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Urban Nature Centers and Housing Prices in Chicago

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Abstract

In 1994, the City of Chicago's Department of Environment made a significant investment to improve the North Park Village Nature Center, one of the City's few accessible natural sites located on the Chicago's north side. A previous on-site travel-cost survey of visitors to the North Park Village Nature Center (McGrath, 2006) showed that, on average, this nature center generates significant annual consumer surplus (the recreational use value) to users of the nature center – about \$1,500 per user per year, or nearly \$322 per visit. These welfare estimates imply the net present value of the sites recreational value to be on the order of \$100 million in 2005 dollars, or about \$2.1 million per acre.

A survey that is limited to users of the center understates the benefits of the investment by neglecting to take into account the benefits enjoyed by neighbors who value the existence of the center without directly using it (the non-use value). Thus, an important question that has not been addressed is whether this investment by the City of Chicago and the possible use and non-use values have been capitalized into property values near the nature center. The City's investment in improving the North Park Village Nature Center may have increased property values because recreational users of the site – who are likely to live nearby – clearly place a high amenity value that these kinds of centers provide.

The objective of this study is to evaluate the effects of proximity to the nature center on nearby residential property values and the subsequent impact in property tax revenue to Cook County. Using both a standard hedonic approach as well as a repeat-sales estimation approach, we estimate a house price index as a function of time and distance from the nature centers. We use the results to estimate (1) the revealed total willingness to pay (use and non-use value) of the nature center as of 2003 and (2) the increase in Cook County property taxes generated by the presence and 1994 upgrade of the nature. This exercise allows us to determine whether the additional tax revenue might actually allow the City of Chicago cover its own costs in redeveloping compromised areas as accessible natural areas.

About the Authors

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Urban Nature Centers and Housing Prices in Chicago

Project Context

The 48-acre North Park Village Nature Center (within the Chicago neighborhood North Park) has a long history of being one of the few accessible natural areas within the City of Chicago city limits. Originally a large woodland area north of the City's Tuberculosis Sanitarium, the site has always been a natural area accessible to local residents. After the Sanitarium's closure in 1973, a number of environmental organizations, including Chicago Audubon, were interested in managing the site. In 1994, after pressure from community groups to make its status as a nature center permanent, the City of Chicago Department of Environment invested about \$1 million of public revenue into the site for an expanded visitors center, cleanup and reconfiguration of the site's wetlands, and control of the nuisance species.

Any accessible environmental amenity would create value to citizens in both its access and through its existence. The value that accrues to citizens from it being an accessible recreational experience is technically referred to as the use value of the amenity. However, an environmental amenity generates value to individuals even if they do not use the amenity. Technically, this is referred to as the non-use value of the environmental amenity.

In an effort to provide an estimate the social value (use value) accruing to residents from this natural site within the urbanized area of Chicago, an on-site travel cost survey was undertaken in the summer of 2005 (McGrath, 2006)¹. This survey provided the residential location and demographic characteristics of visitors that facilitated the estimation of the demand curve for an urban nature center within Chicago and the subsequent estimation of the welfare gains at access to it provides. The estimation results showed that, on average, the North Park Village Nature Center generated significant annual consumer surplus – on the order of about \$1,518 per user per year (with each user using the site about 6 time per year), or about \$322 per visit². This consumer surplus translates into annual social welfare benefits of approximately \$4 million for the North Park Village Nature Center, or about \$84,600 per acre annually. Assuming a 3% public discount rate, the estimated net present recreational use value of the North Park Village nature center to metropolitan residents is estimated on the order of \$100 million in 2005 dollars, or about \$2.1 million per acre.

An important question generated from this initial empirical exercise is: How might this estimated recreational value been capitalized into residential land values around the nature centers? A secondary question is: Did this natural capital investment by the City of Chicago in 1994 generate increases in property value with subsequent increases in residential property tax revenues for the City of Chicago? The estimated demand curve for a nature center implies

¹ This study was undertaken by Daniel McGrath in 2005 with financial support from the Illinois-Indiana Sea Grant College Program. The final report is available online at: <http://www.iisgcp.org/research/projects/coast/rse0104.htm>

² The welfare estimation from the parameter results from a travel cost study is an issue of debate, and there are a number of methods in the literature to provide accurate annual welfare gains from a site visited multiple times. Using predicted values of trips and actual values of trips each has theoretical support. This issue is discussed in Bockstael et al. (1987). Parsons (2003) identifies using predicted values of trips.

a specific spatial structure of welfare, as the vast majority of users live in close proximity to the nature centers. Within the above-mentioned survey sample, the mean distance of Chicago residents to the nature center was 2.9 miles. For nature center visitors living in the suburban Cook County the mean distance to their residence was 6.8 miles. 98% of the single-day users of the site lived within 10 miles of the nature center.

