BENEFITS FROM URBAN OPEN SPACE AND RECREATIONAL PARKS: A CASE STUDY

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ABSTRACT

The hedonic pricing technique was used to measure that component of house price attributable to proximity to a city park, using data on sale prices and characteristics of houses in Worcester, MA. Aggregation of these residual values over all houses in the neighborhood of a park provided an estimate of the value of the park, to which was added an estimate of recreation benefits from extrazonal users. The policy question of park system development or contraction was addressed by comparing these benefits with operating costs to gain a net measure of parkland value.

INTRODUCTION

The primary era of city park building in the United States occurred between 1880 and 1910. Since then changes have taken place which have left many urban parks in a state of decline. Today there is evidence of a reversal; more people are returning to the cities and rediscovering city resources. Concurrently, many cities are attempting to improve the caliber of their deteriorated park resources, making use of federally sponsored programs like the Urban Park Recovery Program and the Land and Water Conservation Fund.

Questions of how the funds from improvement programs should be spent require both cost and benefit information. Two types of benefits are relevant: (1) recreational benefits that accrue to park users directly; and (2) indirect benefits such as scenic views (or noise). Both types of benefits may be partially capitalized into land values and a number of studies have examined the nature of the relationship between parks and city property values with the intent of establishing the overall economic benefit of parks. Kitchen and Hendon, and Hammer _et al_. found parks to have a positive impact on surrounding property values. More recently, Correll _et al_. investigated sales prices of single family homes in Boulder, Colorado, and reported a drop of $4.20 in total sale price for each foot that a house was located away from a greenbelt.

Most of these studies failed to take into account variation in house juxtaposition or in type of park. When this is done, results may prove more variable. For example, Weicher and Zerbst found a significant property value impact on houses that faced "open-space" parks but there was either a negative or nonexistent impact on houses that backed onto open space or were adjacent to recreational facilities.

A number of questions arise with respect to these findings. We focus on the extent to which property value differentials provide an adequate measure of benefits of different types of parks and on a comparison of the costs and benefits of open space and recreational urban parks. Once these values are understood cities will be in a much better position to recommend the kinds of park development that will lead to an efficient allocation of limited funds.

THEORETICAL CONSIDERATIONS

At least three alternative techniques may be used to estimate the benefits of city parks. Among these are the direct survey method, the travel cost technique and the land value or hedonic pricing approach. The latter method was used here. Several factors influenced our choice. First, as noted by Bishop and Heberlein, "research on both attitude-behavior relationships and recall raise very serious questions about the validity of HV (hypothetical valuation or survey) results." (p. 928). Second, although the travel-cost approach is not applicable to recreational activities involving limited travel (e.g., urban parks), the land value (hedonic pricing) and travel cost procedures often measure the same thing (see Feenberg and Mills).

Development of the hedonic price equation, an inverse demand equation of characteristics, proceeds from assuming that individuals maximize a utility function:

(1) $U(z,h)$

Subject to the budget constraint:

(2) $Y = z + P$

where z represents the utility bearing attributes of a composite private good (with price set to unity), h is a set of housing attributes including distance to park, Y is money income, and P is the housing price function.

A number of assumptions are required to specify the standard housing value function used here and elsewhere in the literature. The underlying utility function is assumed to be weakly separable between groups of commodities. That is, an increase in the consumption of a particular housing attribute is assumed not to influence the consumption of attributes outside the housing group. Also, a house is valued for its utility bearing attributes rather than for the house itself. That is, embodied in any home is a particular set of attributes from which the consumer derives satisfaction. It is these attributes bundled in a particular manner which consumers seek when making consumption decisions (Rosen). Further, all individuals are assumed to have identical tastes and income. The result of utility maximization is an expenditure function for housing:

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(3) $P_i = f(S_i, L_i)$

where P_i = sale price of i^{th} house, and h is divided into

S_i = a vector of structural attributes of i^{th} house; (rooms, number of bedrooms, number of bathrooms, garage, age, taxes paid, type of heat, lot size, fireplaces, condition).

