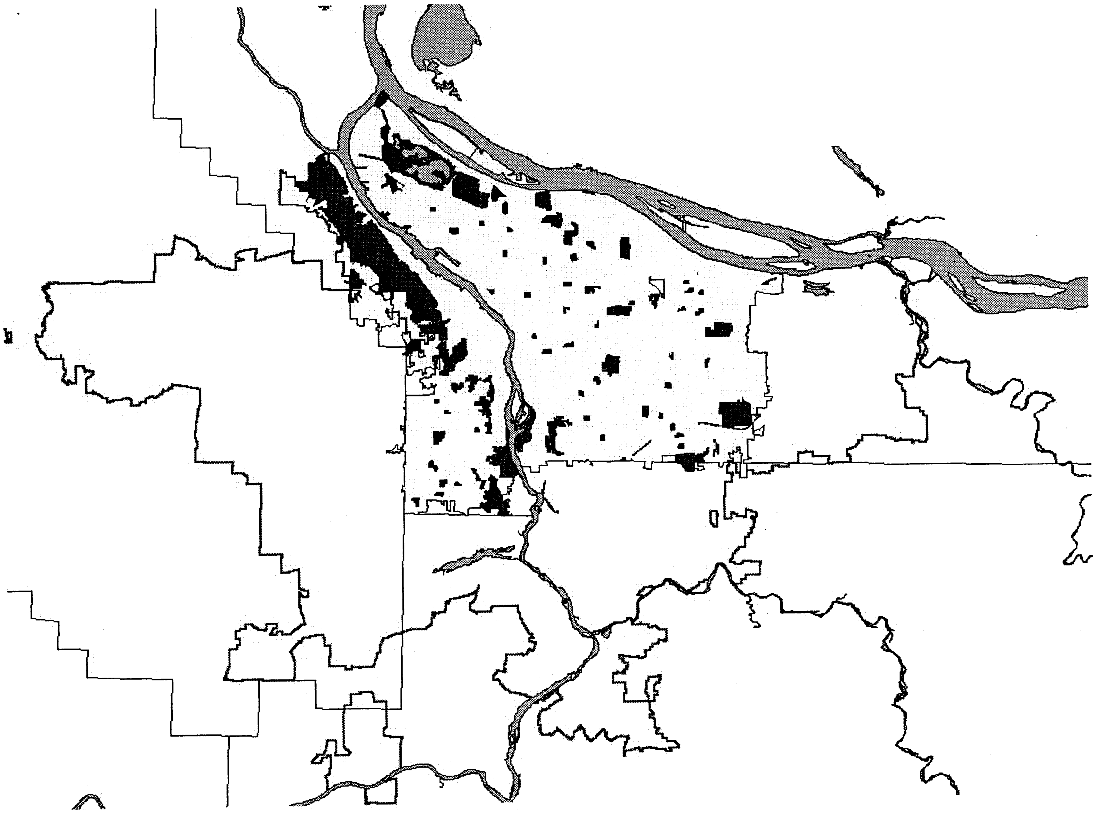
Cropper et al. (1988) suggest simpler functional forms (linear, semi-log, double-log) or more complex forms (linear Box-Cox) when certain variables are not observed or are replaced by a proxy. Recent applications, drawing on the work of Cropper et al. (1988), have primarily used Box-Cox models or have used Box-Cox models to inform their choice of functional form (Streiner and Loomis, 1995; Mahan et al., 2000; Kulshreshtha and Gillies, 1993). The flexibility of the Box-Cox model, and the lack of theoretical guidance on an appropriate function form, makes it an attractive model for estimating hedonic price functions.

The results presented in this article are based on a hedonic price function that is estimated using a Box-Cox transformation of the dependent variable:

$$y^{(1)} = (y^1 - 1)/1; \tag{2}$$

$$y_i^1 = b_0 + b_1 x_{1i} + \cdots + b_k x_{ki} + e_i. \tag{3}$$

FIGURE 1
City of Portland within Multnomah County with Major Rivers and Open Spaces



The maximum likelihood value for λ is estimated using equation (3); this value is used to estimate the parameters of the model using ordinary least squares.

