THE INFLUENCE OF PARKS AND GREENSPACE ON THE VALUE OF COMMERCIAL REAL ESTATE

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THE INFLUENCE OF PARKS AND GREENSPACE ON THE VALUE OF COMMERCIAL REAL ESTATE

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DEDICATION

To Lindsey

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SUMMARY

The effect of parks on residential real estate has been well recorded; however little research has been done to estimate the effects of parks on commercial real estate values. With the help of Geographic Information Systems and the transactions of nearly 10,000 properties from 2000 to early 2011, I produced three different hedonic commercial real estate sales models. Controlling for building characteristics, demographic variations within census groups, and locational attributes, I find that proximity to parks plays a role in the valuation of some property types. Little evidence is found to support the hypothesis that properties in proximity to parks are valued higher; however co-location of parks and other attributes could play a beneficial role in supplying cities with more parks while boosting surrounding property values.

CHAPTER 1

INTRODUCTION

Commercial real estate (CRE) pricing is marked by a wealth of anecdotal evidence, but lacks rigor on the determinants of rents and prices. Previous studies focus on structural characteristics and some have involved locational characteristics, but most remain focused on a single to a few property types. There is considerable interest in the roles that parks and green space play in spatial variation in commercial properties in urban and suburban areas.

More recently, interest in the benefits of green space brought on by the wave of green infrastructure benefit studies makes this concern evermore salient (De Ridder et al., 2004). In the recent past, perceptions of green space and parks have shifted and this could be reflected in a change in the prices of commercial real estate buildings (Kaplan, Austin, & Kaplan, 2004). One study has looked at whether "green" in the form of Leadership in Energy and Environmental Design (LEED) certification pays off for buildings, and this study will seek to determine whether different property types value proximity to "green" park space and, if so, then how much (Eichholtz, Kok, & Quigley, 2009).

If society values parks on a greater scale than previously, then there is considerable belief that placing parks near different commercial structures could have positive benefits for property values within urban settings (Gregory McPherson, 1992). This could manifest itself in the form of parks near offices for employees to enjoy breaks and recreation time. Multifamily properties could increase prices for improved views and a place of recreation within walking distance of their facility. Raw land in proximity to parks benefits from unobstructed views and a potential to integrate designs that embrace parks and green space into their future improvements.

The Purpose of this paper is to provide evidence on the locational determinants of various commercial property values in the Atlanta region. My analysis is unique in that the data focus on a broad array of property types and merges transaction information with geographical information system data, allowing construction of direct measures of distance to recreation, proximity to important transportation hubs, and census block group level data. It is my hope to determine whether parks influence property values with a measurable degree of statistical significance.

CHAPTER 2

LITERATURE REVIEW

Previous studies have found that parks influence property values in residential properties. Homes located closer to successful parks command higher values (Crompton, 2001b). This study investigates the price-distance relationship by measuring distance from the homes to the closest park and relies on a Geographical Information Systems (GIS)-based system to measure locations. Generally, proximity to parks is found to increase housing prices, but not in all cases (Crompton, 2001a). The magnitude of the value of locating close to parks is found to be substantial in many studies, but these studies overlook the effects on commercial property values. Given the extensive amount of commercial properties, it would be beneficial to understand the price effects of locating near parks.

Bastian et al. look at raw rural lands in Wyoming to discuss the differences in land value based on recreational and scenic amenities associated with some lands versus others. They find that the impact of amenity and agricultural productions are statistically significant. Their findings point to the fact that amenity variables such as scenic views, distance to town, and sport fishery productivity can have positive effects on prices. Their research demonstrates that the value of some property types is contingent on certain environmental amenities (Bastian, McLeod, Germino, Reiners, & Blasko, 2001).

Miller et al used a sample of 643 energy star office buildings located in a number of cities, and over 2,000 non-energy star buildings to regress the price premiums associated with Leadership in Energy and Environmental Design- certified office buildings. Using CoStar, a commercial real estate database, they find their results support the hypothesis of the additional value of LEED certified buildings. They find that investment in LEED certified buildings pays off. Little attention is paid to locational variables. They only focus on dummy variables for certain years, specific cities, age, and whether the structure is LEED certified (Miller, Spivey, & Florance, 2008). This study suffers from a lack of spatial amenity values, which have been shown to significantly affect the values of properties, and my study will address this shortcoming.

A study performed by Smith examines the impact of economic development tools such as Tax Increment Financing (TIF) on the local commercial real estate market. Studying Chicago and using a data set of 4,022 commercial sales observations, Smith's results show that TIF designation stimulates market interest expressed as an increase in the rate of change in implicit prices for Chicago (Smith, 2009). Smith's study only estimated the effect of the distance to central business districts, but did little to study additional locational factors.

Bollinger et al. used a sample of a few thousand office buildings located in Atlanta to regress the quoted annual rental rate per square foot of office space on building characteristics and locational variables. Their primary focus was to determine whether the proximity of office buildings to central business districts (CBD) are reflected in office rents. Using data from the city of Atlanta they use a regression to determine rent costs on various locational and structural variables. Some of these important variables included the number of floors, the total square feet, along with the distance to CBD. Their results indicate that the value of meeting face-to-face and locational proximity to CBDs are still an important part of pricing office buildings (Bollinger, Ihlanfeldt, & Bowes, 1998). This study is the first to consider more locational variables for office structures and considers the distance versus dummy variables.

My research is distinguished from the above studies by the use of extensive sale data of nine commercial property types and not well-understood amenity values. Parks have been shown to create statistically significant effects on the values of residential structures; however no research in the United States has considered the price effect on commercial real estate of proximity to parks. In the next section, the theoretical model which underlies my estimated equations is presented. Cleaning of the data was necessary to remove those observations with missing or miscoded variable information.