L_i = a vector of locational attributes of i^{th} house; (distance to park in feet as measured by public access distance (PACDIS), or distance to park as measured by straight line distance (SLID), and distance to central business district (DCBD).

The concept of duality assures us that an expenditure function of this type is a transformation of that separable part of the utility function dealing with housing characteristics. Specification of this transformation function is a convenient starting point since application of Shephard's theorem generates inverse demand functions for characteristics.

Identification of these demand functions requires additional assumptions. The housing market is assumed to be in equilibrium and the supply of housing attributes is assumed to be perfectly inelastic at each location. Also, spatial variations in housing characteristics (including distance to park) are assumed to be fully capitalized into house prices.

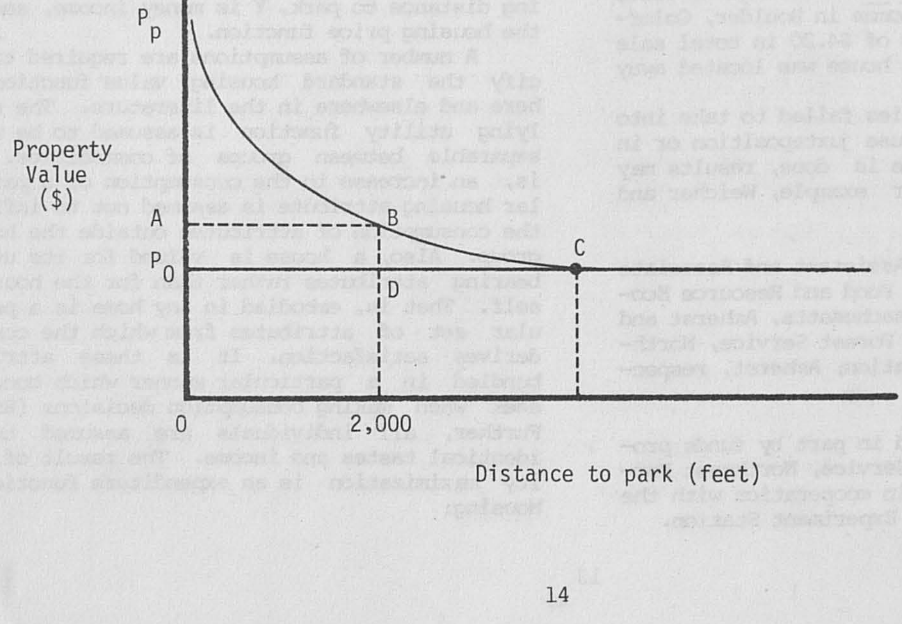
Not surprisingly, given the number and sometimes heroic nature of the assumptions there is much debate as to whether property value differentials provide an adequate measure of the benefits of city parks. One problem is the difficulty in obtaining data on the myriad of factors which influence property values. A more fundamental problem with this approach is that many of the benefits of city parks may not be captured by an analysis of land values. For example, the impact of city parkland upon adjacent property values will understate the value of parkland if some park users live outside the perimeter specified in the property value analysis.

Figure 1 illustrates the nature of this problem. Value of a park may be viewed as the volume of a cone whose height is the increase in property value due to proximity to the park and whose base measures distance from the park. One would remove the central plug from this cone to represent the space occupied by the park. Then figure 1 is a section through one side of the remaining cone, and each of the areas defined below must be rotated about the center of the park to measure volume, or value of the park.

In the absence of a park, the value of property equals P_0. With a park the value of adjacent property is higher than it would have been otherwise by the amount P_p minus P_0. As distance from park increases property values decline with distance along P_pBC, and the area P_0P_pC measures the benefit of the park. In applying the property value approach to measure this area, data from properties close to park are used since beyond a certain distance (say 2,000 feet) the

Figure 1

Distance to Park and Property Value



effect of the park is lost in the "noise" from other neighborhood characteristics and from competing parks. In practice, area P_pAB is measured by most functional forms of the property value approach and the value of the park will be underestimated by the area $ABCDP_0$. We therefore assume that at the boundary of the zone of park influence (say 2,000 feet), error in benefit estimation given by the area $ABDP_0$ would result. Beyond this boundary there would also be error given by BDC, the magnitude of which can be measured by the value of direct user benefits to residents living beyond the zone of park influence captured by the property value technique.

