PARK AVAILABILITY AND EXPENDITURE EFFECTS ON CRIME, POVERTY, WEALTH AND OBESITY INDICATORS

by

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Urban parks play an important role in cities. Lack of understanding about their effects on urban dwellers and their capacity to play a role in promoting social well-being could diminish their benefits. With population growth in cities, park managers may need to increase the quantity and quality or diversify parks to achieve the same results. The relationship between availability and expenditure on parks and urban quality of life has received little research attention. An analysis of 75 US cities determined that park density, operational expenditure and park acreage as a percentage of the city are significantly related to average levels of income, obesity and violent crimes. Optimum park density is 49 people per acre of park. Violent crime is a key determinant of whether urban parks generate a virtuous cycle improving health and income and reducing obesity rates or a vicious cycle achieving the contrary.

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CHAPTER I

INTRODUCTION

Some literature suggests that urban parks have a key role in affecting behavior, levels of stress, health and other aspects that contribute to the livability and management costs of a city. The study of optimal aspects of parks, type of investments, facilities, distribution and numbers of parks in a city has been somewhat marginalized in the literature. This may have undermined the perceived value and the potential of parks to achieve social and economic objectives for decision and policy makers.

There is general consensus in the literature regarding the potential and actual benefits that society derives from urban parks. Recent studies show that parks increase property taxes from increasing housing values in their proximities and provide health benefits from promoting exercising and reducing stress levels. They can help reduce crimes, attract a higher paid workforce to cities, enhance the quality of the air and water, and reduce water runoff costs and others.

Three major papers have addressed how crime plays a key role in the benefits that societies derive from parks. Troy and Grove (2008) find that parks can either create a virtuous or vicious cycle on housing prices and that this effect depends on crime. S Doyle, A Kelly-Schwartz, M Schlossberg, and J Stockard (2006) find the same relationship between obesity rates, crime and walkability. Gobster (1998) finds that parks can work as ethnic magnets or ethnic walls and also that crime is a determinant factor.

Kuo and Sullivan (2001) find that urban vegetation reduces crimes in a study conducted at Ida B.Wells, a large public housing development in Chicago. Troy and Grove (2008), Doyle et al (2006), Gobster (1998), Kuo and Sullivan (2001) suggest that parks have the

potential to reduce crime by creating more cohesive communities and reducing stress levels, among other factors; and that the management, quality, distribution and quantity of parks can be a determinant factor which policymakers can affect.

The four studies mentioned above and others later mentioned usually have utilized small samples and have approached this area with a variety of methods; Doyle et al. (2006) utilized a big sample but directly examined park variables only in preliminary studies. Doyle (2002) preliminary study with a six city sample found "that the communities with a higher number of acres of parks per thousand people were also the communities with lower than expected levels of heart disease" (Doyle, 2002, p. 64). This thesis has the objective of expanding the evidence to test these relationships from studying the largest US cities for which data is available.

In doing so I also want to explore the possible relationship of poverty with high park densities, low percentage of city parks and high investment per acre of park. If parks attract higher income populations they may also influence gentrification. It is possible that such a park area to investment structure generates gentrification and this may be related to extreme poverty rates in cities.

Thesis Structure

This thesis is organized into five chapters. Chapter two reviews the literature on the subject. Chapter three out lays the methods and describes the variables utilized in this study; chapter four presents my findings, and chapter five gives the conclusions and describes possible future research.

CHAPTER II

LITERATURE REVIEW

The importance of Urban Parks has been addressed through history. In the nineteenth century Frederick Olmsted (1997) noted "the influence and value of a public recreation ground in preserving the health and vigor and especially the moral tone of the larger class" (p. 108). More recently, the Trust for Public land has determined seven major quantifiable benefits obtained from urban parks: "property value, tourism, health, community cohesion, clean water, and clean air" (Harnik and Welle, 2009, p. i).

Troy and Grove (2008) find that "increasing desirability of parks and decreased levels of crime self-reinforce each other, creating a virtuous green cycle" (p. 244). They also find that the opposite is true. "As crime rates climb above this threshold, the direction of the relationship switches and parks negatively influence house prices" (p. 244). This dynamic is also found with obesity rates, crimes and walkability. (Doyle et al, 2006)

This chapter is divided into four categories, each of which deals with factors that have been linked to parks in the literature. The first section addresses health, the second crime, the third wealth and poverty and the fourth briefly touches on environmental services.

Health

The literature suggests that the study of the relationships between health and parks in urban areas is still in its preliminary stages, and, as Payne, Orsega-Smith, Godbey and Roy (1998) point out, this is critical knowledge as public recreation and park services are reconceptualized. The connections are starting to develop. For instance, Doyle et al. (2006) found that walkable areas with low crime rates reduce obesity. Payne et al. (1998) found a strong relationship between the health of older adults and presence of local parks. One of their conclusions is that local parks save health costs in the most health expensive and intensive health user demographic group.

Bedimo-Rung, Mowen, and Cohen (2005) note that "previous leisure research has focused on the role of park-based leisure in improving moods, reducing perceived stress, and enhancing a sense of wellness. However, few studies have explicitly investigated the impact of park-based leisure activity levels on the physical health of park users" (p. 161). Similarly, Coley, Levine, Kuo and Sullivan (1997) noted that, "natural landscaping encourages greater use of outdoor areas by residents. Spaces with trees attracted larger groups of people, as well as more mixed groups of youth and adults, than did spaces devoid of nature" (p. 468)

The benefits from parks and green spaces are not only related to wellness and obesity rates. Bodin and Hartig (2003) conclude that green spaces also affect the restoration gained through outdoor running. Ulrich (1981) studied how green views in hospital rooms accelerate recovery, reduces nurses' complaints on patients, analgesic drugs taken by patients, and other factors. These results suggest that is not only the use of parks that benefits health; it is also being in and looking at natural environments that increase health.

The classic literature links many of the benefits to health from parks to environmental factors. "Physicians and concerned laypersons became empiricists of the physical landscape and atmosphere in an attempt to better understand issues of health and well-being. Physicians supplied the essential connection for the development of a salubrious landscape by evaluating specific characteristics of air, land, and water that

were believed to affect human health; in so doing, they contributed to a general public understanding of the correlation of health and environment" (Szczygiel and Hewitt, 2000, p. 734).

As noted in this section the benefits of urban parks related to health extend the effect of exercising to faster recovery rates, lower stress levels, perceptions of better health, better quality of air, water and others. Given the lack of adequate data this study focuses on the correlation between the existence of parks and obesity rates when accounting for income, poverty, crime and different park variables.