CHAPTER 3

DATA

The study area is the Metropolitan Statistical Area (MSA) of Atlanta, Georgia, which contains the entire city of Atlanta and all surrounding suburban areas of 50 cities and 28 counties. The Atlanta MSA is a large area with a population of 5,475,213 and covers 8,376 square miles ("Metropolitan and Micropolitan Statistical Area Estimates," 2011). Using CoStar, a complete description and sale price[1] of every commercial transaction from January 1st, 2000, to February 20th, 2011, was obtained and combined with various neighborhood characteristics believed to influence property values. Property transactions were divided into nine different property types including industrial, retail, sports and entertainment, flex, healthcare, hospitality, land, office, and specialty. One would anticipate the determinants of price would differ based on the property types. In the case of parks, one could assume the effect of parks to make little difference for the price of industrial properties and a statistically significant difference for hospitality properties. The land transactions have the potential to mirror mostly neighborhood characteristics outside of their few structural characteristics including size and geographic features which were subsequently unreported. The neighborhood attributes were obtained from U.S. Census data (*circa* 2000) and Atlanta Regional Commission Databases.

Nineteen variables are included to measure the attributes of the location that would enter a property's value function and possibly affect how that building was valued. These variables included distance from a variety of public safety buildings such as police departments (lpddist) and fire departments (lfiredeptdist). Additionally, the proximity to transportation types was measured by looking at the distance to expressways

[1] Prices were adjusted for real values using Atlanta consumer price index.

(lexpressdist) and MARTA rail lines (lmartarail). Proximity to certain public services also included the distance to prisons (lprisondist), nursinghomes (lnursingdist), health departments (healthdepdist), state buildings (statebuilddist), and colleges (highereddist) and schools (lschooldist). The distance to central business districts was measured (lcbd_dist) with the assumption that, in most cases, the central business district would be located closely to town halls with the exception of Atlanta where Midtown and Five Points subway stations served as central business districts. The focus of this study was to measure the benefits of proximity to parks; therefore distance to parks was measured (lparkdist).

In addition to these distance variables, six of the nineteen variables described the locational aspects of properties at the block group level. This study investigated the price effects of properties located with specific percentages of certain populations (percblack and perchisp). Furthermore, the number of manufacturing jobs (manufact) and unemployed persons (unemploy) were measured. It is anticipated that these variables could affect prices of properties. Lastly, the median incomes (lmed_inc) and median housing values (lmed_hou_val) of block groups of properties were tracked to understand price effects for certain properties. Table 1 provides a list and explanation of all relevant variables.

Table 1 Variable Definitions and Sources

Variable	Definition	Data Source
lsaleprice	Natural log of the sale price	CoStar
woodframe	Building is constructed by wood frame, yes = 1	CoStar
masronry	Building is constructed by masonry, yes = 1	CoStar
steel	Building is constructed by steel, yes = 1	CoStar
metal	Building is constructed by metal, yes = 1	CoStar
reinforcedconcrete	Building is constructed by reinforced concrete, yes = 1	CoStar
land_area	Size of the property (Acres)	CoStar
numberof1bedrooms	Total number of 1 bedrooms on property	CoStar
numberof2bedrooms	Total number of 2bedrooms on property	CoStar
numberoffloors	Total number of floors on property	CoStar
numberof3bedfrooms	Total number of 3 bedrooms on property	CoStar
numberofotherbedrooms	Total number of 4+ bedrooms on property	CoStar
totalparkingspaces	Total number of parking spaces on property	CoStar
numberofrooms	Total number of rooms on property	CoStar
numberofunits	Total number of units on property	CoStar
parking_ra	Parking ratio on property	CoStar
percentoffice	Percent office on property	CoStar
loading_do	Total number of loading docks on property	CoStar
atlanta	Property is located in city of Atlanta, yes = 1	CoStar
sportsentertainment	Property is classified as sports and entertainment, yes = 1	CoStar
specialty	Property is classified as Specialty, yes = 1	CoStar
retail	Property is classified as retail, yes = 1	CoStar

office	Property is classified as office, yes = 1	CoStar
multifamily	Property is classified as multifamily, yes = 1	CoStar
land	Property is classified as land, yes = 1	CoStar
industrial	Property is classified as industrial, yes = 1	CoStar
hospitality	Property is classified as hospitality, yes = 1	CoStar
healthcare	Property is classified as healthcare, yes = 1	CoStar
flex	Property is classified as flex, yes = 1	CoStar
educ	The average number of years of education within block group of the property	2000 Census
lparkdist	Natural log of the distance to parks	ARC
lcbd_dist	Natural log of the distance to central business district	ARC
lprisondist	Natural log of the distance to prison	ARC
lfiredeptdist	Natural log of the distance to fire department	ARC
lhighereddist	Natural log of the distance to higher education facility	ARC
lpddist	Natural log of the distance to police department	ARC
lnursingdist	Natural log of the distance to nursing home	ARC
lhealthdepdist	Natural log of the distance to health department	ARC
lstatebuilddist	Natural log of the distance to state government building	ARC
lschooldist	Natural log of the distance to school	ARC
lmartaraildist	Natural log of the distance to marta rail line	ARC
lexpressdist	Natural log of the distance to expressways	ARC
age	Age of property	CoStar
lbldg_sf	Natural log of the total square feet of improved property	CoStar
manufact	Total number of manufacturing jobs within block group of the property	2000 Census
unemploy	Total number of unemployed workers within block group of the property	2000 Census
percblack	Total percent of population that is African American within block group of the property	2000 Census
perchisp	Total percent of population that is Hispanic within block group of the property	2000 Census

lmed_inc	Natural log of the median income of population within block group of the property	2000 Census
lmed_hou_val	Natural log of the median house value within the block group of the property	2001 Census
agesquared	Age of property squared	CoStar
build_code	Property is classified as class A = 1, B = 2, C = 3, D = 4, F = 6	CoStar
Popdensity	The number of individuals living within the block group	ARC

Park space descriptions were provided by the Georgia GIS Clearinghouse. These park polygons provided a number of details about the parks including attributes making it possible to see how specific attributes of parks can influence property values. It is anticipated that the contribution of parks to property values fluctuates based on the different types of commercial properties.