One problem, then, is to determine the extent to which the property value technique provides an adequate measure of the benefits of different types of parks. Based on the analysis above, we hypothesize that the property value approach may underestimate benefits of recreational parks relative to open space parks.

DATA AND METHODOLOGY

The Worcester, Massachusetts park system was chosen for analysis. Five parks were selected for study: Elm, Beaver Brook Playground, Hadwen, Lake and Greenwood. The first two are adjacent and were combined for analysis. Sales and house characteristics data were obtained from the Worcester Multiple Listing Service for sales from January, 1977, to June, 1980 (n = 170).

Four different functional forms of equation (3) were initially considered: linear, semi-logarithmic, logarithmic and quadratic. The semi-log and quadratic forms were linear in the variables with the exception of DCBD and distance to park, which were expected a priori to have a nonlinear relationship. Results of the initial analysis favored the semi-log form although only slightly and it was selected for further study. It was estimated with observations taken to 4000 feet, 3000 feet and 2000 feet from the park(s). From an F criterion the estimation with observations to 2000 feet was superior.[1] However, severe multicollinearity was found between several of the structural variables and in particular between distance to park and distance to the central business district.

One way to avoid the multicollinearity problem between distance to park and distance to central business district would be to eliminate the latter variable. This will, however, result in statistical bias of undetermined size and sign. Consequently, principal components regression was selected as the appropriate estimation technique (Morzuch).[2]

A crucial issue in principal component regression centers on component deletion which results in biased estimators (see Hill, Fomby and Johnson). Since we know that the restrictions imposed by the deletion of components are false, we used the noncentral F test (Toro-Vizcarrondo and Wallace) which tests the probability that the bias introduced by the restrictions is overwhelmed by the reduction in the variance of the estimates. To determine the number of components to delete we used the sequential testing method in which the previous restricted model becomes the new maintained hypothesis.

The independent variables are defined in Table 1. Number of rooms, number of bedrooms, number of bathrooms, size of garage, lot size and number of fireplaces were expected to have a positive influence upon sale price. The condition vaiable was taken from the Multiple Listing Service rating. Property taxes tend to increase with size and quality of house, but since these are included as separate explanatory variables we assume that taxes act as a proxy for the quality of public services and were expected to have a positive sign. All distance variables are in log form and were expected to have a negative sign. Dummy variables were used to denote type of heat, year of sale and park neighborhoods.

RESULTS

Inspection of the results in Table 2 shows fourteen of the eighteen coefficients each significantly different from zero at or above the ninety percent level of the PACDIS model and fifteen for the SLID model. All coefficients were of the expected sign.

The coefficient on the distance to park variables and the functional form of the model imply that there is an advantage to locating near a park. A house located twenty feet from the parks studied sold for approximately $2,675 more than a house 2000 feet from a park. However, approximately 80 percent of the locational rent was lost after 500 feet.[3]

Principal components regression was then performed on each of the four parks. The results are summarized in Tables 3 and 4. The components were constructed from the same explanatory variables as in the pooled model less the park dummy variables. The sign on coefficients generally conformed to those of the pooled model. However,

[1] Chow tests were performed to determine whether or not the different distances constituted different populations. That the data for the 0-2000 foot zone can be pooled with data from greater distances was rejected at the ninety percent level. Thus, the subset of data within the 0-2000 foot range was used for estimation purposes throughout this study.

[2] Although there are several alternatives to principal components regression, it is regarded as the best technique in cases of high correlations, large numbers of regressors and relatively few observations, which is the situation here.

[3] The impact of selection of components on the estimate of the coefficients for PACDIS and SLID is of importance for estimating the effect of city parks upon property value. The results appear reasonably stable with respect to component deletion. For example, when all but 5 components are deleted the magnitude of the coefficients on PACDIS and SLID increased in size by approximately 30 percent compared with deletion of all but 9 components.