III. DATA

The Portland metropolitan area (Figure 1) covers approximately 460 square miles and is highly urbanized. The study area includes the section of the city of Portland located within Multnomah County, an area of approximately 145 square miles that contains the most urbanized portions of the Portland metropolitan area.

The city of Portland is divided into five quadrants. The northwest quadrant of Portland is divided by the Willamette River, which flows north into the Columbia River. Streets east of the Willamette are labeled "North," and those west of the river are labeled "Northwest." Residents of southwest (SW) and northwest (NW) Portland have a higher income profile than residents of north (N), northeast (NE), and southeast (SE) Portland.

The data set consists of 16,636 single-family home sales in the city of Portland within Multnomah County for 1990, 1991, and 1992 and includes home characteristics such as the number of bathrooms, lot acreage, house total square footage, and age. Metro's Regional Land Information System Geographic Information System database was used to compute the distance from each house to the central business district, and the distance, up to 1,500 feet, to the nearest open space.

Home sale prices were adjusted to 1990 dollars using a housing price index constructed from data on the median home sale price for homes located in Multnomah County during the study period. Homes selling for less than their assessed land value and observations with obvious recording errors were deleted from the data set. Summary

TABLE 1
Summary Statistics for Home Characteristics

Variable	Mean	Standard Deviation	Minimum	Maximum
Real price (1990 dollars)	$66,198	$49,243	$3,846	$949,554
Age (years)	51.29	24.91	0	119
Fireplaces	0.90	0.71	0	9
Bathrooms	1.29	0.54	1	8
Total square footage	1,396	582	304	13,311
Lot acreage	0.16	0.16	0.01	7.2

statistics for homes in the data set are presented in Table 1.

Open spaces were assigned into one of five categories: urban parks, natural area parks, specialty parks/facilities, golf courses, and cemeteries. Definitions for the first three categories are provided in Table 2.

In total, 201 open spaces were identified in the study area. The majority of these open spaces are urban parks. The number of homes within 1,500 feet of the different open space types, the mean open space acreage, standard deviation, minimum, and maximum values are presented in Table 3. Open space summary statistics are calculated with respect to the number of homes within 1,500 feet of a specific open space type.

IV. RESULTS

Two models were estimated to explore the relationship between open spaces and a home's sale price. In the first model, dummy variables were created to reflect homes located within 1,500 feet of one of the five open space types. Interactive variables for acreage and acreage squared by open space type were also created. Results are presented in Table 4.

Coefficients on the explanatory variables were as expected and are consistent with prior results. Bathrooms, fireplaces, and house total square footage are positive and statistically significant, but age and heavy traffic noise, as compared to light traffic noise, are negative and statistically significant. Quadrant by central business district interactive dummy variables show signs that conform to expectations. Quadrants that are on Portland's east side show a decline in a home's sale price as distance from the central business district increases, whereas NW and SW quadrants show an increase in home

TABLE 2
Definition of Open Space Categories

Open Space Type	Definition
Urban park	More than 50% of the park is manicured or land scaped and developed for nonnatural resource dependent recreation (e.g., swimming pools, ball fields, sports courts).
Natural area park	More than 50% of the park is preserved in native and/or natural vegetation. Park use is balanced between preservation of natural habitat and natural resource–based recreation (e.g., hiking, wildlife viewing, boating, camping). This definition includes parcels managed for habitat protection only, with no public access or improvements.
Specialty park/facility	Primarily one use at the park and everything in the park is related to the specialty category, e.g., boat ramp facilities.

Source: Waiwaiole, personal communication.

