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The Economic Impact of Urban Green Space Investments: A Case Study for Chicago

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Abstract

This paper explores the effect of park proximity and other characteristics on residential sales prices in the City of Chicago. The hedonic property method is applied to data on parks, residential home sales prices, home characteristics and neighborhood variables. Preliminary results indicate significant contributions of large parks to property values, however mixed results on the effect of smaller neighborhood parks. The paper concludes with a discussion of the model extensions to a more comprehensive set of green space including community gardens, and the development of spatial models for ecosystem services.

This research is being conducted in cooperation with the Department of Environment at the City of Chicago and the Chicago Park District. Research assistance is provided by Dan Plechaty and Jake Torcasso at the University of Chicago. GIS assistance is provided by Todd Schuble and Ben Merriman at the University of Chicago.

I. Introduction

Chicago's long legacy of investment in public park and lakefront access spans from Frederick Olmstead and Daniel Burnham's redesign of the south side Jackson Park for the 1893 Columbian Exposition to the 1909 Plan of Chicago developed by Burnham and Edward Bennett, which was dedicated to preserving Chicago's lakefront and acquiring land for an outer park system, to the present time with the development of the internationally-recognized Millennium Park. In addition to its large parks and public areas, Chicago also has a wide network of neighborhood and pocket parks which are surrounded by residential properties throughout the City.

The notion that parks contribute to the economic development through property value increases goes back to the early nineteenth century (Crompton 2005). The idea has been developed based on the premise that properties with proximity to parks experience incremental value, which then leads to the economic basis for which private residents fund public parks through property taxes and other means. The principle goes beyond parks into other types of open space or notably "green spaces", which can include agricultural land in rural areas or natural areas, forests and golf courses in more urban settings.

The notion of green space as an economic investment is of interest to municipal planners and policy makers who seek the development of financing mechanisms for public goods and community improvements, private investors and developers seeking incremental value for properties in competitive markets, natural resource managers seeking ways in which green spaces can provide environmental quality improvements and ecosystem health, and city managers who can utilize the ecosystem services of green spaces to reduce the burden on physical infrastructure such as those used for storm water run off and control.

This research explores the economic value of large landmark style parks as well as smaller neighborhood parks in Chicago as measured through marginal contributions to residential property sales prices. The remainder of the paper is organized as follows. A description of the model and variables is provided followed by a summary of the data sources. Initial results are reported and discussed followed by suggestions for additional research as well as the model extensions currently underway.

II. The Hedonic Property Method in Practice

Parks are a classic example of a public good. Since public parks can be shared by all with little to no direct cost, there is no market in which park space is privately and efficiently allocated. Accordingly, there is no directly observable "price" or value for parks. While some parks require entrance fees and combinations of public and private funding, the full value of a park is generally not directly observed and is best measured through non-market valuation techniques. More, et al. (1988) describe three valuation techniques but note that one such method—the hedonic property method (HPM), is capable of measuring the full value of parks both in direct and indirect use. The HPM, which is based on the principle that park proximity increases property values, examines all of the factors contributing to a property's value and generates results in estimates of the marginal contributions of each factor—including environmental variables such as parks and green space.

The hedonic property method has been well applied in the economic literature[1]. Many authors have focused specifically on the effects of parks on property values (Espey and Owusu-Edusei 2001, Crompton 2005). Others studies have extended the analysis beyond parks to other types of open spaces including natural areas and golf courses (Bolitzer and Netusil 2000, Lutenhiser and Netusil 2001). Several papers have considered the effects of open space on residential property values in rural and exurban

[1] See Crompton 2005 for an excellent overview of hedonic property studies from the past several decades.

areas where open space can include privately-owned or developable land (Irwin 2002.) Since the permanency of this type of open space is less established, several authors have introduced modeling techniques to deal with the endogeneity effect of open space which may also be part of the residential property market (Geoghegan 2002, Irwin 2002). This problem is not as prevalent for public parks in urban settings, which can generally be considered as permanently-preserved open space. However, the permanency issue arises again with a growing type of urban open space—community gardens, which have recently been studied using the hedonic property method and presents an interesting medium between farmland and park space that is particularly relevant in urban settings (Voicu and Been 2008).