Table 1: Definition of Variables

		Expected Sign
Structural		
Rooms	Number of rooms	+
Bedrooms	Number of bedrooms	+
Bathrooms	Number of bathrooms	+
Garage	Number of cars capacity	+
Age	Age of house, years	
Lot size	Area of lot, square feet	+
Fireplace	Number of fireplaces	+
Condition	1=excellent; 2=good; 3=fair; 4=poor	−
Gas	1 if gas fueled heating, 0 otherwise	−
Taxes	Property taxes assessed, in year sold, in dollars	+
Sold 1977, 1979, 1980	1 if house sold in that year, 0 otherwise	− 1977 + 1979, 1980
Locational		
DCBD	Straightline distance from house to central business district, feet	−
SLID	Straightline distance from house to park, feet	−
PACDIS	Distance from house to park entrance using shortest public access route, feet	−
D603, 604, 607	Dummy variables for park neighborhoods, 1 if house is in the neighborhood, 0 otherwise.	

Table 2: Results of Principal Components Regression on Semi-Log Form, Pooled Model, Eleven Components Deleted

Explanatory	PACDIS		SLID	
Variable	Coefficient	t-Ratio	Coefficient	t-Ratio
Rooms	588.90	4.534	588.60	4.572
Bedrooms	1255.30	5.438	1257.60	5.451
Bathrooms	2619.90	10.021	2638.70	10.106
Garage	246.36	1.189	218.73	1.037
Age	−4.97	−.538	−4.78	−.525
Lot size	.31	5.718	.31	5.661
Fireplace	3454.20	6.975	3454.40	6.973
Condition	−740.45	−2.853	−715.02	−2.862
Gas	−701.13	−1.171	−656.14	−1.106
Taxes	5.16	10.203	5.12	10.252
Sold 1980	3721.80	3.899	3763.00	3.985
Sold 1979	2661.60	4.276	2736.10	4.292
Sold 1977	−4593.40	−7.364	−4633.40	−7.463
607	−947.98	−1.667	−973.24	−1.696
604	−1427.10	−1.803	−1454.00	−1.833
603	1215.50	2.669	1244.40	2.693
DCBD	−483.26	−.894	−484.36	−.906
PACDIS	−575.56	−3.866		
SLID			−585.74	−3.579
Intercept	20851.00	4.041	20789.00	4.113
	$R^2 = .76$		$R^2 = .77$	

Table 3: Principal Components Regression: Semi-Log Form Public Access Distance

Explanatory Variable	Elm-Beaver Brook Coefficient	Elm-Beaver Brook t-Value	Greenwood Coefficient	Greenwood t-Value
Rooms	602.37	3.462	259.92	1.327
Bedrooms	1199.20	4.660	169.81	.436
Bathrooms	2266.50	6.817	2278.60	4.722
Garage	-1442.80	-2.131	-221.77	-.824
Age	-12.69	-.649	-5.42	-.460
Lot size	.49	7.405	.24	2.451
Fireplace	4888.80	7.754	869.63	1.004
Condition	-943.95	-2.434	-505.99	-1.425
Gas	-953.83	-.873	1659.60	4.029
Taxes	3.68	8.142	6.15	4.641
Sold 1980	4112.30	3.187	-11400.80	-2.195
Sold 1979	2347.60	1.722	4278.70	4.544
Sold 1977	-4806.40	-5.494	-2757.90	2.796
DCBD	-6635.50	-2.556	2508.80	.879
PACDIS	-14.06	-.021	-1140.20	1.896
Intercept	74042.00	2.689	83.26	.003
R^2	.85		.67	

Table 4: Principal Components Regression: Semi-Log Form Public Access Distance

Explanatory Variable	Hadwen Coefficient	Hadwen t-Value	Lake Coefficient	Lake t-Value
Rooms	-188.21	-.382	649.18	1.781
Bedrooms	1446.50	1.912	2670.60	3.999
Bathrooms	2963.70	3.590	-2290.90	-1.500
Garage	1617.00	1.844	1067.30	2.568
Age	-45.49	-1.658	9.96	.604
Lot size	.03	.256	.42	5.118
Fireplace	661.41	.770	2697.10	2.520
Condition	-1390.40	-2.260	-584.36	-2.180
Gas	3056.90	2.380	518.77	.471
Taxes	1.03	.527	4.54	2.562
Sold 1980	1879.80	1.161	15205.00	4.249
Sold 1979	347.60	.385	848.55	.851
Sold 1977	-1843.30	-1.754	-2001.70	-1.582
DCBD	-6631.70	1.173	3154.70	.393
PACDIS	-627.48	1.743	-488.76	-1.613
Intercept	96166.00	1.666	-14500.00	.195
R^2	.52		.79	