Crime

Crime and urban parks seem to be correlated and engaged in dynamics with housing prices and obesity rates. Pendelton (2000) comments, "to suggest that leisure settings are or will be plagued with crime is not warranted by existing data... recent events combined with a limited amount of emerging data simply signal that the issues of crime and enforcement are, in some way, a part of the leisure experience" (p. 115).

Gobster (1998) finds that parks work as green magnets in separating ethnic groups when levels of crimes are low; the opposite is also true when crime is high in cities. As mentioned earlier this dynamic is also true with housing prices, parks and crime levels. Low crime levels and proximity to parks reinforce each other increasing housing prices, the opposite is also true with high crime levels. (Troy and Grove, 2008)

Several studies related to at risk youth programs have addressed the need to utilize parks and recreation resources to back up school learning and youth at risk programs. (Witt, 2004) (Witt, 2001) Others have also found that after school programs reduce behavioral problems in youth. (Gregory, 1996), (Steinberg, Riley and Todd, 1993) Levels of vegetation have been also found to reduce crime rates. Kuo and Sullivan (2001) note "the findings indicate a large and systematically negative link between levels of vegetation and police reports of crime in this setting" (p. 360).

There is evidence that crime acts as a decisive component related to possible park benefits or liabilities. The hypothesis currently is that crime and parks are engaged in a

dynamic process in which they build on each other over time. Adequate park management and amenities have been found to affect crime but no studies found to date have addressed how spending on parks or quantity of parks may affect crime and create either a virtuous or vicious cycle.

Pendleton and Thompson (2000) analyze the criminal career in leisure and recreation settings. They suggest crime in these places happens in a step process in which different strategies should be utilized to reduce it at different stages. "Without a park-specific model of crime and enforcement, managers are left to conventional beliefs about crime, criminals, and cops that, in our experience, often miss the mark" (p. 63)

Studying crimes in the parks context requires a diverse set of perspectives. I want to determine what park variables are related to crime and also account for crime as a possible factor that controls the relationship with obesity, income per capita and poverty. This study utilizes crime variables as both dependent and control variables in different regression analyses.

Wealth and Poverty

"The work on landscape amenities has identified positive values for proximity to public parks, privately owned open space, the natural land cover immediately surrounding household locations and access to natural views." The same study also finds that housing prices increased within a 0.1 kilometer ring of parks, but decreased in relation to the percentage of open space within 1 kilometer ring surrounding the house (Nechyba and Walsh, 2002, p. 189).

An increase in housing demand in an area due to the existence of a park not only results in attracting a higher income population; it also increases the property taxes collected in those areas. Harnik and Welle (2009) conclude that the economic benefit from parks in the city of Washington was $1,198,858,025 for property values and the tax capture from the increased property value due to parks was $6,953,377 in 2006. Bolund and Hunhammar (1999) also report that urban areas with better and more parks have a higher paid workforce.

Parks provide free recreation and exercising that would otherwise have to be obtained with private funds or at recreation areas located at further distances. Harnik and Welle (2009) find that the value of recreation from Boston parks in 2006 to individuals, calculated as the cost they saved from not paying for park amenities, was $354,352,402.

Estabrooks, Lee and Gyurcsik (2003) utilize a series of case studies to demonstrate how physical activity is different in low and high-income populations due to accessibility, quantity and quality of parks in those neighborhoods. The literature suggests that investment in city parks and the creation of new urban parks may have a gentrification effect, but I have not found research literature that reports this relation.

The relationship between income, poverty, crime, and parks may be complex. It is possible that wealthier communities will spend more on parks and have more parks per resident, also attracting higher paid workforce. On the other hand, if crime rates are high and/or if poverty is high, the expenditure and quantity of parks may be lower and yield fewer benefits.

Examining the impact of income per capita may help reveal the connections between park variables and other outcomes, such as obesity rates and crime rates. Therefore utilizing crime and income per capita as both dependent and control variables may shed light on the different possible relationships.

Environmental Benefits

It is important to briefly mention that parks provide various environmental benefits such as clean air, temperature regulation, water runoff management, and water filtering. Because cities utilize enormous amounts of energy to provide clean water, air, to regulate temperature, and provide other environmental benefits, the energy and cost savings in this realm from parks are important, yet often unaccounted for. Unfortunately, lack of information regarding energy consumption, and water management costs in cities has made it impossible to explore this relationship within this thesis.

Summary and Research Questions

Literature suggests that park availability and expenditure may be associated with obesity rates, income per capita, poverty, and crime rates. Literature also suggests that crime rates may play an important role determining the benefits that parks may yield to society. This thesis has two main objectives, the first is to answer the following research questions and the second is to propose further studies.

These are the research questions:

- What are the relationships between park densities, park expenditure and park percentage of city land area?
- Is there a relationship between parks in city (measured by investment in parks per acre, park density and park % as land area) and obesity, income, poverty and crime rates when controlling for latitude, age of city, crime, poverty and income per capita?
- Is there a curvature in the relation between park variables and obesity, income, poverty and crime variables?
- Is one of the park measures in cities either more significantly or less significantly related to any of the dependent variables?

CHAPTER III

VARIABLES AND METHODS

This chapter is divided into two sections, data sources and analysis. The first section introduces the sources of the information utilized to calculate the dependent and independent variables. This section also includes a brief explanation of the dependent and independent variables. The second section describes the specific analysis I utilized.

Data Sources

The data utilized for this thesis come from a variety of sources. The data on crime was downloaded from the FBI statistical records. (http://www.fbi.gov) From this dataset I utilized violent crime and motor vehicle theft data.

The data for population per city, income per capita, extreme poverty, and latitude came from the census 2008 American community survey. (http://factfinder.census.gov)

Obesity rates were obtained from the National Center for Chronic Disease Prevention and Health Promotion 2008 survey. (http://apps.nccd.cdc.gov)

The data on park acres, park expenditure, park acres as percent of city acres, park operational expenditure and recreational expenditure came from The Trust for the Public Land. (http://www.tpl.org)

City foundation dates came from the 2010 World Almanac. (World Almanac, 2010)

Dependent Variables

- Violent Crimes per capita: This variable was created by dividing the total number of violent crimes reported by the total number of habitants in each city.
- Motor Vehicle Theft per capita: This variable was created by dividing the total number of motor vehicle theft crimes reported by the total number of habitants in each city.
- Income per capita: This variable is directly used from the American Community Survey and it represents total monetary income in a city divided by the total inhabitants.
- Extreme poverty: this variable represents the percentage of people in a city whose income is less than one-half of the officially designated poverty level.
- Obesity rates: The obesity rates represent the population percentage in each city whose BMI (body mass index) is greater than 30. The National Center for Chronic Disease Prevention and Health Promotion considers persons with a BMI greater than 30 to be obese.