TABLE 3
Summary Statistics for Open Spaces

Open Space	Number of Homes Within 1,500 feet	Number of Open Spaces	Mean Open Space Acreage	Standard Deviation (acres)	Minimum (acres)	Maximum (acres)
Cemetery	659	15	110.93	15.63	0.9	58.9
Urban park	7, 070	115	19.89	36.71	0.38	195.66
Natural area park	1, 093	34	78.21	155.88	0.03	645
Golf course	497	8	168.81	38.27	25.8	232
Speciality park/facility	741	29	7.21	19	0.18	175

TABLE 4
Estimated Coefficients—Open Space Dummy Variables

Variable	Estimated Coefficient	t-Statistic	Marginal Implicit Price (1990 dollars)
Bathrooms	0.2178*	11.88	$4,097.65
Age (years)	−0.00726*	−19.56	−136.63
Fireplaces	0.4690*	36.10	8,824.52
Home total square footage	0.00137*	79.10	25.71
Lot acreage	0.4870*	9.59	9,163.61
Average traffic noise	−0.0379	−1.26	−713.21
Heavy traffic noise	−0.2786*	−6.43	−5,242.47
*E*CBD*	−1.07*E*-6	−0.18	−0.02
*N*CBD*	−4.96*E*-5*	−33.27	−0.93
*NE*CBD*	−3.33*E*-6*	−3.50	−0.06
*NW*CBD*	4.77*E*-5*	19.17	0.90
*SE*CBD*	−1.95*E*-6**	−2.03	−0.04
*SW*CBD*	3.07*E*-5*	24.55	0.58
Cemetery	0.04561	0.797	858.24
Urban park	−0.1154*	−5.31	−2,171.93
Natural area	0.3332*	7.44	6,269.17
Golf course	−2.475*	−3.12	−46,567.59
Specialty park/ facility	0.1287*	2.93	2,421.64
Cemetery acreage	−0.00333	−.394	−62.82
Urban park acreage	0.00970*	8.24	182.57
Natural area acreage	0.00351*	4.14	66.16
Golf course acreage	0.0349*	3.89	655.77
Specialty park/facility acreage	0.0247*	5.69	463.95
Cemetery acreage^2	1.77*E*-4	1.09	3.32
Urban park acreage^2	−3.13*E*-5*	−5.26	−0.62
Natural area acreage^2	−7.03*E*-6*	−5.13	−0.13
Golf course acreage^2	−1.03*E*-4*	−4.20	−1.94
Specialty park/facility acreage^2	−1.13*E*-4*	−3.34	−2.12
Constant	17.60*	446.89	
Number of observations 16,636; $\lambda = 0.1005^*$; adjusted $R^2 = 0.658$			

*,**,***denote significance at the 0.01, 0.05, and 0.10 levels, respectively. CBD = central business district.

sale price with increasing distance from the central business district.

The effect on a home's sale price of being within 1,500 feet of an open space is composed of three factors—the open space type dummy variable and two interactive variables, acreage and acreage squared by open space type. The estimated effect of being within 1,500 feet of an open space was evaluated using the mean acreage of each open space type (Table 3) in the data set. Results show that natural area parks, on average, have the largest statistically significant effect (1% level) of $10,648 in 1990 dollars, on a home's sale price holding all other factors constant. Golf courses ($8,849), specialty parks/facilities ($5,657), and urban parks ($1,214) are also found to have a positive and statistically significant effect (all at the 1% level); cemeteries, on average, do not have a statistically significant effect on a home's sale price.

The quadratic form for the acreage variable allows the open space size that maximizes a home's sale price to be calculated. The size of a natural area park that maximizes a home's sale price is estimated to occur at 258 acres—the largest size of the open space types studied. Golf courses were the second largest at 169 acres, followed by urban parks at 148 acres, and specialty parks/facilities at 112 acres. The optimal size of a cemetery was estimated to be negative eight acres. The quadratic function estimated for each open space type, the mean acreage of each open space type, and the estimated effect on a home's sale price in the study area (*), are displayed in Figure 2.