the magnitude of the coefficients suggest variability between parks, sometimes markedly so. At the point of partitioning, the distance to park variable had a negative sign in all four regressions but was significant in only three.

The results with respect to the distance-to-park variable are summarized in Table 5. Some of the differences in location rent may be the result of differing park characteristics. Elm/Beaver Brook park is a central city recreational park. The insignificant coefficient on distance-to-park may be a result of noise resulting from use of the recreational facilities. Also, vandalism was much higher at Elm/Beaver Brook than at the other parks studied, and congestion was more pronounced. Greenwood park is a small park with open space and a swimming pool which is located in a remote corner of the park. The remainder of the park is open space and the surrounding community is isolated from the central city. Consequently, density of users at Greenwood is likely less than at Elm/Beaver Brook. Hadwen and Lake are relatively large open space parks with recreation facilities located away from adjacent properties.

The total dollar impact of each park on land values was estimated by assuming that the boundary of each park is described by a circle with radius r. The number of properties within a band of width W from the park's edge is then given by:

$$(4)\ N(W) = (\Pi/A)\ (2rW + W^2)$$

where A is the average lot size.

The location rent, LR, for the average home R feet from a park is given by:

$$(5)\ LR = \beta LN\ (1920) - \beta Ln\ (R)$$

where β is the coefficient of PACDIS (Table 5) and the zone[4] of park influence ranges from 0 to 2,000 feet.

Although house lots vary in size and shape, a square lot was taken as typical and mean values for all variables except PACDIS were assumed. Location rents were obtained by evaluating equation (5) for R = 20,..., 1920 in 100 foot increments. The resulting values for LR were then multiplied by the number of homes, N(W), within each 100 foot wide corresponding band from the park's edge. Given this procedure the overall impact of parks upon property values ranged from 29 thousand to 1.4 million dollars (See Table 6).

Size of park obviously influences the number of houses in proximity to it and in general parks which have open space, picnic facilities, etc., appear to yield higher economic rents than parks which are designed primarily for intensive recreational uses. Although no definitive statement can be made, the results appear to support those of Weicher and Zerbst in that 'open space' parks appear to add to property values more than do recreational parks.

The next step is to examine the extent to which the property value analysis provides an adequate measure of the benefits of different types of city parks. Of principal concern is whether or not the recreation benefits provided by each

[4] Since the logarithm of zero is undefined, our discrete approximation of the volume of the land value cone used values starting at 20 feet.

Table 5: Effect of Distance to Park on House Price

Park	Location Rent**	Coefficient on PACDIS*
Elm-Beaver Brook	$64	-14.06 (.021)
Greenwood	$5000	-1140.20 (1.896)
Hadwen	$2900	-627.48 (1.743)
Lake	$2300	-488.76 (1.613)
All Parks	$2675	-575.56 (3.866)

*Number in parentheses are t values.

**Advantage due to locating 20 feet from park as opposed to 2,000 feet from park.

Table 6: Impact of Parks on Property Values

Park	Coefficient on Ln PACDIS	Park Value
Elm-Beaver Brook	-14.06	$29,715
Hadwen	-627.48	$1,024,972
Greenwood	-1140.2	$1,421,845
Lake	-488.76	$1,015,408

park were captured by the land value technique. In order to examine this issue users at each park were interviewed to determine where they lived. From this survey we estimate that 49 percent of users live within 2,000 feet of the Elm/Beaver Brook park, 41 percent live within 2,000 feet of Greenwood and 25 percent live within 2,000 feet of Hadwen and Lake parks.