To compute the proximity of each commercial property to address characteristics, each property in the MSA was spatially referenced with the aid of a digitized map obtained through CoStar. The map contains the latitude/longitude coordinates of the centroids of all of the properties. This reference makes the properties accurate within three feet. With the use of ARCVIEW Geographic Information Systems (GIS), linear distances to a number of neighborhood characteristics were computed for each property and then logged. Table 2 provides the summary statistics of all variables.

TABLE 2 Summary Statistics for Variables

Variable	Observations	Mean	Std. Dev.	Min	Max
lsaleprice	13452	14.15833	1.198221	9.21034	19.8932
woodframe	13519	0.115097	0.3191511	0	1
masronry	13519	0.368592	0.4824409	0	1
steel	13519	0.035136	0.1841296	0	1
metal	13519	0.046009	0.209513	0	1
reinforcedconcrete	13519	0.109624	0.3124314	0	1
land_area	13519	14.6476	55.51264	0.02	2125
numberof1bedrooms	13519	2.764702	21.63998	0	550
numberof2bedrooms	13519	3.718026	26.54085	0	630
numberoffloors	13519	0.814187	1.60206	0	50
numberof3bedfrooms	13519	0.796361	7.646476	0	192
numberofotherbedrooms	13519	0.020712	1.13363	0	100
totalparkingspaces	13519	47.87248	180.1347	0	6868
numberofrooms	13519	1.170057	14.39081	0	521
numberofunits	13519	10.33789	59.76598	0	1180
parking_ra	13519	0.773814	1.835281	0	10
percentoffice	13519	1.702024	9.462587	0	100
loading_do	13519	0.843554	6.598229	0	245
atlanta	13519	0.147496	0.3546129	0	1
sportsentertainment	13519	0.001701	0.0412134	0	1
specialty	13519	0.013758	0.1164909	0	1
retail	13519	0.234559	0.4237384	0	1
office	13519	0.101117	0.3014947	0	1
multifamily	13519	0.056365	0.230634	0	1
land	13519	0.435017	0.4957776	0	1
industrial	13519	0.117021	0.3214566	0	1

hospitality	13519	0.010282	0.1008804	0	1
healthcare	13519	0.004438	0.0664743	0	1
flex	13519	0.025742	0.1583691	0	1
educ	13519	1382.061	1387.155	0	8309
lparkdist	11969	10.5354	0.8555513	5.32713	12.9443
lcbd_dist	11969	9.15293	0.8940975	4.3266	11.9954
lprisondist	11969	9.208319	0.8640089	1.90712	11.0627
lfiredeptdist	11969	8.396748	0.7931255	2.72417	10.0434
lhighereddist	11969	9.524496	1.020376	3.05343	11.7855
lpddist	11969	8.738173	0.8573791	1.90712	10.9269
lnursingdist	11969	8.213496	0.8986564	0.131948	11.0727
lhealthdepdist	11969	10.06152	0.8161031	4.71901	11.3273
lstatebuilddist	11969	10.65167	1.118549	5.08276	12.8052
lschooldist	11969	10.51715	1.343143	4.34727	12.9311
lmartaraildist	11969	10.24357	1.524644	1.92877	12.9448
lexpressdist	11969	9.885598	1.610969	4.38559	12.8774
age	13519	2.97E+1	20.33144	1	1.81E+2
lbldg_sf	13519	134.8399	153.6595	0	986
manufact	13519	73.11022	173.961	0	4182
unemploy	11631	30.53639	29.62855	0	100
percblack	11631	9.920138	12.51116	0	78.2327
perchisp	11622	10.73744	0.4317712	7.823646	12.1281
lmed_inc	11315	11.81881	0.4803106	9.769957	13.72646
lmed_hou_val	13519	1294.275	2030.291	1	32761
agesquared	13519	9.546686	1.482859	4.85203	14.28551
Popdensity	11643	1.04E+7	9497213	0	1.38E+08
build_code	5674	2.55E+00	6.17E-01	1	6.00E+00

CHAPTER 4

MODEL

The model for hedonic price estimation was divided into three distinct models. The first hedonic price model estimated the effects of sites are expressed as follows:

(1a) $\log SP_{\text{all properties}} = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \varepsilon.$

Where:
logSP = natural log of the sale price of all properties
α = The intercept
β_1 = The coefficient of structural characteristics
β_2 = The coefficient of locational characteristics
β_3 = The coefficient of all census related data
ε = The robust error term

This model looked at the transaction of all commercial property types, and the regression included every variable in the first model. One exception to using all available variables involved the inclusion of a building code variable to the office transactions regression (2a). The building code was not a recorded factor in the other property types, but it is very likely that this building code will be statistically significant for office properties. The regression in model 1a was performed to determine whether certain characteristics were important across all property types.

Eq. (1) assumes the price-distance relationship, or price-distance gradient, is described by the reciprocal transformation. Under this transformation, a negative estimated coefficient for the distance variable indicates that a price will decrease with distance at a linear rate.

The functional form used in Eq. (1) was chosen based upon the following process. First, I identified functional forms which imply a price-distance gradient that is consistent with the nature of the external effects parks and other neighborhood characteristics may have on nearby properties: local flora may (1) provide an air filter, (2) infiltrate and reduce stormwater, (3) create a recreational amenity to those nearby. The magnitude of these effects is expected to decline with an increasing distance from parks to a negligible level at some certain distance. The nature of the external effects of parks thus implies that price will decrease with distance from parks until the price effect is negligible.