The technical modeling of hedonic property valuation has evolved over time although due to little a priori knowledge of the appropriate parameterization of hedonic models, the fundamental model is still best expressed using basic functional forms (Irwin 2002, Cropper, et al. 1998). Technical modeling advances have been made based on the recognition of the importance of location and geography along with the rapid advancement of mapping tools, and in particular the adoption of Geographic Information Systems (GIS) in economic modeling. These tools have been particularly important in location-based valuation techniques where clusters of economic activity develop based on proximity. Accordingly, the spatial dependence of model parameters has been treated to improve precision of estimates and efficiency of errors by removing sources of spatial heterogeneity and spatial error correlation (Irwin 2002, Kong, et al. 2007, Hoshino and Kuriyama 2010).

Table 1 shows selected factors which contribute to home sales price based on a review of the literature.

Table 1 Factors Influencing Urban Property Values

Home Characteristics	▪ Home Size ▪ Lot Size ▪ Age ▪ Number of Bedrooms ▪ Number of Bathrooms ▪ Parking/Garage ▪ View
Location Properties	▪ Distance to City Center ▪ Distance to Airports ▪ Distance to Public Transportation ▪ Recreational Facilities
Neighborhood Characteristics	▪ Socio-Economic and Demographic Composition ▪ Rates of Homeownership ▪ Crime Rates ▪ Quality and Accessibility of Schools ▪ Retail Presence ▪ Social Activity Indicators ▪ Cultural Activity Indicators
Environmental Characteristics (Presence, Number and Distance)	▪ Parks ▪ Beaches ▪ Tree Cover ▪ Other Green Space

III. Chicago Data Sources

Property Data

Residential sales prices and property characteristics from the Multiple Listing Service are obtained through Midwest Real Estate Data, LLC. This analysis uses the sales prices and characteristics for 11,532 single-family detached residential properties sold in Chicago in 2003. A summary of the home characteristics is provided in Table 2.

Table 2: 2003 Sales Prices for 11,532 Single Family Residential Homes in Chicago

Variable	Mean	Std. Dev.	Min	Max
Sales Price	$240,359	$239,714	$5,000	$3,962,500
# Parking Spaces	1.59	0.79	0	9
# of Bedrooms	3.42	1.01	0	9
# of Baths	1.66	0.75	0	7

Park Data

Data on parks was obtained from the Chicago Park District. Overall, there are 573 parks in Chicago ranging from less than .01 acre pocket parks with no facilities to the 1,200 acre Lincoln Park, which includes tennis courts, a golf course, volleyball, a rowing lagoon, a bird sanctuary, horseshoes pits, a chess pavilion and many other amenities and facilities. Clearly, not all parks serve as substitutes for others. Table 3 lists the larger landmark or magnet parks defined here as parks over 70 acres. These parks feature larger facilities and amenities and offer a different type of experience than a smaller neighborhood park which may be better suited for a playground, picnic facility or community garden.

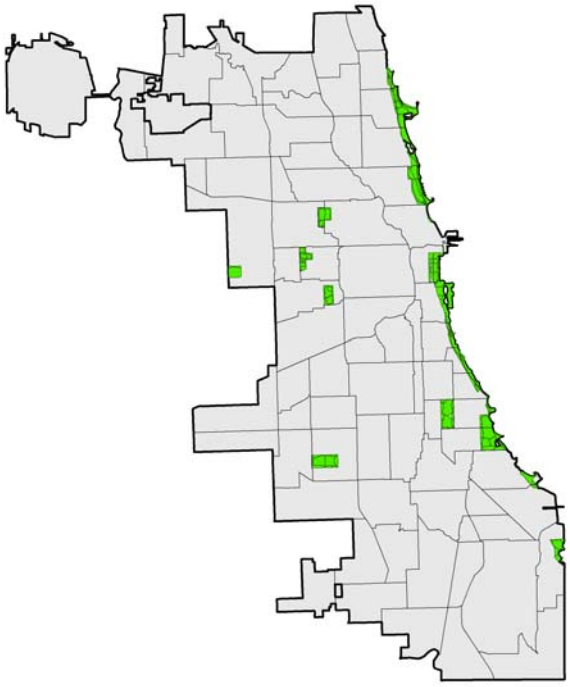
Table 3: Chicago Parks over 70 Acres

Park	Direction Location	Size (Acres)
Midway Plaisance	South	80
Warren (Laurence)	North	89
Northerly Island	Near South (Lakefront)	91
Columbus (Christopher)	Near South/West	135
Douglas (Stephen)	Near South/Near West	174
Garfield (James)	West	184
Calumet	South	198
Humboldt (Baron Von)	Near North/West	206
Grant (Ulysses)	Downtown (Lakefront)	244
Marquette (Jacques)	South	320
Washington (George)	South	366
Jackson (Andrew)	South	542
Burnham (Daniel)	Downtown (Lakefront)	585
Lincoln (Abraham)	North (Lakefront)	1,212