To compute the total annual benefit of city parks, the impact of each park on property values was derived by amortizing the benefit figures in Table 6 over an infinite time horizon using a 10 percent interest rate as the opportunity cost of capital. Total park attendance data were then obtained from the City Parks Department. These attendance figures were multiplied by the percent of users living beyond 2,000 feet from each park to obtain estimates of the number of park users who lived outside the zone of influence captured by the hedonic technique. This amount was then multiplied by $2.80, the value used by Federal and State agencies for day use general recreation areas, to yield an (admittedly crude) estimate of recreation benefits which were added to the amortized property value effect to obtain annual park benefits.[5] Park benefits were then compared to cost.

As shown in Table 7, benefits were estimated to outweigh the operation and maintenance costs of all of the parks studied. Of particular interest is that an analysis based solely upon the property value approach would have resulted in a negative net benefit for the Elm-Beaver Brook park. The benefit minus cost figures (column 8 of Table 7) indicate the magnitude of the annual return to the land associated with each of the parks. For the five parks combined the return to parkland net of operating costs was estimated to be $1,988 per acre per year.

Using the same 10 percent rate of interest, the capitalized value of parkland would average $19,880 per acre. To make a decision on development of any part of the park system, this value would have to be compared with similarly located raw agricultural land, if such existed, zoned for development. It is also an average rate, and marginal changes in park area might have higher or lower impacts. Considering the irreversible nature of such decisions, they require a broader perspective than that offered by this preliminary study.

CONCLUSIONS

The information provided in this study can be used to facilitate decisions about the efficient allocation of park development monies. For example, open space parks appear to add to property values more than do recreational parks. The expenditure of funds to control noise, congestion, etc. at recreational parks may be one means of increasing the property value benefits of recreational parks. There is also the question of the distributional impacts of such policies, a question that we did not pursue here.

Although the property value benefits of most of the parks studied appear to be substantial in relation to cost, these benefit figures are lower than total park benefits for several reasons. First, recreation benefits are not fully capitalized into land values. In this respect the hedonic approach did not adequately capture the economic value of the city parks studied. This approach appears to be particularly inadequate as a means of measuring the value of recreational parks. Second, if the parks did not exist, all land values including those furthest from the park(s) might well be lower. Third, models of the type presented above often contain specification error(s). Nelson, for example, points out that most location rent studies do not adequately control for accessibility. As a result the estimated value of an amenity may be lower or higher than its true social value. Although accessibil-

[5] The city of Worcester for example, formulated a five year park development program in 1978. Various approved community block grant funds, tax levy funds and Federal reimbursement funds totalling 1.8 million dollars were made available for park development. A comparison of the benefits and costs of different types of city parks would provide decision-makers with improved information for the allocation of these funds.

Table 7: Park Analysis Summary

Park	Acres[a]	Annual Property Value Benefit	Total[a] Recreation Attendance	Number of Recreationists Living Beyond 2000 ft. zone	Annual Recreation Benefit	Annual[a] Operating Cost	Benefits Minus Cost
Elm-Beaver Brook	76	$ 2,972	60,515	30,863	86,416	$ 74,000	$ 15,388
Greenwood	15	142,185	29,301	17,288	48,406	21,000	169,591
Hadwen	50	102,497	---[b]			4,000	98,497
Lake	78	101,541	36,335	27,251	76,303	26,000	151,844
Total	219	$349,195	126,151	75,402	211,125	$125,000	$435,320

[a] Source: City of Worcester, Annual Report, 1978.

[b] Attendance figures not available.

ity was included in our analysis, environmental factors such as noise, air pollution, etc., were not explicitly included in the model specification. Micro-neighborhood factors such as crime rates, etc., were also excluded due to the difficulty in obtaining data (see Li and Brown).

Despite these limitations, the results clearly indicate that different types of parks yield different economic benefits. Parks which emphasize "open space" may be the most effective in relation to the operating costs involved and may yield the highest return to the park land resource.[6] These results are of significance since parks represent an important expenditure in any city's budget and yet relatively little information is available as to the value of different park types in relation to cost.

[6] If people with lower incomes use recreational parks more than open space parks, then emphasis might be placed upon the development of recreational parks for equity reasons.

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