The second model was developed to break down regressions based on individual property types versus the combination of all in the first model. Two exceptions to this second model include not individually regressing healthcare and sports and entertainment facilities. There were too few observations to run individual regressions on those property types. The individual property type regression models are as follows:

(2a) $\log SP_{office} = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \varepsilon$
(2b) $\log SP_{retail} = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \varepsilon$
(2c) $\log SP_{industrial} = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \varepsilon$
(2d) $\log SP_{multifamily} = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \varepsilon$
(2e) $\log SP_{land} = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \varepsilon$
(2f) $\log SP_{flex} = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \varepsilon$
(2g) $\log SP_{specialty} = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \varepsilon$
(2h) $\log SP_{hospitality} = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \varepsilon$

It is anticipated that the different models will produce different coefficients for independent variables, and different variables will be statistically significant based on the property type.

The third model is as follows:

(3) $\log SP_{allproperties} = \alpha + x_{prop}\, \beta_1 x_1 + x_{prop}\, \beta_2 x_2 + xprop \beta_3 x_3 + \varepsilon$

Where:

x_{prop} = a dummy variable discerning whether the property was a certain type and it's corresponding interaction variable. For instance, if the model is analyzing an industrial property, then the variable would be valued as one instead of zero. The variable is then multiplied by different independent variables to measure interactions.

All models are estimated using sales over the period 2000 through 2011. The length of this period provided a satisfying number of sales for most of the nine land uses. The control variables entering Eq. (1) are extensive. The variables generally fall into three categories: property characteristics that are provided by CoStar, location oriented variables that are created with GIS; and location-oriented variables assigned by census block group.

Briefly, the property characteristics include the lot-size and the square footage, age, and a quality type and adequacy. Location-oriented variables included distances to the fifty city central business districts, expressways, and subway railways. Also included are variables describing the exterior wall type, the parking type and adequacy. Variables that vary by census block group include population density, employment densities, percent of the population that is non-white, and the real median household income in the block.

Eq. (1) is estimated without separating for eight different property types: multifamily buildings, industrial facilities, office buildings, retail buildings, vacant land, flex, specialty, and hospitality. The vacant land category excludes all lots zoned for single family homes. In preliminary regressions, all 54 variables were included for each land-use. As expected with this number of property descriptors in each equation, there were many variables with statistically insignificant coefficient estimates. In the final regressions reported here, variables with p-values greater than .05 were dropped from each equation leaving only results that rejected the null hypothesis with a 95% confidence interval.

Eq. (2) is estimated by separating out each property type to discern where the differences among property types were, and also to imprecisely understand whether some property types could be pooled together based on their variables. I wanted to determine what the price effects were on individual property types for distance to park space. The results would indicate whether certain property types valued proximity to park space more or less than other property types.

Eq. (3) estimates how some of the variables regressed in property type interact based on the property type. Using a Chow test, this model estimates how the coefficients of the same variables on different property types behaved and how closely they behaved the same (Toyoda, 1974). Specifically, this model focuses on whether the different property types can pool together the natural logarithm of the distance to parks. It is anticipated that these cannot be pooled together because dissimilar property types will value the proximity to parks differently.

Some final estimation issues remain. The first concerns whether sales price observations should be restricted to only those properties which lie within some maximum distance from a commercial property site. The second issue is whether a correction for heteroscedasticity is necessary.

CHAPTER 5

RESULTS

Three separate regression models were estimated:

(1) Simple natural log of the sale price model that included all variables except the building code, and looked at the coefficients understood across all property types

(2) Specific independent models including all possible independent variables for each property type (office, retail, industrial, multifamily, land, flex, specialty, and hospitality)

(3) Stacked model and chow test to determine whether the coefficients of independent variables for different property types behave the same

The resulting log-linear model was estimated.

5.1 Simple Model

Table 3 reports the results obtained from estimating all property type gradients for metropolitan Atlanta using 'simple' models. Only the statistically significant variables are shown; however the full output is available in the appendix. Consider the second column, which reports the results obtained from the regression of the natural log of the sale price of all property types on all variables. Measuring the distance from parks did not return any statistically significant result for the first model.

Table 3 Simple Model Output

Number of Observations: 9996

F(50,9945): 277.84
R-squared: 0.7128
Root MSE: 0.66365

lsaleprice	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]	
lparkdist	0.019811	0.013934	1.42	0.155	-0.0075	0.047125	
woodframe	0.11858	0.024143	4.91	0	0.071255	0.165904	**
masronry	-0.11096	0.017219	-6.44	0	-0.14471	-0.07721	**
steel	0.296975	0.039686	7.48	0	0.219182	0.374769	**
metal	-0.49954	0.035094	-14.23	0	-0.56833	-0.43075	**
reinforcedconcrete	0.157137	0.022627	6.94	0	0.112783	0.20149	**
numberof1bedrooms	0.004256	0.002129	2	0.046	8.31E-05	0.00843	*
numberof2bedrooms	0.005001	0.002219	2.25	0.024	0.000652	0.009351	*
atlanta	0.049318	0.022018	2.24	0.025	0.006159	0.092477	*
educ	7.22E-05	1.19E-05	6.05	0	4.88E-05	9.56E-05	**
lprisondist	0.035105	0.010624	3.3	0.001	0.01428	0.055929	**
lhighereddist	-0.04939	0.00947	-5.22	0	-0.06796	-0.03083	**
lmartaraildist	-0.03946	0.010329	-3.82	0	-0.05971	-0.01921	**
age	-0.02791	0.001008	-27.69	0	-0.02988	-0.02593	**
manufact	-5.01E-04	0.000108	-4.65	0	-0.00071	-0.00029	**
percblack	-0.0027	0.000377	-7.15	0	-0.00343	-0.00196	**
lmed_hou_val	0.291085	0.023981	12.14	0	0.244076	0.338093	**
agesquared	0.000162	9.52E-06	1.70E+01	0	0.000144	0.000181	**
lbldg_sqft	0.602573	0.009761	61.73	0	0.583439	0.621707	**
popdensity	5.61E-09	9.59E-10	5.85E+00	0	3.73E-09	7.49E-09	**
_cons	6.339933	0.392833	16.14	0	5.569901	7.109965	**