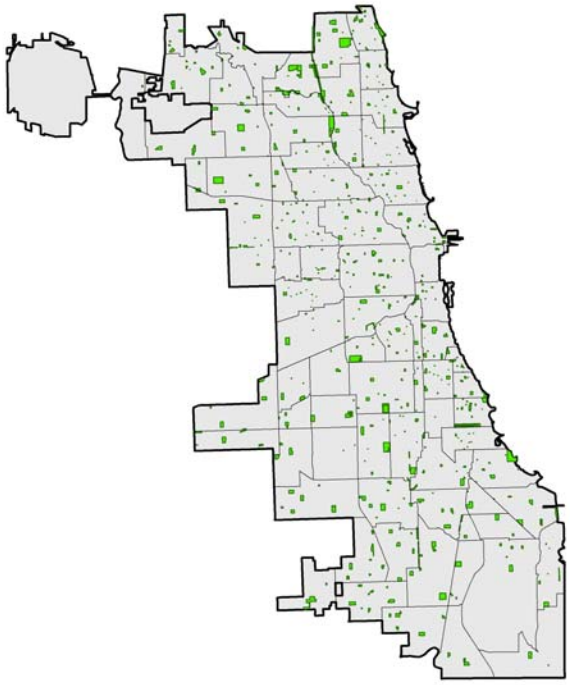
Figure 1 shows the location of Chicago parks over 70 acres as well as the remaining smaller parks throughout the City.

Figure 1: Location of Chicago Parks over and under 70 Acres

Parks over 70 Acres



Parks under 70 Acres



Location and Neighborhood Variables

Table 4 shows the average distances to parks, downtown Chicago, and the closest public transit train stop that were computed using GIS. Currently, distances are computed using Euclidean or straight line distances for simplicity but will be updated using more sophisticated road networks which provide more accurate paths by accounting for roads, park entrance points, and the fastest travel routes.

Table 4: Average Distance to Points of Interest (n=11,532)

Distance (Miles)	Mean	Std. Dev.	Min	Max
Train Stop	1.58	1.11	.01	6.84
Downtown	8.66	2.70	.01	16.5
Nearest Airport	6.31	3.11	.01	14.33
Lakefront	5.33	2.42	.01	10.78
Large Park	2.60	1.73	.01	7.50
Small Park	0.34	0.19	.01	1.31

Data from the 2000 U.S. Census data is used given it is the closest year to the 2003 home sales data. A summary of census variables as well as other neighborhood descriptors is provided in Table 5.

Table 5: Summary Statistics of Selected Neighborhood Characteristics

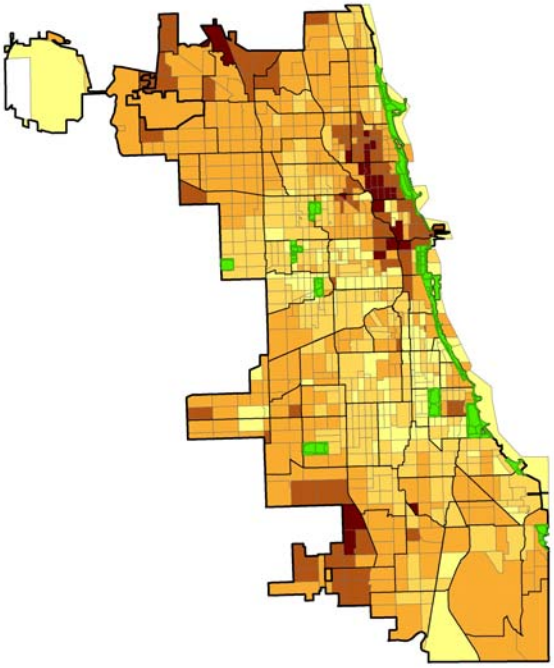
Description	Mean	Std Dev	Min	Max
Household Income	$44,026	13,958	0	$127,031
Percent over 25 with College Degree	19.20%	15.97	0	88.84%
Percent Hispanic	23.26%	25.47	0	97.66%
Percent Black/African American	33.69%	41.88	0	99.68%
Percent White	37.44%	33.1	0	94.47%
Per-Capita Property Crime Rate	0.0441	0.0167	0.01	0.13
Per-Capita Violent Crime Rate	0.0112	0.0095	0	0.05