There is a general view within the literature (McConnell, 1990) that the recreational value would be subsumed within the overall environmental value determined through a hedonic analysis. However, there are no studies in the economic literature that address this issue by comparing the results of a travel cost study and a hedonic valuation approach for the same environmental amenity. This study seeks to fill this gap. A straightforward hedonic analysis of the North Park Village Nature is presented to provide a comparison of the estimated flow recreational values from this urban natural amenity to the stock measure of value of the same site obtainable from the hedonic approach.

Literature Review and Theoretical Consideration

The hedonic literature is quite mature with a number of survey articles identifying the utilization of this technique in valuing environmental attributes within urban areas. Studies by Palmquist (1991) and Taylor (2003) provide thorough overviews. Haab and McConnell (2002) provide a discussion of the estimation of hedonic price equations. A recent overview of the use of hedonic models to value environmental externalities is Boyle and Kiel (2001), which examines the consistency of valuation and if estimated prices change over time. A large majority of environmental applications of the hedonic method is on the marginal valuation of environmental disamenities – namely air quality, water quality, and toxic waste impacts (Kohlhase, 1991; Legget and Bockstael, 2000; Smith and Huang, 1993).

Few hedonic studies have focused on the valuation of accessible natural areas within the urban environment. This neglect may be explained by the fact that urban areas often do not have significant natural area recreational amenities that merit formal valuation. A recent contribution in this area is Tyrvaainen and Miettinen (2000) who explore the contribution that proximity and view to forested areas have on residential properties in Finland. Another contribution relevant for this study is Lockwood and Tracy (1995) who undertake both a contingent valuation analysis and travel cost analysis to determine jointly the use and non-use value of an urban recreational park in Sydney Australia. Importantly, the Lockwood and Tracy study does provide economic values for comparison of the values estimated for this study. Using a travel cost analysis, Tyrvaainen and Miettinen calculate that the social benefits (use value) from a 543-acre park in Sydney to be between \$15 and \$22 million (in 2005US\$) per year or between \$28,000 and \$48,000 per acre. From the contingent valuation analysis, the non-use value of the park is estimated to be at least \$1.7 million (in 2005US\$) per year. This analysis implies a non-use value-to-use ratio for an urban recreational amenity of between 8 and 11 percent.

It must be emphasized, however, that there is a large body of literature focused on the use of the hedonic technique to value urban public goods (Bartik, 1988; Brookshire, et. al, 1982; Parsons, 1990). McMillen and McDonald's (2004) study of the impact of Chicago's new Midway rapid transit line provides a model for this analysis. McMillen and McDonald utilize both a hedonic and repeat-sales approach to determine the time path of the transit

station gradient for the new Orange Line to Midway Airport, which opened in fall of 1993. The study finds that the anticipated benefits of the new line began to be capitalized into house prices as early as 1987. The gradient rose from a value of 4.2% in 1987 to a high of 19.4% during 1991 through 1996, and then declined to 9.5%. Using this estimated gradient, the study determined that the aggregate increase in property values in Chicago was about \$215 million in 1997\$, about half of the transit line construction costs.

Data Sources

The dataset for this analysis includes the sales prices for all houses sold in Cook County, Illinois for the twenty-year period from 1983 to 2003 (with the exception of 1992, which is unavailable). This dataset was provided by the Illinois Department of Revenue from transaction tax records. Specific residences were identified by their standard Property Identification Number (PIN) so that the housing characteristics recorded by the Cook County Assessor could be matched with the sales information. Each street address was geo-coded to provide the latitude and longitude for each residence. All distances were calculated using latitude and longitude information. The top and bottom 4% of the sales price data was eliminated from the dataset to reduce the probability of non-arm's length sales, to eliminate zero-price sales, and to eliminate the influence of unrepresentative very high-priced properties.

Table 1 below presents the summary statistics of the dataset. In the above-mentioned travel cost study, the residential location of the 338 survey respondents provided some guidance as to the data selection. Of the respondents that resided in Chicago, the median and mean residential distances to the North Park Village Nature Center were 2.4 miles and 2.9 miles respectively, with 98.7% of the Chicago residents living within 10 miles of the nature center.