Independent Variables

- People per acre of park (Park Density) was computed by dividing the total population per city by the acres of park in the city. This figure represents how many people exist per acre of park and is named park density since it represents the population density per acre of park.
- Park expenditure per acre of park (2007): total park expenditure divided by the total acres of park per city. Included in the park expenditure is operational expenditure (Landscape and tree maintenance, other maintenance tasks, recreational programming, administration and debt service) and capital expenditure (capital improvements, land acquisition). Data on the investment in parks are from the year 2007 which is the most recent year The Trust for the Public Land has data available. All the expenditure-in-parks variables for this study are from 2007.

- Operational expenditure per acre of park (2007): This variable is calculated by dividing expenditures on landscape and tree maintenance, other maintenance tasks, administration and debt service by the total acres of park.
- Capital expenditure per acre of park (2007): This variable is calculated by dividing capital expenditures, including capital improvements and land acquisition, by the acres of park per city.
- Recreational expenditure per acre of park (2007): Recreational expenditure divided by the total city acres of park.
- Park acres as % of city land area: This variable is taken directly from the Land for the Public Land Trust. It is the total park area divided by the total city area.

Control Variables

- Latitude: This variable is the location of the different cities in a north to south direction, thus providing a rough measure of warmth of climate, which could be related to demand and use of parks, and maintenance of them due to climate.
- City Age in years: The city foundation dates represent an historical timeline of cities design and planning thoughts. Many cities had a diverse foundation mode; I have tried to use dates of either European foundation or European acquisition from Indians. Taking 2008 as a base I calculated the age of each city in years. The age of cities could be related with different planning stages, the use of the automobile and other factors that may affect land use form.

Analysis Plan

I explore the relationships between the different measures of park availability and expenditure in cities and obesity rates, income per capita, poverty, motor vehicle theft, and violent crimes while also controlling for latitude, crime, income per capita and age of city.

The main steps include the creation of a data base, analysis of possible outliers, regression analysis, residuals analysis, quadratic analysis, analysis between the park variables, a five-city analysis and a frequency of effect conclusion chart.

Data Base

This first task this thesis required was the creation of the database for the 77 biggest US cities for which the Trust For the Public Land had park data. I joined the data available in excel format with SQL based on their city's name. The variable information that was obtained in a PDF format was manually copied into the database. Having the main variables I proceeded to do the arithmetic to create variables per capita, per acre of park, logarithms and other needed variables.

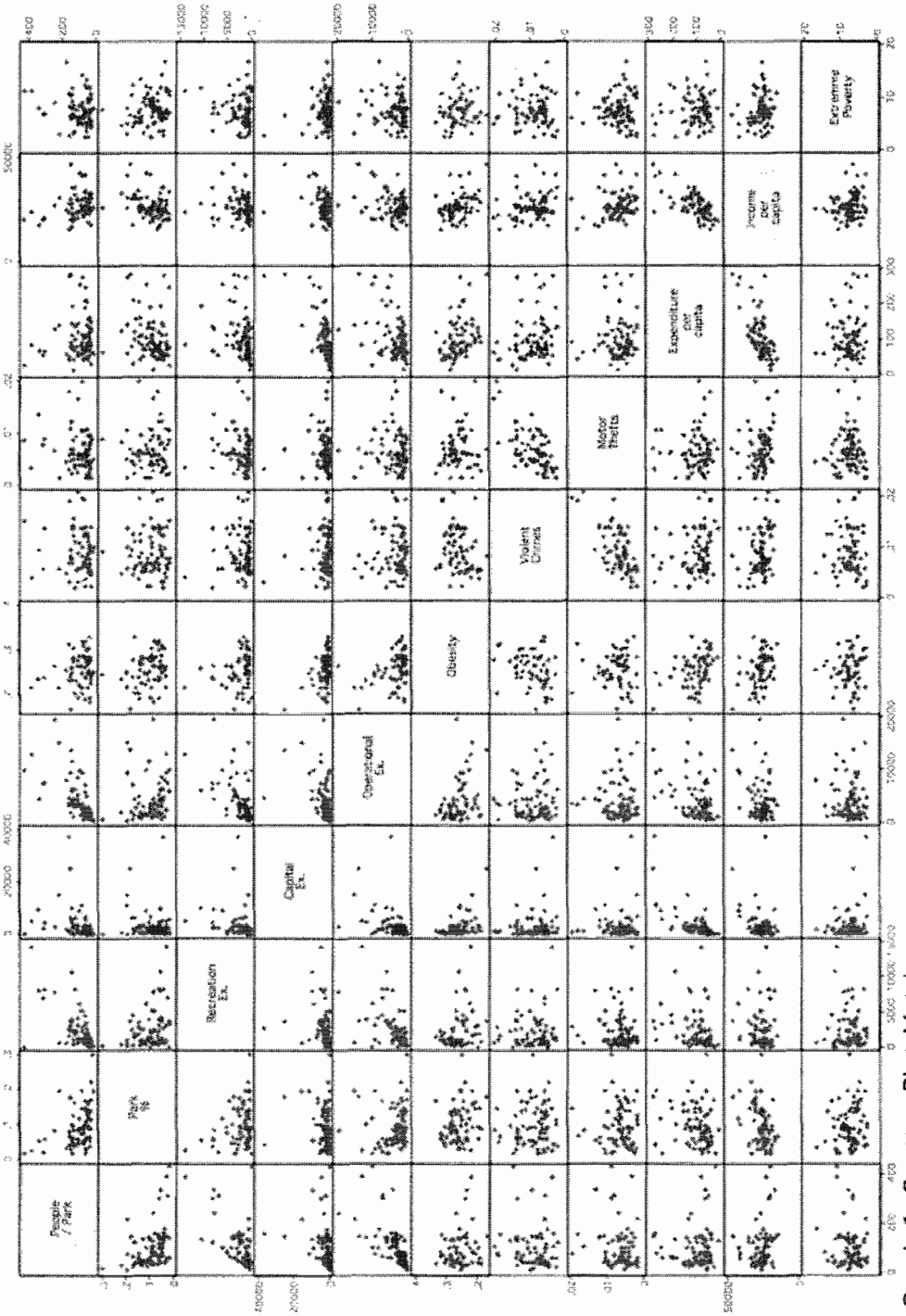
Outliers and Logarithms

When my dataset was complete and a distribution analysis was done, two cities, Anchorage and Santa Ana, were identified as outliers and eliminated from the study. The rest of the analysis is based on the 75 other cities. The 77 cities with their park density indicator and ranks are displayed in table 1. It is important to note that the outlier analysis was also performed for park percentage as city area and for expenditure per acre of park and both of these cities continue to stand out as outliers.