Though natural area parks require the largest acreage (258 acres) to attain the maximum impact on a home's sale price, the largest effect on a home's sale price is estimated to occur for homes located within 1,500 feet of a 112-acre specialty park/facility. The size of specialty parks, urban parks, and natural areas are below the acreage that would maximize the impact on a home's sale price—the mean size of specialty parks, 7.21 acres, is the *smallest* of the open space types in the study area. The maximum acreage impact for a golf course, 169 acres, is virtually identical to the mean golf course size in the study area, 168.81 acres.

A second model was estimated to determine if distance to an open space affects a home's sale price. Dummy variables were

FIGURE 2

Open Space Acreage and Home Sale Price ($1990)

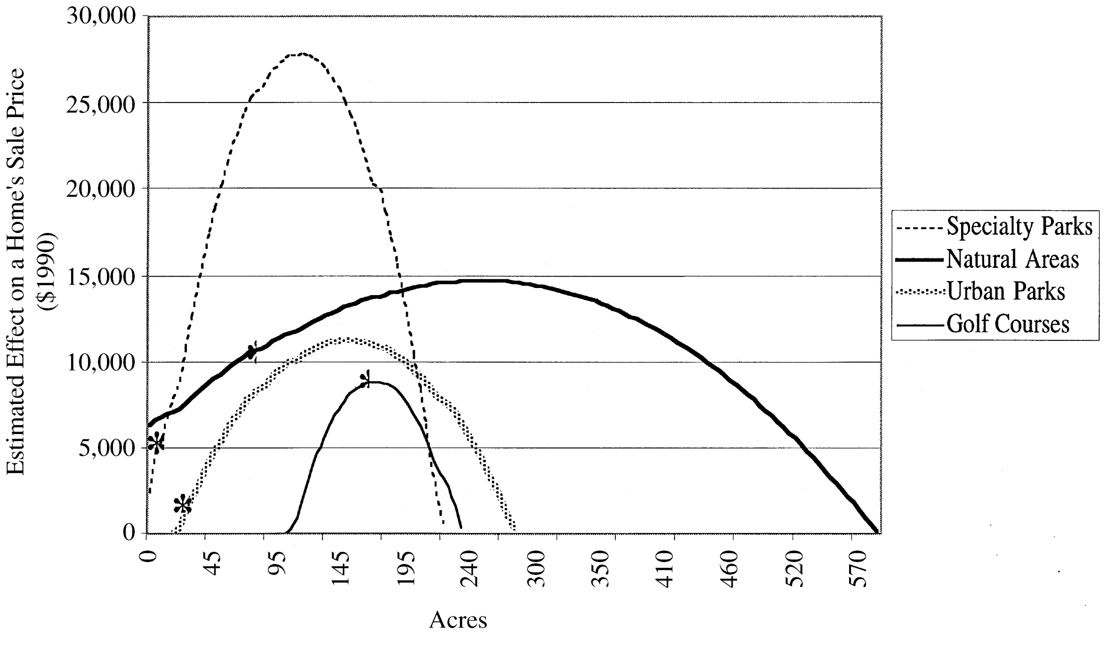


TABLE 5
Distance Variables Evaluated at the Mean Open Space for each Open Space Type (1990 Dollars)

Variable	Urban Park	Natural Area Park	Golf Course	Speciality Park/Facility
Distance ≤ 200	$1,926***	$11,210*	$13,916*	$7,396***
Distance 201–400	2,061*	10,216*	7,851*	5,744**
Distance 401–600	1,193***	12,621*	2,814	10,283*
Distance 601–800	817	11,269*	8,842*	5,661*
Distance 801–1,000	943	8,981*	8,898*	4,972*
Distance 1,001–1,200	1,691*	8,126*	4,391***	4,561*
Distance 1,201–1,500	342	9,980*	4,366**	t3,839*

Number of observations 16,747; $\lambda = 0.0995^*$; adjusted $R^2 = 0.656$

*, **, ***denote significance at the 0.01, 0.05, and 0.10 levels, respectively.

created to reflect the interaction between seven different zones that range in size from 200 to 300 feet and the open space types. Home and neighborhood variables used in the first model were retained for the second model, except the traffic (nuisance) variables, a possible negative externality from open space proximity that is captured by the interactive zone and open space dummy variables, were dropped. The estimated effect of home and neighborhood characteristics were virtually identical to those reported in Table 4.[1] Estimates of the relationship between a home's sale price and distance to an urban park, natural area park, golf course, and specialty park/facility, evaluated at the mean open space size in the study area, are presented in Table 5.