Table 1 Descriptive Statistics		
Variable	Hedonic Model Full Sample N = 274,834	Repeat Sales Sample N = 95,606
Price (Sale #1)	177,156 (124,696) [10,000, 987,500]	135,965 (88,655) [10,000, 980,000]
Price (Sale #2)	--	207,873 (125,812) [10,000, 985,000]
Lot Size (square feet)	5,283 (3,204) [430, 268,234]	5,053 (2,835) [416, 115,347]
Building Area (square feet)	1,673 (738) [400, 16,550]	1,644 (707) [400, 8,364]
Number of Bedrooms	3.508 (1.186) [1, 10]	3.491 (1.194) [1, 10]
Number of Bathrooms	1.737 (0.727) [1, 9]	1.718 (0.710) [1, 7.5]
Age (number of years at sale)	57.859 (24.957) [0, 113]	54.847 (24.142) [0, 113]
Fireplace (1 if yes, 0 if no)	0.194	0.183
Central Air (1 if yes, 0 if no)	0.299	0.281
Garage1 (1 or 2 cars)	0.263	0.268
Garage2 (3 or more)	0.042	0.038
Basement (1 if yes, 0 if no)	0.830	0.822
Attic (1 if yes, 0 if no)	0.399	0.410
Porch (1 if yes, 0 if no)	0.295	0.311
EL (1 if within 1 block of el station, 0 if not)	0.049	0.049

Table 1 Descriptive Statistics continued		
Variable	Hedonic Model Full Sample N = 274,834	Repeat Sales Sample N = 95,606
Distance to CBD	10.144 (3.975) [0.789, 20.284]	9.978 (3.958) [0.789, 20.284]
Distance to closest airport	8.334 (2.724) [1.389, 15.191]	8.444 (2.686) [1.758, 15.116]
Distance to closest rail line station	1.136 (0.699) [0.008, 3.318]	1.035 (0.523) [0.026, 2.757]
Distance to highway	1.717 (0.885) [0.040, 4.799]	1.744 (0.885) [0.040, 4.752]
Distance to North Park Village Nature Center	5.471 (2.308) [0.049, 9.999]	5.497 (2.242) [0.055, 9.999]
Chicago	0.517	0.528
Suburban	0.483	0.472
1983	0.039	0.000
1984	0.039	0.002
1985	0.046	0.007
1986	0.057	0.017
1987	0.055	0.025
1988	0.054	0.036
1989	0.052	0.042
1990	0.047	0.046
1991	0.045	0.049
1992	no observations	no observations
1993	0.049	0.057
1994	0.051	0.061
1995	0.048	0.054
1996	0.050	0.061
1997	0.050	0.064
1998	0.053	0.073
1999	0.057	0.082
2000	0.047	0.072
2001	0.046	0.068
2002	0.048	0.074
2003	0.066	0.110

Note: The sample average is presented in all cells. For continuous variables, the standard deviation is in parentheses and the minimum and maximum in brackets. The full sample has 274,834 observations. For repeat sales, 69,138 properties were sold at least twice, with a number being sold more than twice. The total repeat sales dataset was 95,606

Of the survey respondents residing in suburban communities, the median and mean residential distance to the North Park Village Nature Center was 6.4 and 9.8 miles respectively, with 64% living within 10 miles of the nature center. From this profile of survey respondents, we can safely assume that the total effect of the nature center on residential prices will be apparent from properties that are within 10 miles of the nature center. This restriction on location produces a dataset of 274,834 residential property transactions from Chicago and 29 suburban communities, all within the northern half of the metropolitan Chicago region.

Proposed Project Objective and Econometric Methodology

Recognizing the implicit spatial structure of estimated consumer surplus accruing from the recreational value of the North Park Village Nature Center, this project uses a hedonic analysis to validate the consumer surplus estimates from the travel cost approach. The analysis begins with the estimation of time-varying distance gradients, which show the change in the effect of proximity to the North Park Village Nature Center on residential property values. The distance gradients are then used to measure the increase in residential property tax revenue accruing to the City of Chicago due to the Nature Center. We use both a standard hedonic and a repeat sales approach to estimate the house price index as a function of time and distance from the nature center. We use the results to estimate (1) the revealed total willingness to pay (use and non-use value of the nature centers) and (2) the increase in Cook County property taxes generated by the nature centers. This exercise allows us to determine whether additional taxes revenue might actually allow the City of Chicago to cover its own costs in redeveloping blighted areas as nature centers.