When analyzing the distribution of the different variables through box plots and scatter plots it was clear that the following variables required a logarithmic transformation: obesity rates, park density, park % of city acres, operational expenditure per acre of park, recreational expenditure per acre of park, and capital expenditure per acre of park. Graph 1 briefly displays how the selected variables to be log transformed have a distribution that is highly skewed and thus requires such transformation.

Table 1. Cities Rank Per Park Density

Rank	City	Park Density	Rank	City	Park Density
1	Anchorage	1	40	Washington	78
2	Jacksonville	8	41	Sacramento	80
3	Albuquerque	15	42	Arlington	80
4	El Paso	22	43	Wichita	82
5	Virginia Beach	24	44	St. Petersburg	83
6	Kansas City	26	45	Seattle	97
7	San Diego	28	46	Pittsburgh	99
8	Austin	29	47	Tampa	101
9	Raleigh	32	48	Denver	101
10	Louisville/Jefferson County metro government (balance)	35	49	St. Louis	105
11	Colorado Springs	37	50	Fort Wayne	105
12	Phoenix	37	51	Glendale	116
13	Aurora	38	52	Boston	121
14	Oklahoma City	38	53	Henderson	125
15	Charlotte	38	54	Buffalo	127
16	Bakersfield	38	55	Baltimore	130
17	Milwaukee	40	56	Toledo	133
18	Greensboro	41	57	Philadelphia	133
19	Portland	41	58	Las Vegas	138
20	Lincoln	42	59	Cleveland	139
21	Houston	43	60	Atlanta	140
22	Dallas	44	61	Corpus Christi	142
23	Omaha	46	62	Long Beach	142
24	Lexington-Fayette urban county	48	63	Jersey	145
25	Cincinnati	49	64	Tucson	148
26	Tulsa	53	65	San Francisco	150
27	Columbus	53	66	Detroit	155
28	St. Paul	56	67	Chandler	159
29	Nashville-Davidson metropolitan government (balance)	57	68	Los Angeles	161
30	San Jose	58	69	Mesa	177
31	Plano	59	70	New York	219
32	Honolulu CDP	60	71	Chicago	241
33	Fort Worth	64	72	Miami	304
34	Minneapolis	65	73	Fresno	316
35	Riverside	66	74	Newark	339
36	San Antonio	69	75	Anaheim	388
37	Indianapolis (balance)	72	76	Stockton	432
38	Memphis	73	77	Santa Ana	950
39	Oakland	77			



Graph 1. Scatter Plot Matrix

Regressions

There are two types of regressions performed, Lin-Log and Log-Log. (Gujarati, 2004) The first means that the X variables are log transformed and not the Y variables. The second means that both the X and Y variables are log transformed. The analysis per each dependent variable was performed in two step-wise backward elimination processes.

The first process started with a full model that regressed the dependent variables on the park-related independent variables. The second process started with the first full model with the addition of the following control variables: income per capita, crime rates, extreme poverty rates, age of city and latitude. Findings are only reported if they were found to be consistent in both processes and with identical coefficients encountered on the second process. Due to space and lack of marginal benefit the first process results are omitted.

In the second step-wise regression I started with the following model: Y = b0 + B1 Log Park Density + B2 Log Park % as City Area+ B3 Log Capital Expenditure per Acre + B4 Operational Expenditure per Acre + B5 Recreational Expenditure per Acre + B6 Age of City + B7 Latitude + B8 Income per capita + B9 violent crimes per capita + B10 Motor theft per capita + error. One by one I eliminated the less significant variables until only variables that were significant at a level $p< 0.10$ were left in the model. I utilized Q-Q graphs and residuals vs. fitted graphs to determine assumption problems.

The two models that I utilized include log-transformed variables. To interpret the lin-log models I utilized a factor of 2 to explain the effects as a doubling on the independent variable will be associated by a change in the mean of Y by a factor of log ($2^{\wedge B}$). The log-log model utilized in the obesity findings is interpreted as a doubling of X is associated with a change in the median of Y by 2^(beta) units. (Gujarati, 184) Log-lin models are interpreted as an unit change on X will change the median of Y by e^(beta). Variables that are not log transformed on both X and Y are interpreted as a unit change on X will have a beta*X change on Y.

If the model shows that any of the variables regarding parks were significantly related to the dependent variables I utilized a quadratic graphic and regression to see if there were optimum points for changes in this relationship. The model utilizes a square term for curvature and the non-squared variable. (Ramsey and Schafer, 2002) This regression was subject to the same residual analysis as the first regressions in the second regression process.

Relationship Between Park Variables

This section analyzes through scatter graphs the relationships between expenditure in parks, park density and park percentage of city acres. This analysis is conducted to determine the relationship between these variables and if there might be tradeoffs between the different park variables. The main tradeoff I expect to clarify is quantity of land as percentage of the city area versus expenditure per acre of land and people per acre of park.

City Analysis

I utilized 5 cities as case studies chosen by their characteristics on the park variables. I chose 2 cities with the closest number near an maximum or minimum from a quadratic effect of a park variable, 2 extreme cities and one average city. This section's purpose is to quantify the expected differences between the variables in the selected cities and compare them against each other and to their average.

Quartile Analysis

To further the findings on crime's relation to the possible benefits from urban parks I utilized manual breaks to create four crime categories. The objective of the manual break I utilized is to isolate the cities with the highest and lowest crime rates. With this information I compared cities in those two groups.

CHAPTER IV

FINDINGS

This report of the data analysis is divided into four sections. The first section, Summary Statistics, summarizes the data using descriptive statistics. The second section analyses the relationships between the different variables of parks, addressing question one. Section three, Dependent Variables Analysis, analyses variable-by-variable questions two and three. Section four, Park Density Relations, addresses questions two and four utilizing the findings from the previous sections, a specific five-city analysis, a quantile analysis and a significance conclusion.

To review, these are the research questions:

- What are the relationships between park densities, park expenditure and park percentage of city land area?
- Is there a relationship between parks in city (measured by investment in parks per acre, park density and park % as land area) and obesity, income, poverty and crime rates when controlling for latitude, age of city, crime, poverty and income per capita?
- Is there a curvature in the relation between park variables and obesity, income, poverty and crime variables?

- Is one of the park measures in cities either more significantly or less significantly related to any of the independent variables?

Summary Statistics

The summary statistics presented in table 2 exclude the 2 outliers mentioned in the methodology section. This table includes the 75 cities and the 12 variables I am using for this study.

It is important to note that the variable recreational expenditure per acre of park had two values of 0 and capital expenditure per acre of park had one value of 0. Applying a log transformation to both variables reduced the sample size by two cities from 75 to 73.