Park and Neighborhood Data

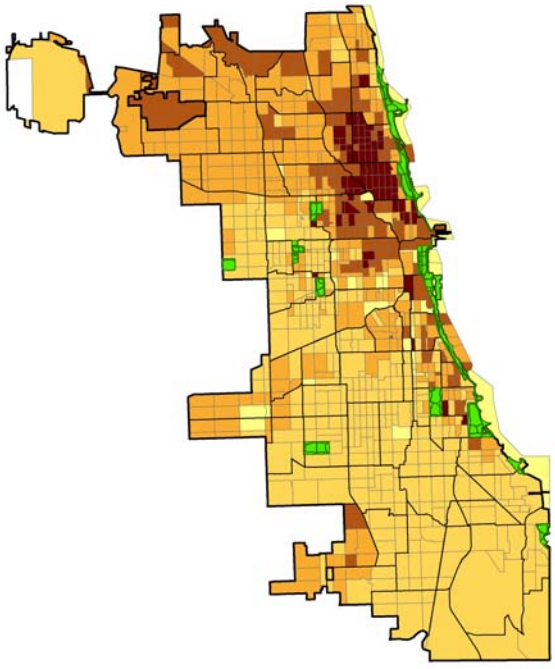
Figure 2 shows the location of the large Chicago parks and the distribution of income distribution and homes sold in 2003. Darker shades reflect higher values.

Figure 2: Large parks and income and large parks and home sales price.

Large parks and Income



Large parks and Sales Price



While the maps in Figure 2 are useful in showing the spatial distribution of parks by income and home sales price, there is little insight into the marginal contribution of parks to sales prices, which is important from an investment and planning perspective. This marginal contribution can be better isolated using regression analysis to control for property, location and neighborhood differences across properties.

IV. Model and Preliminary Results

The basic hedonic pricing model is applied here as:

SP = f(H, A, P, L, G) where

SP = log sales price of residential single-family home
H = vector of home characteristics
A = vector of area and neighborhood characteristics
P = vector of neighborhood park variables
L = vector of large landmark parks and lakefront variables
G = vector of variables indicating other types of green and social space such as gardens and playgrounds.

Several functional forms were explored for the regression analysis. The model reported here is a hybrid semi-log/double-log model where the dependent variable—sales price is in log form as well as the distances while the other variables are in raw form. This model was chosen for reporting here based on fit as well as its popularity for hedonic analysis based on a review of functional forms in the literature (Espey, Irwin 2002, Voicu and Been 2008) and the discussion provided by Cropper, et al (1988).

Table 6 reports results from four different models which differ only in the specification of the park variables. Models 1 and 2 both use a dummy variable to indicate if the property is within 1500 feet of a small park but differ in the specification of the large park variable. Model 1 uses the log distance to a large park while Model 2 uses a dummy for properties within 3000 feet of a large park. Models 3 and 4 use the same two specifications for the large park variable, respectively but use the log of distance to the nearest small park instead of the dummy variable for proximity to a small park as in Models 1 and 2.

Table 6: Coefficient Estimates and Regression Results

(Dependent Variable = Log Sales Price)