The objective of this study is to estimate the time path of the effect of distance from the North Park Village Nature Center on Chicago's north side on house prices. The econometric methodology follows McMillen and McDonald's (2004) approach to estimating the reaction of housing prices to Chicago's new CTA Orange Line. The development of the nature center by the City of Chicago Department of Environment was known well in advance, and the public was engaged in the sites planning before site remediation and construction. Thus, it is possible that gradients may appear before the nature center upgrade was completed. The estimating equation is structured to account for possible temporal variation in the nature center gradients.

The base estimating equation is the standard hedonic price function:

$$\ln P_{i,t} = \alpha_t + \delta_i D_i + \beta X_i + u_{i,t} \quad (1)$$

where: $P_{i,t}$ is the sales price of residence i sold at time t ; D_i is the distance of the residence i from the nature center; X_i is the vector of all other residence-specific characteristic and distance variables determining residential real estate values with the City of Chicago.; and $u_{i,t}$ is an error term. The estimated values of α_t form the house price index. These values are the estimated coefficients for a set of dummy variables indicating the quarter of sale.

In preliminary models, the estimated nature center gradient was volatile when allowed to vary freely on a yearly basis over the 20-year period. It is reasonable to assume that the gradient would change but would do so smoothly over time. One technique to produce a smooth estimated time path for the distance gradient of nature center is to include both a distance variable and a variable of distance multiplied by some time measure, additionally controlling for the time measure using a dummy variable. This approach produces the following functional form:

$$\ln P_{i,t} = \alpha_t + \delta_{1i} D_i + \delta_{2i} D^* t + \beta X_i + u_{i,t} \quad (2)$$

The estimated parameters of the distance and distance*time variables, δ_1 and δ_2 , provide the starting value of the nature center distance gradient and how the gradient changes with each subsequent time period. In this analysis, a cubic function was chosen with the time units being a quarter (3 month) period.

The repeat-sales method, originally proposed by Bailey, Muth, and Nourse (1963) as a method for constructing real estate price indexes, is also used in this study to estimate the distance gradient of the nature center over time. The repeat-sales approach is derived directly from Equation (1). For the i^{th} house in the sample that sells more than one during a given period, the difference in the log of the sale prices between the sale at time, t , and a sale at a prior period, s is expressed as:

$$\ln P_{i,t} - \ln P_{i,s} = \alpha_t - \alpha_s + D_i (\delta_t - \delta_s) + u_{i,t} - u_{i,s} \quad (3)$$

Equation (3) is a repeat-sales estimator that expresses the percentage change in the price of a house as function of an implicit set of time-specific explanatory variables. Important for this analysis is the time-specific coefficients of the distance to the North Village Park Nature Center, $\delta_1 \dots \delta_T$. These parameters show how the value of the nature center gradient changes over time.³ By controlling for the effect of omitted variables that do not change over time, the repeat-sales estimates are potentially subject to less misspecification bias than standard hedonic estimates. However, the reduction in bias comes at the expense of a significant reduction in sale size and an increase in the possibility of selection bias. In this study the reduction in sample size is from 274,834 to 95,606 observations⁴.

Empirical Results

The hedonic model (equation (2) above) includes housing and neighborhood characteristics listed in Table 1, dummy variables for 80 quarters from 1983 to 2003⁵, 30 dummy variables identifying Chicago neighborhoods and 29 dummy variables identifying suburban communities to control for possible fixed effects. Additional variables control for spatial

³ The distance variable is interacted with a standard series of discrete variables that are used to estimate the price index, $\alpha_1 \dots \alpha_T$.

⁴ Within the repeat-sales dataset, there are 68,751 houses that sold twice, 20,777 houses that sold three times, 5,010 houses that sold four times, 930 that sold five times, and 138 that sold six times.

⁵ This excludes the year 1992.

Table 2 - Hedonic Regression Results

Variable	Coefficient	T-value	Variable	Coefficient	T-value
Constant	5.952	232.88	Porch	0.005	3.65
LN Lot Size	0.364	138.17	Age	-0.003	-95.65
LN Building Area	0.244	142.43	Distance to CBD	0.041	40.02
Bedrooms	-0.007	-9.22	Distance to Airport	0.025	23.00
Bathrooms	0.044	35.59	Distance to nearest rail line	-0.022	-15.00
Fireplace	0.128	74.52	Within 1 block of EL station	0.002	0.89
Central Air	0.015	10.55	Distance to nearest highway	0.034	31.18
Garage1	0.009	6.76	DNPVNC (Distance to North Park Village Nature Center)	-0.026	17.39
Garage2	0.012	4.31	DVPVNC * Quarter	-0.009	9.45
Basement	0.057	34.93	DVPVNC * Quarter^2	0.003	10.50
Attic	-0.006	-5.21	DVPVNC * Quarter^3	-0.002	11.59
R ² = .7968					