Table 2. Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Park Density	75	102	85	8	432
Park Acres / City Acres	75	0.10	0.06	0.02	0.3
Capital Expenditure / Acre	75	3390	5485	0	36809
Operational Expenditure / Acre	75	4075	3808	172	19569
Recreational Ex. / Acre	75	2412	2671	0	14101
Violent Crimes / Capita	73	0.0090	0.0044	0.0021	0.0208
Motor Vehicle Theft / capita	74	0.0067	0.0037	0.0014	0.0200
Income Per Capita	75	26449	5852	15255	46015
Poverty	75	7.6	2.8	2.5	16.7
Obesity Rates	64	0.26	0.04	0.17	0.33
Latitude	75	36.7	4.9	21.3	47.6
Age of City	75	216	85	55	467

Relationship Between Park Variables

There is an inverse relationship between park acres as percentage of city acreage and all the other park variables. When there is a higher percentage of park acres over city acres capital, operational and recreational expenditure per park acre diminish. The same holds true for park density, more percentage of acres of park over city acres diminishes the number of people per acre of park in a city. For park density an increase in park area holding the number of people constant reduces the amount of people per acre of park.

Table 3 is a correlation matrix between the different variables regarding parks. This table shows the strength of the relation between the percentage of park acreage, park density, the different measures of expenditure per acre of park and the dependent variables. A one percent increase in park density is associated with almost a half percent reduction in the percentage of park acreage. Also, the tradeoff for operational and recreational expenditure is almost 1/3 a percentage change in parks acres as percentage of cities acreage.

Table 3. Correlation Matrix

Logs	Obesity (ln)	Violent Crimes	Motor Vehicle	Income Capita	Poverty	Park Density (ln)	Park % (ln)	Rec. / Acre	Capital / Acre (ln)	Op. / Acre (ln)
Obesity (ln)	1									
Violent Crimes	0.27	1								
Motor Vehicle Cr.	-0.02	0.66	1							
Income Capita	-0.45	-0.3	-0.25	1						
Poverty	-0.03	-0.03	-0.002	-0.23	1					
Park Density (ln)	-0.19	0.2	0.21	-0.13	0.12	1				
Park % (ln)	-0.25	-0.14	-0.07	0.36	-0.25	-0.49	1			
Rec / Acre (ln)	-0.33	0.04	0.16	0.1	0.13	0.67	-0.23	1		
Capital / Acre (ln)	-0.44	-0.05	0.08	0.42	-0.02	0.53	0.01	0.57	1	
Op. / Acre (ln)	-0.37	0.002	0.13	0.24	0.13	0.79	-0.27	0.67	0.68	1

Dependent Variables Analysis

This section is divided into two main analyses that are reported on a variable-by-variable base. The first regresses the dependent variables on latitude, age of city, income per capita, violent crimes per capita, motor theft crimes per capita and the logarithms of park density, park acreage percentage of city acreage, operational expenditure per acre of park, capital expenditure per acre of park, and recreational expenditure per acre of park. This first analysis constitutes an elimination process of non-significant variables. The results are summarized in table 4.

The second analysis use quadratic equations focusing on cases where park variables are found to be significantly related to the dependent variables. In both analyses basic testing for collinearity and residual autocorrelations were performed.

Violent Crimes per Capita

Analyzing the relationship of parks to violent crimes per capita I found that park density and park operational expenditure are associated with violent crimes. The regression is violent crimes per capita = 0.012 – 0.0019 log operational expending per acre + 0.0028 Park Density + error. The adjusted R2 for this regression is 0.07

Keeping park density constant a doubling of operational expenditure in cities is associated with a decrease in violent crimes of -1.4 violent crimes per 1000 people, CI (-0.00259, -0.00015). Keeping operational expenditure per acre constant a doubling of park density is associated with an increase in the mean of violent crimes by 1.9 violent crimes per 1000 persons, CI (0.00047, 0.01492).

To put the effect of these variables in perspective the city with the minimum park density of 8 persons per acre of park will be expected on average to have 51 violent crimes per every 1000 persons less than a city with 432, the maximum people per acre of park found in the 75 cities. A city with 7.51 $/acre, the minimum operational expenditure per acre is expected on average to have 15 more violent crimes per 1000 persons than a city with the maximum operational expenditure per acre found in this 75 cities, 118.21$.

Table 4. Regression Table															
Regressions Table	Violent Crimes			Motor Vehicle Theft			Poverty			Income per Capita			Obesity Rates (ln)		
	b	s.e.	prob.	b	s.e.	prob.	b	s.e.	prob.	b	s.e.	prob.	b	s.e.	prob.
Constant	0.013	0.004	0.006	0.01	0.002	<0.001	-0.44	3.2	0.89	9152	4712	0.061	-1.09	0.141	<0.001
People / Park (ln)	0.003	0.001	0.010	------	------	------	------	------	------	-6253	1186	<.001	-0.069	0.025	0.007
Expenditure/park acres (ln)	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
Operational expend/park acres (ln)	-0.002	0.0009	0.029	------	------	------	------	------	------	3890	1041	<.001	------	------	------
Capital expend/park acre (ln)	------	------	------	------	------	------	------	------	------	1948	556	0.001	------	------	------
Recreat expend/park acre (ln)	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
Park acres/City acres (ln)	------	------	------	------	------	------	-1.18	0.53	0.03	------	------	------	-0.07	0.035	0.051
Income Per Capita	------	------	------	-1.37E-07	7.14E-08	0.06	------	------	------	------	------	------	-7.97E-06	2.85E-06	0.007
Violent Crimes Capita	------	------	------	------	------	------	------	------	------	------	------	------	14.62	4.84	0.004
Motor Theft Capita	------	------	------	------	------	------	------	------	------	-295481	148981	0.051	-12.15	5.61	0.035
Latitude	------	------	------	------	------	------	0.14	0.07	0.05	------	------	------	------	------	------
Age of City	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
R-Squared	0.09			0.03			0.09			0.416					0.382
R-Squared (adjusted)	0.07			0.01			0.06			0.393					0.326
F	3.52			1.97			3.49			12.63					6.91
prob.	0.034			0.16			0.04			<.0001					<.0001
n	73			74			75			73					62

In the former case there is much more variability, therefore making park density an important factor for city parks.

Analyzing the residuals there is no evidence of residual problems, I utilized Q-Q graphs and residuals vs. fitted graphs. The variables income per capita, poverty, age of city, latitude, capital expenditure, recreational expenditure and park acreage as city acreage were not found to be associated with violent crimes per capita. There was no quadratic relationship between park operational expenditure and park density and violent crimes.