Variables	Model 1	Model 2	Model 3	Model 4
Structural characteristics				
# of Bedrooms	0.0559***	0.0560***	0.0560***	0.056***
# of Bathrooms	0.1669***	0.1650***	0.1667***	0.1649***
# of Parking Spaces	0.1444***	0.1440***	0.1444***	0.144***
Log of Lot Size	0.1924***	0.1921***	0.1925***	0.1922***
Location Characteristics				
Log Distance Downtown	-0.3531***	-0.3638***	-0.3616***	-0.3702***
Log Distance to the Lake	-0.0195**	-0.0214**	-0.0223**	-0.0235**
Log Distance to Train	-0.0650***	-0.0657***	-0.0654***	-0.0661***
Airport within 1 mile[a]	-0.0693**	-0.0470**	-0.0652**	-0.0443**
Neighborhood characteristics				
Log Per-Capita Income	0.1159***	0.1223***	0.1143***	0.1208***
Percent w/College Degree	0.0068***	0.0068***	0.0068***	0.0068***
Percent Black/African American	-0.0071***	-0.0070***	-0.0071***	-0.007***
Percent Hispanic	-0.0055***	-0.0054***	-0.0056***	-0.0054***
Log Per-Cap Property Crime Rate	0.0363**	0.0338**	0.0339**	0.0319***
Log Per-Cap Violent Crime Rate	-0.4697***	-0.4732***	-0.4705***	-0.4739***
Submarket Neighborhoods				
Near North/Lake[a]	0.2094***	0.2185***	0.2086***	0.2177***
Southwest[a]	-0.1680***	-0.1636***	-0.1693***	-0.1653***
Park characteristics				
Log Distance to Large Park	-0.0316***		-0.0298***	
Large Park within 3000 feet[a]		0.1334***		0.1295***
Small Parks				
Log Distance to Small Park			0.0251***	0.0215***
Within 1500 feet[a]	-0.0185**	-0.0155**		
Pool in Nearest Park[a]	-0.0292***	-0.0293***	-0.0314***	-0.031***
Playground in Nearest Park[a]	0.0467***	0.0506***	0.0461***	0.0501***
Soccer Field in Nearest Park[a]	0.0378***	0.0386***	0.0351***	0.0363***
Constant Term	11.7204***	11.4528***	11.64***	11.3905***
Adjusted R-squared	*0.7875*	*0.7829*	*0.7871*	*0.7831*
Number of Observations	*11,113*	*11,113*	*11113*	*11,113*

[a]Dummy variables

*significant at 10% level; ** significant at 5% level; *** significant at 1% level

Discussion of Results

All of the models display good fit with the adjusted R^2 consistently around .78, and strong significance and expected signs for most property, neighborhood and location variables. Estimates did not change significantly across models yet all are reported to show the consistency of the park variables, regardless of specification. The home structural characteristics are as expected—significant and strong marginal contributors given the incremental change from the addition of a bedroom, parking spot or bathroom. Sales prices decrease with distance to downtown and transit stops, and properties within one mile of an airport experience lower sales prices, as expected.

Income, education, the race/ethnicity variables and violent crime are all significant with the expected signs. The results indicate that an increase in property crime has a positive incremental effect on sales price. This could be due to strong effect of violent crime and the prevalence of property crime in wealthier areas but a more careful examination into property crime rates is necessary before conclusions can be reached. Only the two strongest submarket indicator variables were used in the models reported here to distinguish the outlier areas with the highest sales prices and the lowest sales prices.

The park variables yield mixed results. Proximity to large parks have significantly positive effects on sales prices, regardless of specification. The marginal effect of proximity to a large park is smaller than the effect of proximity to downtown, the closest train stop or the closest airport, but larger the effect of proximity to the Lake. Proximity to small parks, on the other hand had a consistently negative effect on property values, regardless of specification. Additional specifications of the small park variable were explored including setting minimum size requirements for small parks of at least .15 acres and .25 acres. These specifications maintained the result of a negative effect of small parks on sales price. While this is somewhat hard to explain, an interesting result is that the amenities in small parks also had significant effects on sales price. Playgrounds and soccer fields were significant and positive however pools were significant and negative, which may be a result of more willingness to travel to use pools

leading to congestion or a loitering effect of public pool use. Several additional models were used to estimate the marginal effect of small park amenities on small park proximity but the overall effect was unclear. For small parks within 1500 feet of a property, the overall negative impact of small parks was reinforced but for small parks within 500 feet of a property, results were unclear as the positive playground effect dominated. While it's clear that the large parks in Chicago have positive effects on property sales prices, further research into the effect of small parks and small park amenities as well as other types of green space and recreational facilities is necessary to draw any general conclusions about the overall effect of green space investments.