Number of observations = 274,834

The dependent variable is the natural log of the sales price

Note: The regression included 80 dummy variables indicating the quarter of sale, 30 dummy variables indicating the Chicago neighborhood (if sale in Chicago) and 29 dummy variables indicating the community (if suburban) to control for fixed effects

characteristics established within the literature to be valid determinants of value within the City of Chicago. These are distance to the central business district, distance to closest airport (O'Hare or Midway), distance to the closest rail station (the Chicago CTA if the house sale is within Chicago and commuter rail if it is within a suburban community), the distance to the nearest highway interchange, and a variable indicating whether the property is within 1 block of a CTA station. As discussed above, additional spatial variables include the distance to the North Park Village Nature Center and distance multiplied by time in a cubic functional form. These variables were included to facilitate the identification of the time path of the nature center distance gradient, the objective being to determine if there has been a change in the gradient since the investment by the City of Chicago in 1994. The hedonic regression results are presented in Table 2.

The empirical results of the hedonic model imply that the characteristics of the house and neighborhood are all significant and nearly all have all the expected effects. Interestingly, the number of bedrooms exhibits a negative effect, but the magnitude of the parameter is nearly zero. This result is explained by the presence of variables controlling for square footage and the number of rooms: having controlled for these variables, an increase in the number of bedrooms implies small bedrooms when most homeowners prefer larger rooms. The coefficients for the dummy variables for Chicago neighborhood and community areas show that how prices vary across neighborhoods for reasons not accounted for by the model specification.⁶

The results pertaining to distance to downtown Chicago (the CBD) shows distance as an amenity with a positive gradient of .04, which is consistent with the positive CBD gradient in previous studies (McMillen and McDonald, 2004). This result is not surprising given that the sample has been restricted to 10 miles from the northern-most areas of the city. Distance from the airport (in this case O'Hare) is, as expected, an amenity, as is distance from the highway. Also, as expected, distance from either the CTA station or a community rail station is a disamenity, exhibiting a small but strongly significant negative coefficient.

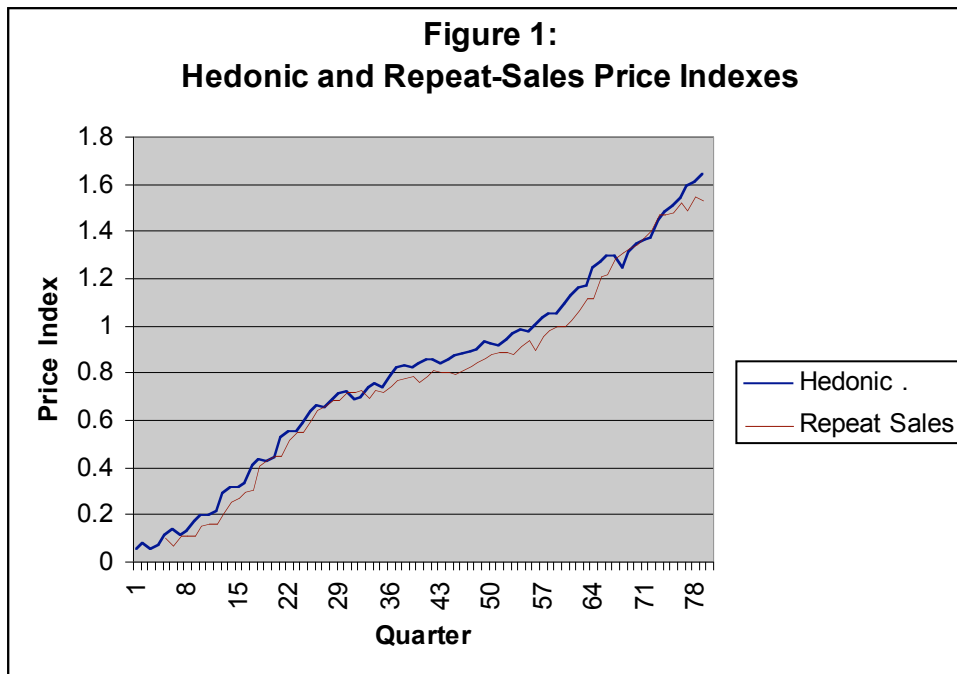
The focus of the hedonic results is the parameter estimate of the nature center gradient. The estimation results identifies a negative and significant gradient that begins at the value of about -0.025 in 1983, increasing to -0.035 in 1989, and subsequently stabilizing to a value of -0.033 in 1994. The time path implied by the cubic function of the nature center gradient is presented in Figure 1. The most important result is that after the significant investment by the City of Chicago into the nature center in 1994, the distance gradient exhibits a further decrease to approximately -0.45 in 2003.