(* = 95% confidence, ** = 99% confidence)

As the results show, most estimated coefficients for structural characteristics are statistically significant. Out of the following table, seven of the total nineteen structural variables are statistically significant. Prices are lower for buildings constructed with masonry and metal, but increase value when constructed from wood frames, steel, and reinforced concrete. Additionally, as the size of the building increases so does the price and this makes logical sense. Lastly, an increase in the number of units with two bedrooms and one bedroom returned a statistically significant result for the first model.

The age of a building had a significant effect on the price. The model formulated the natural log of the sale price a function of age and age squared, mimicking some turning point at which age increases the value of a property until a certain point. Consider the formula:

$$\mathrm{Ln}(saleprice) = Ax + Bx^2 + c$$

Where:

x = age (in years of building)

A = coefficient of age variable

B = coefficient of age^2 variable

C = constant term (intercept)

The value of properties age to a point where the price is at a minimum, and then they subsequently increase in value. The formula for this point is when $A + 2Bx = 0$. The value of properties according to the first equation bottom out at 86 years of age and then begin to increase.

From a locational perspective, the large model of all property types returns a handful of significant regression variables. Locating in the city of Atlanta improves property values with a good degree of statistical significance. There is an increase in property values for an increase in population density within the block group of the property and a positive increase in property values for a more educated block group.

Additionally, property values increased when they increased distance from prisons, which indicates a negative amenity value with locating close to prisons. Values decreased as properties moved away from higher education facilities, therefore there is a potential amenity benefit of locating close to colleges and universities. Interestingly, the value of properties increased as they moved from schools; however schools often locate in more residential settings. From a commuter and transportation aspect, properties located closer to rail benefit from higher prices.

As residential real estate studies term it, neighborhood characteristics also presented a statistically significant effect on property prices. For instance, an increase in the number of manufacturing employees negatively affected the value of properties. Also, an increase in the percentage of minority groups such as African Americans in the block group of a property had a negative effect on the value of the property. Property values significantly increased as the median value of homes increased.

5.2 Specific Independent Models

Results obtained from estimating models which include a full set of variables with regressions based on specific properties are on table 4. This table presents the statistically significant coefficients for the independent models and describes which independent variables are significant across different properties, and whether they are positive or negative.

Table 4 Specific Independent Models

	Hospitality		Retail		Office		Industrial		Multifamily		Land		Flex		Specialty	
lsaleprice	Coef.		Coef.		Coef.		Coef.		Coef.		Coef.		Coef.		Coef.	
lparkdist	-0.19843		0.071606	*	0.09465		-0.00808		0.014674		-0.01918		-0.11186		0.166616	
woodframe	0.283018		0.143127	**	-0.0921		-8E-05		0.051153		0.132516	**	-0.06391		-0.21912	
masronry	0.274909		-0.08098	*	-0.04063		-0.19625	**	-0.13558		-0.10623	**	-0.0299		-0.21406	
steel	-0.3616		0.261213	**	0.580807	*	0.369238	**	0.326419	*	0.253909	**	0.246057		0.063646	
metal	-0.26259		-0.58026	**	-0.29696	*	-0.65752	**	-0.45288	**	-0.41318	**	-0.6206	**	-0.61842	**
reinforced concrete	0.883852	**	0.136942	**	0.17739		0.243771	**	0.184802	**	0.131814	**	0.298517		-0.07423	
number of floors	0.036104		-0.02816		0.01766		0.063878		-0.01201		-0.0728		-0.13364		0.248167	**
parking ratio	-0.05427		0.010706		0.022153		0.007598		0.017689		0.251584	**	-0.03151		-0.03068	
percent office	(omitted)		0.002572		0.001139		0.000996		(omitted)		(omitted)		0.000157		-0.01348	**
atlanta	-0.35148		0.070444		0.047355		-0.06183		0.148493	*	0.075759		-0.06915		-0.12498	
education	0.000134		9.46E-05	**	3.55E-05		5.33E-05		3.56E-05		7.95E-05	*	0.000112		0.000186	
lcbd_dist	0.257713		-0.0191		-0.04037		0.008675		-0.04165		0.009113		-0.21346	**	-0.20443	*
lprisondist	-0.08139		0.048695	*	-0.05189		0.023822		0.099302	*	0.033398	*	0.082883		0.077557	
lfiredeptdist	-0.26989	*	0.019935		-0.01473		0.000326		0.085984	*	0.018851		-0.01088		0.074489	
lhighereddist	0.14684		-0.05256	**	-0.03599		-0.0517		-0.12326	*	-0.04984	**	0.113636		-0.08534	
lstatebuilddist	-0.58886	*	0.022262		0.01008		0.012151		0.106053	*	-0.03662		-0.15567		-0.2301	*
lmartaraildist	0.11894		-0.03889		-0.04126		0.012427		-0.09489	*	-0.04321	**	0.034707		-0.01421	
age	-0.06547	**	-0.02561	**	-0.0275	**	-0.02835	**	-0.02898	**	-0.02825	**	-0.03673	**	-0.02402	**
manufact	-0.00222	*	-0.00095	**	-0.0007		-0.00065	*	4.34E-05		-0.00042	*	-0.00093		-0.00053	
percblack	-0.00239		-0.00228	**	-0.00331		-0.00368	**	-0.00371	*	-0.00333	**	-0.00235		-0.0014	
lmed_inc	0.530394		0.006584		-0.00458		0.095939		-0.36241	**	-0.03317		-0.26265		0.1715	
lmed_hou_val	0.156228		0.306815	**	0.330217	**	0.277972	**	0.479798	**	0.241808	**	0.43261	*	-0.22005	
agesquared	0.000535		0.000145	**	0.000231	**	0.000163	**	0.000152	**	0.000166	**	0.000278	*	0.000135	**
lbldg_sqft	0.422762	**	0.610225	**	0.751276	**	0.624987	**	0.612016	**	0.613143	**	0.612087	**	0.611616	**
popdensity	5.55E-09		6.29E-09	**	-1.96E-09		6.84E-09	*	1.37E-09		6.33E-09	**	1.50E-08		-4.87E-09	
Build_Code	(omitted)		(omitted)		-0.18771	**	(omitted)		(omitted)		(omitted)		(omitted)		(omitted)	
_cons	11.43939	*	4.706533	**	5.296551	**	5.800563	**	7.768593	**	7.357223	**	8.808994	**	12.58273	**
R-Squared	0.7856		0.7153		0.8084		0.7311		0.7725		0.7376		0.741		0.8062	
F	11.31		131.1		44.99		92.28		58.99				17.7			
Observations	99		2294		367		1143		574		4408		241		150	