Motor Vehicle Theft

Motor Vehicle theft is negatively correlated with income per capita and with none of the park variables. The impact of doubling motor vehicle thefts on income per capita is less than 0.0001.

Extreme Poverty

Extreme poverty in US cities is related to park area as percentage of city area and to latitude. Keeping the latitude constant a doubling of park acres as percentage of city acres is associated with a decline in the mean of poverty rate by a factor of -0.82%, CI (-1.55, -0.092). Maintaining park percentage of city area constant, every north degree change on latitude increases the mean of poverty by 0.14%. The adjusted R2 is 0.06.

Analyzing the residuals there was no evidence of residual problems, I utilized Q-Q graphs and residuals vs. fitted graphs.

There was also no evidence of quadratic effects of park acreage as percentage of city acreage. The other variables: income per capita, motor vehicle theft per capita, violent crimes per capita, park density, park expenditure per acre of park variables, and age of city were not found to be associated with poverty rates.

Obesity Rates

Obesity rates are associated with park acreage as percentage of cities' acreage, people per acre of park and income per capita. Ceteris paribus in park acreage as percentage of city acreage and income per capita a doubling in park density is associated with a decline in obesity rates by a factor of 0.953, (CI: 0.921, 0.987). Keeping park density and park acreage as percentage of city acreage constant, a increase in 1000$ in the income per capita is associated with a decrease in the median of obesity rates by a factor of 0.99, CI (0.999, 0.999). Keeping income per capita and park density constant a doubling of park acres as percentage of city acres is associated with a decline in obesity rates by a factor of 0.953, (CI: 0.907, 1).

Violent crimes are positively associated with obesity rates while motor vehicle crimes per capita are not. Every extra violent crime per 1000 people committed in cities, is associated with an increase of obesity rates by a factor of 1.015. Every extra vehicle theft per 1000 persons decreases obesity rates by a factor of 0.988.

The adjusted R2 is 0.33; this means that violent crimes per capita, motor vehicle crimes per capita, park acres as percentage of city acres, park density and income per capita explain over 30 percent of the variation in cities' obesity rates. No other variables were found to be associated with obesity rates at a 95% or 90% confidence interval. This analysis included all park variables, income per capita, poverty rates, age of city and latitude.

Analyzing the residuals there was no evidence of residual problems, I utilized Q-Q graphs and residuals vs. fitted graphs. Also evidence suggesting a quadratic effect was rejected once performing the necessary regression and test.

Income per Capita

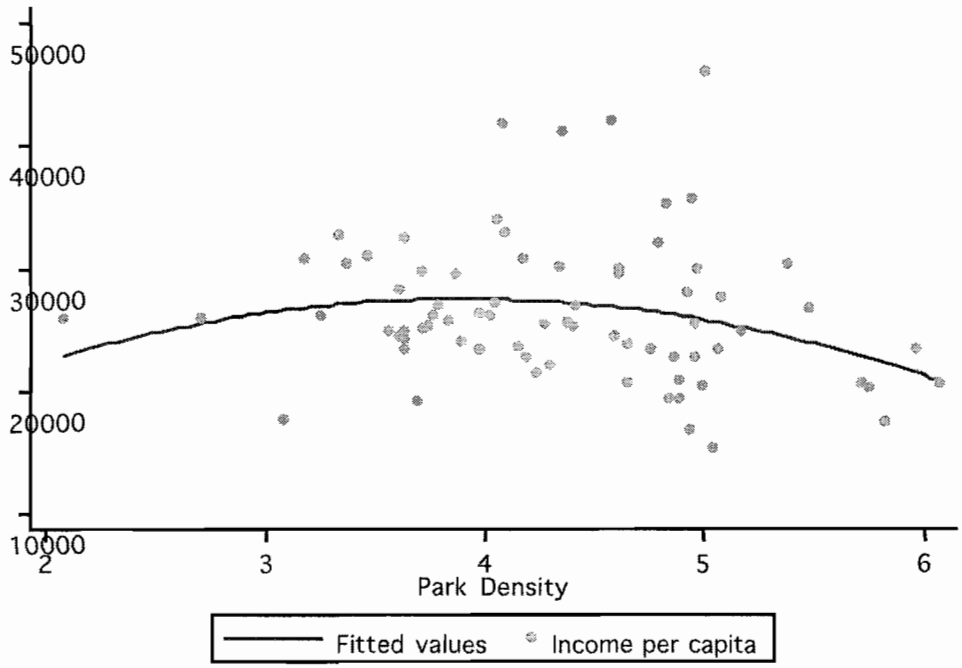
Income per capita is negatively related with park density and motor vehicle thefts and positively related with operational expenditure per acre and capital expenditure per acre. The regression: Income per capita = 10317 (4810) + 3889 Log Operational Expenditure per acre (1041) + 1948 log Capital Expenditure per acre (556) – 6252 log

Park Density (1186) – 295481 Motor Thefts per Capita (148981) + error provides support for the alternative hypothesis that these variables are related to income per capita in US cities.

Considering ceteris paribus for other variables a doubling on operational expenditure, capital expenditure and park density will be associated respectively with a change in the mean of income per capita by: 16.5$, 15$ and -17.5 $. The respective confidence intervals are: (15, 17.4), (13, 16), (-16.5, -18). Every extra motor vehicle theft per 1000 persons is associated with a diminution of income per capita by 295$. The adjusted R2 of this regression is 0.39.

Analyzing the residuals there is no evidence of residual problems, I utilized Q-Q graphs and residuals vs. fitted graphs. None of the other variables were found to be associated with Income per capita.

Graph 2 suggests a quadratic relationship between park density and income per capita. The regression in table 5, Income per capita = 6102.48 + 11019.29 log Park Density (6844.3) – 1415.07 log Park Density 2 (787) + error has an absolute maximum at 49.11 people per acre of park. The adjusted R2 for this regression is 0.04 and for the regression excluding the squared term 0.011. The F-test for the complete versus the reduced model is 3.23 which with a p-value < 0.05. Therefore we can reject the null hypothesis that there is no difference between the complete and reduced model and accept the squared curvature. Analyzing the residuals there is no evidence of residual problems, I utilized Q-Q graphs and residuals vs. fitted graphs.



Graph 2. Quadratic fit of Park Density on Income

Table 5. Quadratic Regression Table			
	Income per Capita		
	b	s.e.	prob.
Constant	6102	14686	0.68
Park Density (ln)	11019	6844	0.112
Sq. Park Density (Ln)	-1415	787	0.076
R-Squared			0.066
R-Squared (adjusted)			0.04
F			2.55
prob.			0.085
n			75

Cities Analysis

This section analyses characteristics of five different key cities by comparing the relationships with park variables and other variables.