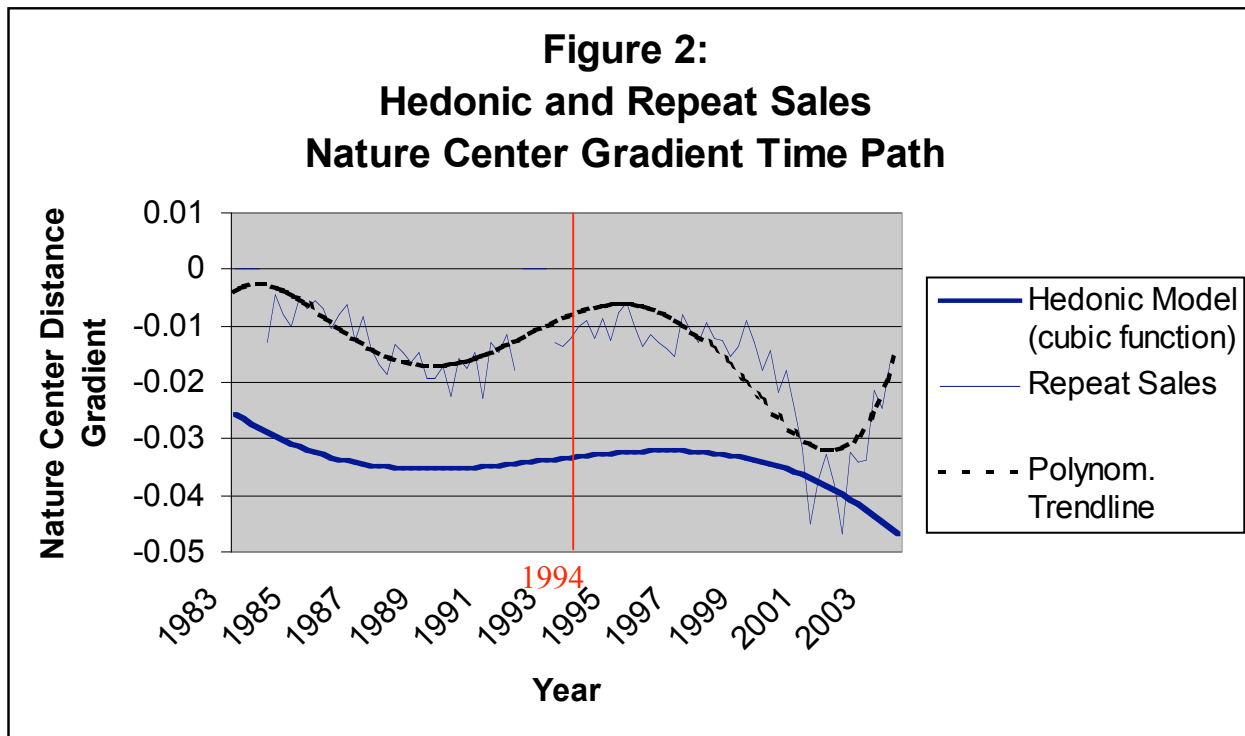
The repeat-sales data are used to estimate Equation (3), where the discrete time periods in the model are quarters. The results of the repeat-sales model are presented in Figures 1 and 2. Figure 1 presents the quarterly nominal repeat-sales price index for 1983:2 to 2004:4 for both the hedonic and repeat-sales models. The two indexes track closely together. House prices on the north side of Chicago increased by over 160% over the twenty-year period.

⁶ The omitted area is Chicago neighborhood area 9 (i.e., Belmont-Cragin at the heart of the City's north side). This neighborhood was chosen as the base because it had the greatest number of sales over the 20 year period.

The results of interest for this study are depicted in Figure 2, which again shows the quarterly indexes for the price gradient with respect to distance from the North Park Village Nature Center. The quarterly index from the repeat-sales model moves somewhat erratically, but, like the hedonic model gradient, it clearly exhibits a negative gradient over the time period of the data, though much less than the gradient identified by the hedonic model. However, the gradient exhibits a clear inflection point at 1994 and becomes more negative between the years 1995 and 2002, the specific years after the City's investment. Also, by 2001, the nature center gradients of the two models are much more in agreement, exhibiting a gradient of about -4% per mile in 2003.