The estimated effects are composed of three factors—the open space type variable interacted with distance, and acreage and acreage squared interacted with open space type. Effects were calculated using the mean acreage of each open space type (Table 3) in the data set. Natural area parks and specialty parks/facilities are found to have a positive and statistically significant effect on a home's sale price for all seven zones. Urban parks have a positive and statistically significant effect for homes located up to 600 feet and within 1,001 and 1,200 feet of the park, but no statistically significant effect for the other distances. Homes adjacent (within 200 feet) of a golf course are estimated to experience the largest effect ($13,916), although the impact drops quickly as distance from the golf course increases. These results are consistent with Do and Grudnitski (1995).

V. CONCLUSIONS

Empirical results indicate that open spaces in the city of Portland, within Multnomah County, have a statistically significant effect on a home's sale price although the effect varies by open space type and with the distance from the home to the open space. Natural area parks are estimated, on average, to have the largest statistically significant effect on a home's sale price. Golf courses, specialty parks/facilities, and urban parks are also found to have a positive statistically significant effect on a home's sale price. The zonal approach provides further insights. In addition to having the largest average effect on a home's sale price, proximity to natural area parks are found to have a positive and statistically significant effect on homes that are up to 1,500 feet from these areas. Though other open space types also have a positive and statistically significant effect on a home's

1. The marginal implicit price of the jth attribute is calculated as follows:

$$(\partial p/\partial x_j)\left\{(1/\lambda)\left[\lambda\left(\alpha+\sum_{j=1}^{j}\beta_j\bar{X}_j\right)+1\right]^{\frac{1i}{\lambda}-1}\right\}\lambda\beta_j,$$

where $\bar{X}_j$ is the mean of attribute j, α is the intercept, and β_j is the estimated coefficient for attribute j.

2. For clarity of presentation, the results for cemeteries, which are not statistically significant, are not reported. Full results are available from the authors.

sale price, the magnitude and "reach" of natural area parks is unique.

Evidence that proximity to an open space will decrease a home's sale price is not found for the study area—all open space types are estimated to have a positive statistically significant effect for homes that are adjacent (within 200 feet) of the open space. However, the estimated effect of being adjacent to an urban park, where negative externalities are usually perceived to be a problem, is the smallest of the open space types.

New acquisitions purchased with funds raised under a $135.6 million ballot measure to preserve open spaces in the Portland metropolitan area are classified primarily as natural areas. The target size for natural areas within Portland's urban growth boundary is a minimum of 400 acres—larger than what is estimated to maximize a home's sale price in our model, but a size that has a large effect on a home's sale price. From the viewpoint of biological diversity, however, "bigger is better" for urban natural area parks. If residents within at least 1,500 feet of these newly preserved natural areas did not anticipate their preservation, we should expect the sale price of homes in proximity to these areas to increase. To the extent that assessed values reflect market values, we should anticipate assessed values and, depending on the tax structure, property tax revenues to also increase. This raises the interesting possibility that Metro's preservation of these natural areas may be partially self-financing. The difficulty remains in disentangling the effect of open space preservation from other changes in the market, for example, increases in population, changing preferences, and so on. The annual cost associated with maintaining these areas is also difficult to estimate and will likely vary from site to site.

The results of this analysis provide important but limited insight into the total benefits of preserving open spaces because the technique employed captures benefits as transmitted through the housing market. Benefits that have a strong public good element are unlikely to be captured using this technique. Results, however limited, suggest that large private benefits for the preservation of these areas exist.

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