Given that there was a quadratic relationship between park density and income per capita and this effect had a maximum; I wanted to explore the two closest cities to that maximum of 49.11, the two extremes of park density and the average of all variables. Table 6 ranks the cities according to their park density without the outliers excluded in chapter III. Stockton has the highest park density, with 432 people per park acre, while Jacksonville has the lowest value, with 8 people per acre of park.

I looked at five cities: Jacksonville, Omaha, Cincinnati, Denver, and Stockton. Table 7 includes descriptive information regarding the dependent, independent variables for these five cities and the total sample. Omaha and Cincinnati have values near the maximum park density value found in the quadratic analysis, while Denver has a value near the average of the total sample, and Stockton and Jacksonville represent the two extremes.

Results in Table 7 illustrate variability among the cities and the relationship between the variables in the analysis. Stockton, the city with the highest number of people per park (park density) expends almost 10 times more on operations per acre of park than Cincinnati and almost twice as much as Omaha, the two cities closest to the point in which park density quadratic effect is maximized when related to income per capita. In addition, Stockton has the highest crime rates, highest obesity rate and lowest income per capita of the five cities.

While Omaha and Cincinnati have similar rates of park density (people per park), Omaha expends almost twice in operations as Cincinnati but five times less in recreational expenditure. Omaha's rate of violent crimes per capita, and its obesity and poverty rates are slightly lower than Cincinnati's while the income per capita of Omaha is slightly (almost 2000 dollars) higher.

Table 6. Cities Park Density Rank Without Outliers

Rank	City	Park Density	Rank	City	Park Density
1	Jacksonville	8	39	Washington	78
2	Albuquerque	15	40	Sacramento	80
3	El Paso	22	41	Arlington	80
4	Virginia Beach	24	42	Wichita	82
5	Kansas City	26	43	St. Petersburg	83
6	San Diego	28	44	Seattle	97
7	Austin	29	45	Pittsburgh	99
8	Raleigh	32	46	Tampa	101
9	Louisville/Jefferson County metro government (balance)	35	47	Denver	101
10	Colorado Springs	37	48	St. Louis	105
11	Phoenix	37	49	Fort Wayne	105
12	Aurora	38	50	Glendale	116
13	Oklahoma City	38	51	Boston	121
14	Charlotte	38	52	Henderson	125
15	Bakersfield	38	53	Buffalo	127
16	Milwaukee	40	54	Baltimore	130
17	Greensboro	41	55	Toledo	133
18	Portland	41	56	Philadelphia	133
19	Lincoln	42	57	Las Vegas	138
20	Houston	43	58	Cleveland	139
21	Dallas	44	59	Atlanta	140
22	Omaha	46	60	Corpus Christi	142
23	Lexington-Fayette urban county	48	61	Long Beach	142
24	Cincinnati	49	62	Jersey	145
25	Tulsa	53	63	Tucson	148
26	Columbus	53	64	San Francisco	150
27	St. Paul	56	65	Detroit	155
28	Nashville-Davidson metropolitan government (balance)	57	66	Chandler	159
29	San Jose	58	67	Los Angeles	161
30	Plano	59	68	Mesa	177
31	Honolulu CDP	60	69	New York	219
32	Fort Worth	64	70	Chicago	241
33	Minneapolis	65	71	Miami	304
34	Riverside	66	72	Fresno	316
35	San Antonio	69	73	Newark	339
36	Indianapolis (balance)	72	74	Anaheim	388
37	Memphis	73	75	Stockton	432
38	Oakland	77			

Table 7. Five Cities Table

Rank	City	Park Density	Income Capita	Poverty	Violent / Cap	Motor Theft Capita	Obesity
1	Jacksonville	8	25853	8%	0.0099	0.0050	25%
22	*Omaha*	*46*	*25728*	*12%*	*0.0060*	*0.0060*	*26%*
24	*Cincinnati*	*49*	*23894*	*14%*	*0.0126*	*0.0048*	*28%*
47	**Denver**	**101**	**29873**	**6%**	**0.0056**	**0.0060**	**19%**
75	Stockton	432	20497	11%	0.0151	0.0087	35%
Average		**102**	**26449**	**8%**	**0.0091**	**0.0067**	**26%**

Rank	City	Park % Acreage	Op. Ex./ Acre	Rec. Ex./ Acre	Cap. Ex./ Acre
1	Jacksonville	20%	172	122	145
23	*Omaha*	*13%*	*1847*	*567*	*478*
24	*Cincinnati*	*14%*	*1058*	*2640*	*3175*
47	**Denver**	**6%**	**5328**	**3021**	**3786**
75	Stockton	2%	9925	0	0
Average		**10%**	**4075**	**2412**	**3390**

In regards to income per capita, violent crimes and motor thefts Denver, the city with an average park density, has the lowest crime rates, poverty rates and obesity of the five cities. It also has a low park percentage of city acreage, which is related to higher expenditures on operations, recreation and capital expenditure, as well as the highest income per capita of the five cities.

Finally, Jacksonville, which has the lowest park density (people/park acre), has the largest percentage of park acreage, but the lowest expenditures per acre. It income per capita, rate of extreme poverty, crime, and obesity rates are mid-range compared to the other five cities.

Quartile Analysis

To further explore the role of crimes in relation to parks I broke the cities into four categories by violent crime rates. Table 8 summarizes the average results from each

quartile and table 9 represents a list of the cities by violent crime rank. I utilized a manual break to isolate the extremes in categories one and four to compare their differences. Rank one includes the most dangerous cities, with violent crime rates equal or greater than 15 in 1000. Rank four are the least violent cities where violent crimes are less than 5 per every 1000 people. Table 8 displays the averages of the cities in each rank, with rank number 1 being the most violent group and number 4 the less violent group of cities.

Table 8. Quartile Table

Rank	Income	Obesity	Recreational	Operational	Capital	People / Park	Park %	Range
1	**21848**	**29%**	**1389**	**5603**	**1305**	**162**	**8%**	>0.015
2	25990	26%	2274	5560	2585	94	9%	<=0.015
3	26775	25%	2064	6003	3332	89	10%	<=0.01
4	**28731**	**24%**	**3203**	**7529**	**5868**	**115**	**9%**	<=0.005
4-1	*6883*	*-4%*	*1814*	*1926*	*4563*	*-47*	*2%*	0.01476
% 1	*32%*	*-15%*	*131%*	*34%*	*350%*	*-29%*	*22%*	-81%
StD	5852	4%	2671	3808	5485	85	6%	0.0021
# StD	1.18	-1.09	0.68	0.51	0.83	-0.56	0.28	7.03

Results in Table 8 demonstrate the relationship of crime with obesity rates and income per capita. The most violent cities (rank 1) have, on average, lower incomes per capita and higher obesity rates than the cities in any other group. The difference in average income per capita between cities in rank 1 and rank 4 (shown in line 5 of the table) is greater than the standard deviation of income per capita. The difference in obesity rates equals the standard deviation. It is also important to note that the difference in average rates of violent crime between ranks one and four is 3.4 standard deviations; this difference is 148 violent crimes per every 10000 persons in 2008.