One concern is the sharp upturn in the repeat-sales nature center gradient in the last 3 quarters, which exhibits a trend opposite of the hedonic model. The last three quarters of 2003 were during a sharp increase in demand for residential properties in Chicago, and it could be the case that, when compared to other properties, the influence of the nature center as a local amenity declined.





Estimating the Aggregate Increase in Property Value

One of the primary motivations for this study is to provide an alternative estimate for the value of the nature center against which the estimated value from the travel cost model can be compared. The first measure of value is a static value as of 2003. The estimate is based on the implied nature center gradient, δ , as of 2003. One aspect of the time path estimation specification in the hedonic model is that the confidence interval increases further along the time path, and it is possibility the estimated values at the end of the function are biased. To be conservative, the average of the estimated quarterly values for 2002 and 2003, a value of -.04315, is used as a proxy for the 2003 gradient. To make an estimate of the contribution of the nature center to property values, we must use a separate dataset of the assessed values of all the residential properties in Chicago in 2003 from the Cook County Assessors office. The assessed values are translated into market prices using the sample average factor of 11.31⁷.

To estimate how much prices rose due to the effect of the nature center, a base distance is needed to establish the limit of the effect of the nature center gradient. One possible choice is the median distance in the travel cost survey sample is 2.4 miles. McMillen and McDonald (2004) in their Midway line analysis chose a distance of 1.5 miles. To be conservative this study will use a distance of 1.5 miles as the edge beyond which the effect of the nature center

⁷ This is the ratio of assessed value at the time of sale to the market sale price for all homes in the dataset within 10 miles of the North Park Village Nature Center. The average ratio for the year 1983 to 1994 is 10.32.

gradient goes to zero. The current market values incorporate the effect of the nature center. The value of the nature center can be approximated as the difference in the sales in its current location and a hypothetical location 1.5 miles from the nature center. The hedonic model implies that the natural logarithm of the sales price of a home located d miles from the nature center is $\ln P = \mu - .04315 \times d$, where μ is a constant incorporating the effects of all other explanatory variables. If the home were located 1.5 miles from the nature center, its sales price would fall to $\mu - .04315 \times 1.5$. Thus, the percentage change in the sales price from moving from d to 1.5 miles from the center is equal to $-100 \times 0.04315(1.5 - d_i)$. Using the assessment data, the estimated sales price for property i is $A_i \times 11.31$, where A_i is the assessed value. If the property were located 1.5 miles from the nature center, its sales price would fall to $A_i \times 11.31 \times (1 - .04315(1.5 - d_i))$. Thus, the formula for the value of the Nature Center can be written:

$$\text{Nature Center Value} = \sum_{i=1}^N (\text{Assessment}_i \times 11.31)(1 - .04315(1.5 - d_i)) \quad (4)$$

The aggregate value of all the 13,121 homes within 1.5 miles of the North Park Village Nature Center is approximately \$4.81 Billion (2003\$). From the above equation using the 2003 gradient identified in the hedonic model the aggregate value of the nature center is \$102.4 million (2003\$) or approximately \$105 million (2005\$).

To estimate how much the 1994 investment by the City in nature center has increased property values since 1994, an estimate of total market value in 1994 is required. Separate regressions identify a price index difference of 1.91 on average (from both estimation methods) for properties between 1994 and 2003. This index implies a total market value of the 13,121 homes in 1994 of \$2.3 billion. Following the same procedure as described above identifies nominal change in home market value of about \$65 million between 1994 and 2003 and a real change in home value of \$31 million from 1994 to 2003.

Using the average 1994 and 2003 nature center distance gradients identified by the repeat sales model (.0107 and .0300 respectively), the aggregate static value of the nature center in 2003 is \$71.5 million (or approximately \$73.3 million in 2005 dollars). The decrease in the gradient from 1994 to 2003 produces a nominal change in home market value of about \$59.1 million.