V. Model Extensions and Current Research

The model shows the basic results of the effect of parks and amenities on home sales prices however there are other types of green space and amenities which affect property values in cities. The basic model is currently being enhanced to incorporate additional types of green space and the associated functions. The following concluding sections of the paper describe the framework for this research

Community Gardens in Urban Settings

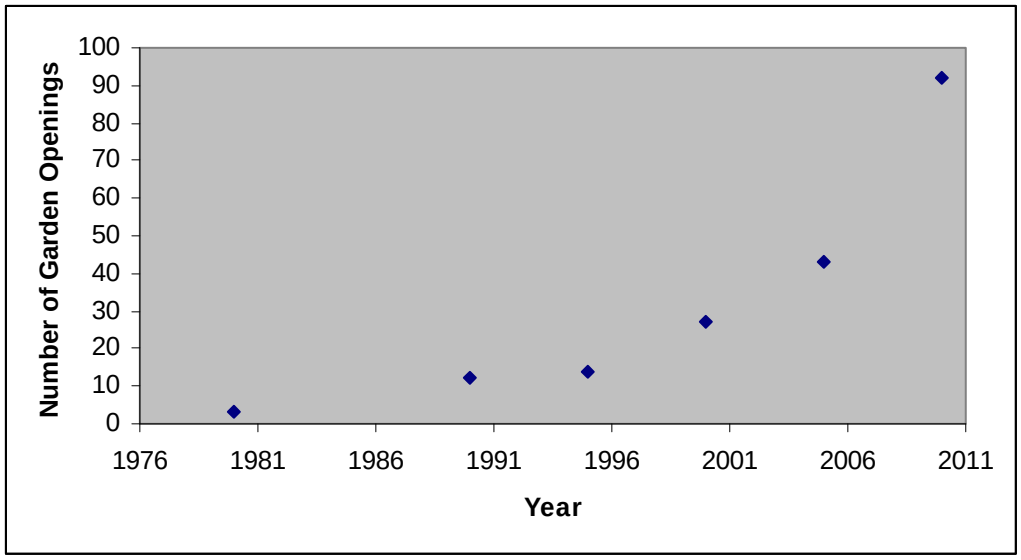
Increased interest in local foods, gardening and cooking, combined with concerns about community sustainability have led to significant growth in the development of community gardens across the country. This interest extends to urban areas where recent declines in land prices have increased the availability of land including the conversion of vacant lots into gardens and urban farms. In the summer of 2010, a survey of garden owners funded under the City's Greencorps[2] program was conducted

[2] The City of Chicago Greencorps program offers horticultural instruction, plant materials and technical assistance to organizations who garden in a public space including schools, faith institutions, libraries, public housing communities and block clubs. The program also provides a green jobs training program for qualified individuals. For more information, see http://www.cityofchicago.org/.

by the author along with the Department of Environment at the City of Chicago (Shaikh, 2011).

Figure 3 shows the number of garden openings in Chicago for gardens started through Greencorps indicating the growth in recent years.

Figure 3: Greencorps Garden Openings in Chicago (1980-2010)



Community gardens represent a different type of green space, both in terms of social engagement and economic production. In addition, gardens are easier to implement than new parks but are also less permanent, which makes application of the hedonic property method more complex due to garden spaces potentially being part of the residential housing market.

Figure 4 shows the concentration of Greencorps gardens and the spatial relationship to large parks while Figure 5 shows the relationship of gardens to the distribution of income in Chicago.