(* = 95% confidence, ** = 99% confidence)

From a structural perspective, the results across the models returned some very consistent similarities and some coefficients unique to specific businesses. In terms of similarities, the size of the building was very consistent. All property types demonstrated with a 99% confidence interval that an increase in the size of the building resulted in greater property values. This helps confirm the validity of the model. In terms of quality, the building code for offices was a very important indicator for property values, and a higher number, which translates into a lower building class, resulted in statistically significant lower values. Structurally, wood frame buildings fared well for higher prices among retail and land properties. All other property types found the results to be statistically insignificant. Masonry structures resulted in lower prices across industrial, retail, and land property types while all others failed to return a statistically significant coefficient. Retail, industrial, multifamily, and land found steel structures to be statistically significant and a boost to property value; however office properties saw a decrease in property values with steel structures. Across all properties, metal structures were considered to be a negative attribute with the exception of office properties that actually have a significant increase in property values. Hospitality found the coefficient to be statistically insignificant. All property types found reinforced concrete structures to affect property values positively. In contrast, office and specialty didn't find reinforced concrete to return statistically significant coefficients. Specialty properties found an increase the number of floors to be positive and significant. A higher parking ratio yielded higher property values for land properties. For specialty properties, an increase in the percent office space decreased the overall value.

Measuring age was a beneficial metric. Most models returned a similar statistically significant result for the age and age squared variables. With the exception hospitality properties, all statistically significant properties returned a positive coefficient for age squared. The coefficients for age were negative and statistically significant for all properties.

The results of locational variables were rather informative. Multifamily structures concluded that locating in Atlanta yielded higher property values. Retail and land regressions demonstrate that locating in block groups with higher levels of education increased property values. As the distance from the central business district increases, the value of flex and specialty properties decreased. Retail, multifamily, and land all benefit in the form of higher property values from increasing distance from prisons. Land, retail, and multifamily properties decrease in value if they are located further from colleges and universities; however retail and land properties benefit from higher values as they locate further from schools. Hospitality and specialty properties both decrease in value as they locate farther from state buildings; however multifamily establishments actually increase in value as they locate farther. Multifamily and land values decrease as the distance from subway rails increases.

From a census-data perspective, the results tell a clear story. Land, hospitality, retail, and industrial property values are harmed by locating in block groups with higher manufacturing employment levels. Industrial, land, multifamily, and retail properties decrease as the percentage of African Americans increases. As the median income of the block group of the property increases, the value of multifamily property decreases. All properties with the exception of hospitality and specialty increase in value with a statistical significance as the median housing values increase. As the population density increases so does the value of retail, industrial, and land properties.

Parks had little influence on property values from the individual models. In spite of all but one property returning statistically insignificant results, a model of the trends is an interesting result to investigate. Table 5 illustrates the results of a model estimating the price effect of $1,000,000 properties of all types increasing their distance by 10%

from a park. These results illustrate a potentially negative trend for land, flex, hospitality, and industrial facilities.

Table 5 Illustration of Spatial Price Effect of Parks from Second Model

PROPERTY	Coefficient	Price 10% dist	Δ Price	Price (95% Conf. Int.)	
SimpModel	0.019811	$ 1,001,981	$ 1,981	$ 999,250	$ 1,004,713
Office	0.0946504	$ 1,009,465	$ 9,465	$ 997,373	$ 1,021,557
Retail	0.0716056	$ 1,007,161	$ 7,161	$ 1,001,535	$ 1,012,786
Land	-0.0191801	$ 998,082	$ (1,918)	$ 994,136	$ 1,002,028
Flex	-0.1118618	$ 988,814	$ (11,186)	$ 968,810	$ 1,008,817
specialty	0.1666162	$ 1,016,662	$ 16,662	$ 992,210	$ 1,041,113
hospitality	-0.1984296	$ 980,157	$ (19,843)	$ 932,980	$ 1,027,334
industrial	-0.0080834	$ 999,192	$ (808)	$ 990,618	$ 1,007,765
multifamily	0.014674	$ 1,001,467	$ 1,467	$ 988,768	$ 1,014,167

5.3 Stacked Model Results

The results of the regression output of the stacked model are available in the appendix. Table 6 illustrates the results of the various Chow tests from modeling Eq. (3). The regression of the independent variables and their interaction terms with each property type illustrates that park coefficients cannot be pooled together by all properties. Additionally, the F values are too great to pool distance to central business districts, the population density, building square-footage, and median income hang on the edge. All variables with an F value lower than 1.5 could be effectively pooled together as they are in the first model.