Estimating the Impact of Tax Revenue

Estimating the impact on tax revenue requires a number of assumptions since the tax rates vary across townships in Cook County and tax levies within the county vary from year to year. However, a rough estimate of the impact on tax revenue is made here based on information provided by the Cook County Assessor's website.⁸ A sample calculation provided by the assessor identifies how tax is calculated from a given assessed value in 2001. The assessed value is multiplied by a state equalization factor of 2.2235. The equalized assessed value is adjusted by \$4,500 for the homeowner exemption. The adjusted equalized

⁸ <http://www.cookcountyassessor.com/ccao/howwhy.html>

assessed value is multiplied by a rate of 0.10. Using this formula, the difference in tax revenue resulting from the nature center’s improvement in 1994 is calculated from the difference of the home value attributed to the nature center in 2003 (using the 2003 nature center distance gradient) from the imputed value attributed to the nature center in 1994 (using the 1994 nature center distance gradient) for each house in the 2003 assessment dataset. Since the \$4,500 homeowner exemption adjustment cancels out, the following equation is used to determine the change tax revenue attributable to the increase in the nature center distance gradient from 1994 to 2003:

$$\text{Delta Tax Revenue}_{03-94} = \sum_{i=1}^N 0.10 \times 2.2234 \times [(NCValue03_i / 11.31) - (NCValue94_i / 10.92)]$$

Note that the assessed value factor changes between 1994 and 2003 from 10.92 to 11.32, which is based on the observations in the dataset. From the nature center distance gradients identified from the hedonic model, the nominal increase in Cook County tax revenue is approximately \$1.205 million. Using the repeat-sales distance gradients, the nominal increase in Cook County taxes is \$1.139 million. The nature center valuation results and the tax impacts from both the hedonic and repeat-sales models are presented in Table 3

Table 3 Comparison of Values between the Hedonic and Repeat-Sales Models		
	Hedonic	Repeat-Sales
Nature Center Value in 2003	\$102,410,045	\$71,474,251
Nature Center Value in 1994	\$37,508,646	\$12,324,694
Change in Nature Center Value (1994 - 2003)	\$64,901,399	\$59,149,557
Change in Tax Revenue (1994 - 2003)	\$1,204,794	\$1,139,334

Summary and Discussion

This study has employed both a hedonic model and a repeat-sales model of a large sample of single-family home sales to estimate the value of an urban nature center within the City of Chicago. From the results of both the hedonic and the repeat-sales estimation methods, there is evidence that the North Park Village Nature Center has been an amenity to the Chicago region since as early as 1983, and there is strong evidence that it became more of an amenity after the City’s investment in the site’s improvement in 1994. The total use and non-use value of the North Park Village Nature Center as identified by the hedonic and repeat-sales models is valued between \$73 and \$105 million.

The empirical results provide evidence that validates the valuation result from the travel cost method previously discussed. Since the value identified via the travel-cost method is a flow

valuation it requires the assumption of a public discount rate. The consumer surplus flow of the North Park Village Nature Center in 2005 is estimated to be about \$3.1 million per year in 2005 dollars. If one assumes a public discount rate of 3%, the travel cost result identifies a use value of the North Park Village Nature Center to be on the order of \$100 million. However, if one assumes a public discount rate of about 6% the use value falls to about half of that figure.

While the estimates of total value are consistent between the two methods, a precise value of the non-use value accruing the nature center continues to be somewhat unclear. However, the hedonic model identifies a total value of about \$105 million. The difference between this figure and the estimated use value from the travel cost analysis of about \$5 million could be interpreted as the current existence value (non-use value) assigned by residences to the nature center. Again this result is consistent with the theoretical result by McConnell (1990) that the recreational value would be subsumed within the overall environmental value determined through a hedonic analysis. The ratio of non-use value to use value is about 5%, which is on the order of magnitude as the ratio determined by Lockwood and Tracy (1995) in their assessment of the urban recreational park in Sydney, Australia.

Importantly, this study also provides evidence that the nature center gradient increased in absolute value after the City of Chicago's investment in the nature center in 1994. Both the hedonic and travel-cost methods identify an absolute increase in the nature center gradient of about 2% per mile from 1994 to 2003. This change in the gradient implies a nominal increase in home value of about \$60 million and the increase in tax revenue likely to be in excess \$1 million. The cost to the City for the upgrade of the nature center was on the order of \$1 million. A strong case can be made that the City's investment here to provide improvement to a public good was a fiscally sound one based in the improvement in property values spurred by the public investment. The North Park Village Nature Center is an urban environmental amenity that has been and continues to be highly valued by the residents of the metropolitan region and most strongly by neighboring residents. This analysis provides direct evidence that this specific public investment in a natural area that had clear recreational value was indeed capitalized into the surrounding residential real estate and that there is evidence that this capitalization provided a payback to government in the form of increased tax revenue.

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