Figure 4: Chicago Greencorps Gardens and Large Parks

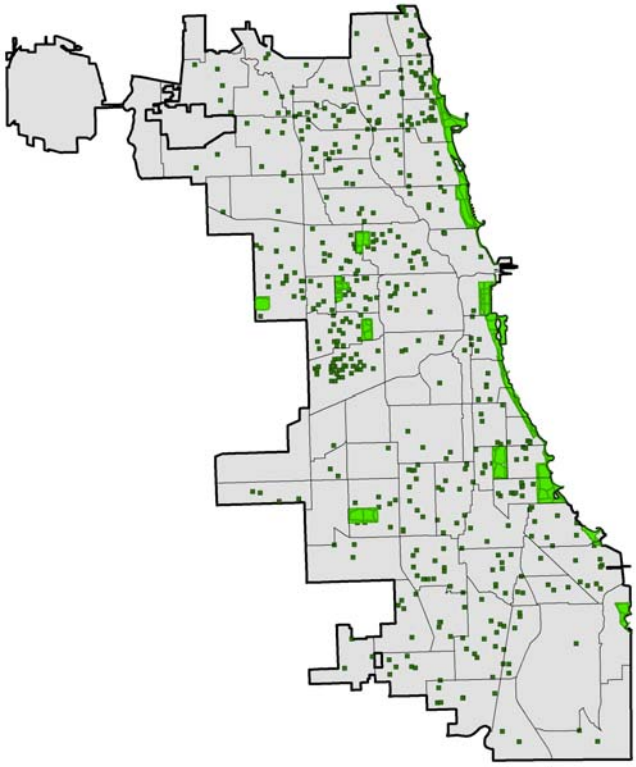
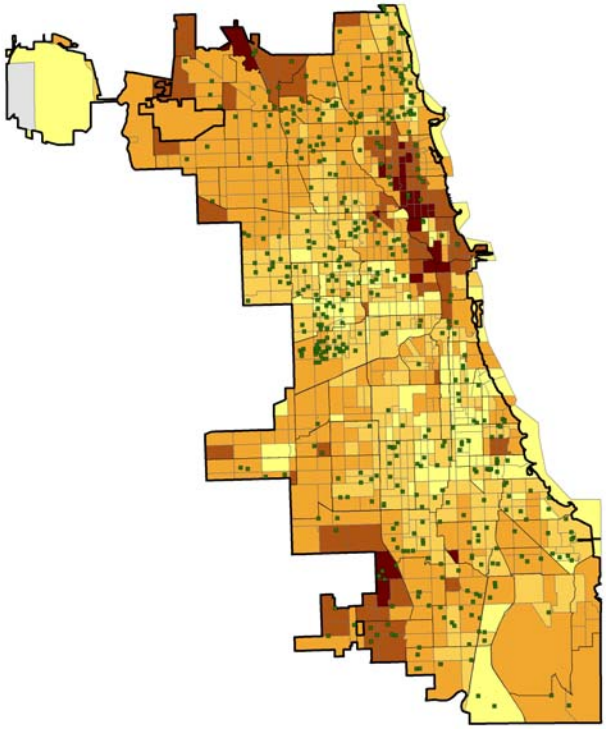


Figure 5: Chicago Greencorps Gardens and Income



In the only published hedonic property study of community gardens found to date, Voicu and Been use a difference-in-difference specification to find that community gardens in New York City have a positive effect on property values, particularly in the poorest neighborhoods. Since much of the recent focus for community gardens has been attached to the provision of fresh food and social activity in low-income areas, the results of this study reinforce the objectives of the City of Chicago's Greencorps program. In order to observe if a similar trend exists in Chicago, the conceptual model laid out in this paper will be applied to the data obtained from the Chicago garden survey and updated years of home sales data and census data, which is due to be released in 2011.

Ecosystem Service Valuation

Another extension of this model will also utilize spatial econometric methods for hedonic property models based on the work of Anselin (1988) and others. Since unobserved spatial heterogeneity can result in biased estimates and spatial auto-correlation can compromise efficiency (Irwin 2002), special attention must be given to models such hedonic property ones that rely on location specific effects.

An important component of this study is the specific ecological benefits provided by the functions of green space. These benefits are inherently spatial in nature due to ecological conditions, such as soil types and watersheds, and the population distribution of residents. Location becomes particularly important for ecological benefits which rely on connectivity of land and hydrological flows, which may or may not be fully represented in an economic study. Since green spaces provide various types of ecosystem services, spatial analysis could observe the marginal contribution of proximate green spaces to different services such as storm water and flood control, soil erosion and habitat provision. Since environmental planners and engineers often base the location of programs on physical indicators such as gallons of storm water diverted, a useful complement would be to quantify the economic value by location. Since ecosystem service value is inherently human-dependent, the economic value of green

space is dependent not only on ecological or physical indicators but also on the distribution of human population (Kozak, et al 2010).

Using the economic valuation model outlined here, additional GIS layers of ecological conditions will be applied in order to assess the ecological benefits per dollar spent on green space. The model will be applied in particular to storm water management, which is of upmost importance to municipalities seeking ways to utilize green infrastructure to manage problems associated with combined sewer systems. This model lays the groundwork for extensions as described above. Further research is currently underway for both the incorporation of community gardens and the spatial analysis of ecosystem service valuation.

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