Table 6. Chow Test Results

Variable	F	Prob > F
lparkdist	1.83	0.0666
lcbdist	1.73	0.087
lbldg_sf	1.43	0.1171
steel	1.29	0.2451
metal	1.14	0.3341
rein. Concrete	1.2	0.2941
med income	1.42	0.1829
perchisp	0.54	0.8014
percblack	0.8	0.6
popden	1.67	0.1118
age & age^2	0.98	0.4811

Though no results appear statistically significant, they point to how properties are likely to be affected by proximity to parks. The stacked model illustrates the differing values placed on parks by the different commercial properties. Though not statistically significant, the results for flex, land, hospitality, industrial, and multifamily properties all demonstrate decreasing property values for an increase in distance from parks. Table 7 demonstrates how a 10% increase in distance from a park influences the values of properties differently. For example, consider in table 7 where I assume eight different property types worth $1,000,000 increase their distance from a park by ten percent. The resulting numbers illustrate that land, flex, hospitality, industrial, and multifamily property values suffer.

Table 7 Simple Illustration of Spatial Price Effect of Parks[2]

PROPERTY	Coefficient	Price 10% dist	Δ Price	Price (95% Conf. Int.)	
Office	0.0748652	$1,005,078.20	$5,078.20	$956,957	$1,053,199
Retail	0.0393843	$1,002,655.78	$2,655.78	$954,911	$1,050,401
Land	-0.01374	$997,474.42	-$2,525.58	$949,895	$1,045,054
Flex	-0.0379849	$996,610.03	-$3,389.97	$946,594	$1,046,626
specialty	0.0813996	$1,008,807.55	$8,807.55	$956,945	$1,060,670
hospitality	-0.0382332	$999,234.22	-$765.78	$945,847	$1,052,622
industrial	-0.0273853	$995,725.23	-$4,274.77	$947,646	$1,043,805
multifamily	-0.0217449	$997,517.93	-$2,482.07	$948,957	$1,046,079

[2] The estimated changes in price contain a significant amount of noise. The 95% confidence interval puts the effect of a 10% increase in distance from parks a negative or positive number. This is informative for trends; however

CHAPTER 6

CONCLUSIONS

This study has provided evidence on the factors that influence spatial variation in different types of commercial real estate transactions. Controlling for structural characteristics, locational characteristics, and census-related features, I find that the variable measuring proximity to park space has an effect on property values and some types of properties benefit from locating closer to parks.

The model demonstrates validity by the consistency of results among key property indicators such as home values, property building sizes, structural variables, and age. This consistency is further demonstrated through the stacked model and chow tests illustrating how the behavior of these variables closely related and could therefore be pooled together across all property types.

The results of the output demonstrate the effect of park space on a variety of property types. The log linear distance to parks represents such a small part of the pricing effects however. After conducting the Chow tests, the results show that the behaviors of the coefficients for distance to parks are not the same. From this research I conclude that there exists an effect of parks on commercial property values and dissimilar property types value parks differently. From this result, I draw the conclusion that locating new parks close to land, flex, hospitality, industrial, and multifamily properties could positively affect the value of those properties. Locating retail close to parks lowers the value of that retail property, and this was a surprising result.

The Chow tests were able to tie together an important aspect of the age equation. Because the F value result from the chow test for age and age^2 was low, the results from the first model are more valid. Looking at the age across all property types is acceptable and demonstrates that all property types can be modeled as a quadratic equation. These results were interesting.

Locational variables were all very small determinants of price by comparison to structural variables. The coefficients of distance variables were all low, and therefore represented a small portion of explanation for the prices of properties. Location was outweighed by structural and census-related variables.

The implications of parks having small effects on commercial values are numerous. If parks alone do not boost surrounding commercial property values, then there is an opportunity for co-location of parks and structures that boost property values in proximity to those structures. From the results, one can infer that co-locating subway stations and parks has the potential to boost property values. These transit-oriented hubs could serve as a center for commuters, outdoor meeting places of businesses, and a place of recreation as commuters wait for the arrival of their transportation. Additionally, the acquisition of land near higher education facilities for the purpose of a "university" park could boost surrounding property values. This expansion would be a part of the campus, and therefore positively affect the values of properties that migrate closer to the campus.

Other studies have investigated the effects of values on commercial properties such as multifamily, offices, retail, and industrial properties. The trends of their findings are consistent with the results of my models. From a census data perspective, certain minority populations contributed to a decrease in property values (Ihlanfeldt & Taylor, 2004). This decline in property values was consistent with my findings. Additionally, an increase in unemployment in the census block group of multifamily properties resulted in an increase in the values of the multifamily properties. One study finds that an increase in the employment density in the tracts of multifamily properties resulted in a decrease in the value of those properties (Ihlanfeldt & Taylor, 2004). This similarity in trends illustrates a potential relationship between apartments and employment densities worthy of further study.

My results for increasing population densities paralleled population density estimates. As population density increased in the Ihlanfeldt et al. study, the value of the properties consistently increased (Ihlanfeldt & Taylor, 2004). All statistically significant results in my study illustrated the same effect.

This study is not without areas deserving improvement and exploration. One critical point of conflict is not studying causality. If the data on parks could have contained when parks were created, and I had transaction data on the same properties before and after the parks creation, then I would be able to perceive whether parks and their creation improve property values.

Anecdotally, parks are not singular entities but a package of benefits located near properties. Parks can be indicative of a community placing an amenity in a region because of the region's health or economic performance. Parks can be symptomatic of healthy communities, but not actual creators of those communities. In further studies I hope to identify indicators of park performance, and return to this data understanding the transactions in proximity to varying qualities of parks.

In sum, commercial property values are priced by a good mix of variables, and parks play a role in that pricing. Transaction values are dominated by structural characteristics of a building, the age, building class, and the size of the structure. Additionally, prices are influenced by the region in which the property is located by demographics, incomes, and home values. This doesn't conclude that parks always provide a minimum effect on prices. Parks come in a variety of qualities, and there exist examples of spectacular commercial real estate locating next to parks, resembling New York City's Central Park or London's Hyde Park. This study represents a formative effort at understanding the effects of parks and green space on commercial property values within the city of Atlanta.

APPENDIX A: RESULTS TABLE

Table 8 Stacked Models

lsaleprice	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]	
lparkdist	0.159462	0.120933	1.32	0.187	-0.07759	0.396515	
steel	7.29E-01	3.28E-01	2.22	0.026	8.62E-02	1.37E+00	*
lmed_hou_val	0.320933	0.114387	2.81	0.005	0.096711	0.545156	**
retlparkdist	-0.1329	0.122639	-1.08	0.279	-0.3733	0.107494	
offlparkdist	-0.10868	0.124556	-0.87	0.383	-0.35284	0.135475	
indlparkdist	-0.20221	0.124347	-1.63	0.104	-0.44595	0.041534	
multilpark~t	-0.18428	0.126803	-1.45	0.146	-0.43284	0.064276	
landlparkd~t	-0.18472	0.121795	-1.52	0.129	-0.42346	0.054025	
flelparkdist	-0.19336	0.134225	-1.44	0.15	-0.45647	0.069747	
speclparkd~t	-0.07139	0.143647	-0.5	0.619	-0.35296	0.21019	
hosplparkd~t	-0.16712	0.151424	-1.1	0.27	-0.46394	0.129701	
multilcbd_~t	-0.28216	0.137447	-2.05	0.04	-0.55159	-0.01274	*
speclcbd_d~t	-0.41447	0.153265	-2.7	0.007	-0.7149	-0.11404	**
hospagesqu~d	0.000582	0.000246	2.37	0.018	9.99E-05	0.001064	*
multilmed_~c	-0.25665	0.081281	-3.16	0.002	-0.41598	-0.09732	**
multilmed_~l	0.315952	0.133776	2.36	0.018	0.053724	0.578181	*
hospage	-0.05332	0.02299	-2.32	0.02	-0.09839	-0.00826	*
retlbldg_s~t	0.383548	0.1613	2.38	0.017	0.067368	0.699728	*

indlbldg_s~t	0.390164	0.161378	2.42	0.016	0.073831	0.706498	*
multilbldg~t	0.399259	0.161816	2.47	0.014	0.082066	0.716452	*
lanlbldg_s~t	0.391771	0.161268	2.43	0.015	0.075653	0.707888	*
flexlbldg_~t	0.373894	0.164448	2.27	0.023	0.051542	0.696245	*
speclbldg_~t	0.382962	0.165887	2.31	0.021	0.057791	0.708134	*
_cons	4.500338	0.313554	14.35	0	3.885709	5.114968	**

REFERENCES

Bastian, C., McLeod, D., Germino, M., Reiners, W., & Blasko, B. (2001). Environmental amenities and agricultural land values: a hedonic model using geographic information systems data. *Ecological Economics, 40*, 337-349.

Bollinger, C. R., Ihlanfeldt, K. R., & Bowes, D. R. (1998). Spatial Variation in Office Rents within the Atlanta Region. *Urban Studies, 35*(7), 1097-1118.

Crompton, J. (2001a). The Impact of Parks on Property Values: A Review of the Empirical Evidence. *Journal of Leisure Research, 33*(1), 1-31.

Crompton, J. (2001b). Perceptions of How the Presence of Greenway Trails Affects the Value of Proximate Properties. *Journal of Park and Recreation Administration, 19*(3), 114-132.

De Ridder, K., Adamec, V., Bañuelos, A., Bruse, M., Bürger, M., Damsgaard, O., . . . Weber, C. (2004). An integrated methodology to assess the benefits of urban green space. *Science of The Total Environment, 334-335*, 489-497. doi: DOI: 10.1016/j.scitotenv.2004.04.054

Eichholtz, P., Kok, N., & Quigley, J. M. (2009). Doing Well By Doing Good? Green Office Buildings.

Gregory McPherson, E. (1992). Accounting for benefits and costs of urban greenspace. *Landscape and Urban Planning, 22*(1), 41-51. doi: Doi: 10.1016/0169-2046(92)90006-l

Ihlanfeldt, K., & Taylor, L. (2004). Externality effects of small-scale hazardous waste sites: evidence from urban commercial property markets. *Journal of Environmental Economics and Management, 47*, 117-139.

Kaplan, R., Austin, M. E., & Kaplan, S. (2004). Open Space Communities: Resident Perceptions, Nature Benefits, and Problems with Terminology. *Journal of the American Planning Association, 70*(3), 300 - 312.

Metropolitan and Micropolitan Statistical Area Estimates. (2011). *Population Estimates* Retrieved March 25, 2011, from http://www.census.gov/popest/metro/CBSA-est2008-annual.html

Miller, N., Spivey, J., & Florance, A. (2008). Does Green Pay Off? *Journal of Real Estate Portfolio Management, 14*(4), 385-399.

Smith, B. (2009). If You Promise to Build It, Will They Come? The Interaction between Local Economic Development Policy and the Real Estate Market: Evidence from Tax Increment Finance Districts. *Real Estate Economics, 37*(2), 209-234.

Toyoda, T. (1974). Use of the Chow Test under Heteroscedasticity. *Econometrica, 42*(3), 601-608.