The variation in the park variables is somewhat smaller. For instance, the park density of the most violent cities (rank 1) and the least violent cities (rank 4) are within one standard deviation and actually higher than the values for the average for cities in ranks 2 and 3. There is also not substantial variation in operational, capital and recreational expenditure.

An example is Stockton, which has the highest park density in the sample, low expenditure in parks, low income per capita, a high obesity rate, and is also within the most violet group of cities. Even though Stockton's operational expenditure per acre is more than five times that of Jacksonville, Stockton does not appear to be receiving the benefits from that expenditure, perhaps because violent crimes impede the potential of parks to yield benefits. As we previously mentioned, Jacksonville is the city with the lowest park density in the sample, and the city is in the violence quartile number 3.

Conclusions

Table 10 utilizes light grey to indicate a significant relationship and black to indicate no correlation between the park and dependent variables. Park density is significantly related to obesity rates, income per capita and violent crimes, making it the most important park variable found in this research. Operational capital expenditures, and the percentage of park land within the city land, were found to be significantly related to two of the dependent variables: income and violent crimes for operational expenditures and poverty and obesity for park acres as a % of city acres. Capital expenditures per acre are related to income, but recreational expenditures are not related to any of the dependent variables in this study.

A possible conclusion from table 10 is that park density, park acreage as percentage of city acreage, and operational expenditure may be important elements when designing parks availability and maintenance structure in a city. Results regarding capital expenditure should be cautiously interpreted, for it is somewhat difficult to define and expenditures in this area may reflect both park purchases and capital improvements. Recreational programming expenditure should be further analyzed as findings in this work suggest no associations with that type of expenditure.

Table 9. Cities Quartile Rank by Violent Crimes			
Violent Rank	**City**	**State**	**Violent Crimes per Capita**
1	Detroit city	Michigan	0.0191
1	Memphis city	Tennessee	0.0193
1	Baltimore city	Maryland	0.0158
1	Oakland city	California	0.0196
1	St. Louis city	Missouri	0.0208
1	Stockton city	California	0.0151
Average			**0.0183**
2	Houston city	Texas	0.0111
2	Philadelphia city	Pennsylvania	0.0144
2	Indianapolis city (balance)	Indiana	0.0122
2	Charlotte city	North Carolina	0.0103
2	Boston city	Massachusetts	0.0110
2	Milwaukee city	Wisconsin	0.0121
2	Nashville-Davidson metropolitan government (balance)	Tennessee	0.0141
2	Washington city	District of Columbia	0.0137
2	Atlanta city	Georgia	0.0138
2	Sacramento city	California	0.0100
2	Kansas City city	Missouri	0.0139
2	Cleveland city	Ohio	0.0143
2	Miami city	Florida	0.0138
2	Tulsa city	Oklahoma	0.0128
2	Minneapolis city	Minnesota	0.0125
2	Cincinnati city	Ohio	0.0126
2	Pittsburgh city	Pennsylvania	0.0108
2	Toledo city	Ohio	0.0123
2	Buffalo city	New York	0.0137
2	St. Petersburg city	Florida	0.0137
Average			**0.0127**
3	New York city	New York	0.0058
3	Los Angeles city	California	0.0069
3	Phoenix city	Arizona	0.0067
3	San Antonio city	Texas	0.0072
3	Dallas city	Texas	0.0089
3	San Francisco city	California	0.0083
3	Jacksonville city	Florida	0.0099
3	Austin city	Texas	0.0052
3	Columbus city	Ohio	0.0077
3	Fort Worth city	Texas	0.0065
3	Denver city	Colorado	0.0056
3	Seattle city	Washington	0.0058
3	Portland city	Oregon	0.0062

Table 9. Continued			
Violent Rank	**City**	**State**	**Violent Crimes per Capita**
3	Louisville/Jefferson County metro government (balance)	Kentucky	0.0077
3	Oklahoma City city	Oklahoma	0.0098
3	Tucson city	Arizona	0.0078
3	Albuquerque city	New Mexico	0.0090
3	Fresno city	California	0.0058
3	Long Beach city	California	0.0068
3	Omaha city	Nebraska	0.0060
3	Raleigh city	North Carolina	0.0057
3	Colorado Springs city	Colorado	0.0053
3	Honolulu CDP	Hawaii	0.0069
3	Arlington city	Texas	0.0060
3	Wichita city	Kansas	0.0084
3	Tampa city	Florida	0.0087
3	Bakersfield city	California	0.0065
3	Aurora city	Colorado	0.0051
3	Riverside city	California	0.0065
3	Corpus Christi city	Texas	0.0078
3	Lexington-Fayette urban county	Kentucky	0.0063
3	St. Paul city	Minnesota	0.0079
3	Newark city	New Jersey	0.0095
3	Lincoln city	Nebraska	0.0051
3	Glendale city	Arizona	0.0053
3	Greensboro city	North Carolina	0.0086
3	Jersey City city	New Jersey	0.0095
Average			**0.0071**
4	San Diego city	California	0.0047
4	San Jose city	California	0.0038
4	El Paso city	Texas	0.0046
4	Mesa city	Arizona	0.0049
4	Virginia Beach city	Virginia	0.0024
4	Anaheim city	California	0.0039
4	Plano city	Texas	0.0023
4	Henderson city	Nevada	0.0021
4	Fort Wayne city	Indiana	0.0032
4	Chandler city	Arizona	0.0032
Average			**0.0035**

Table 10. Summary of Park Relationships					
	Income	Poverty	Obesity	Violent C.	Motor V. Theft
People / Park	X^2		-	+	
Park Percentage		-	-		
Capital Expenditure	+				
Operational Expenditure	+			-	
Recreational Programming Ex.					

CHAPTER V

CONCLUSIONS

The results of this study suggest that there may be a need to balance park expenditure and availability with specific problems and objectives in a community. In this process it is key to acknowledge the relationship between crime and other community attributes on order to maximize the benefits derived from parks. Knowing the tradeoffs and the relationships between park and socioeconomic variables might help decision makers better utilize parks and the funding allocated for them.

This concluding section is divided into three parts. The first part will review the findings. The second part discusses possible implications of the findings, and the third part suggests potential future studies.

Findings

To review the findings:

- There is a trade-off between park quantity and expenditure per acre of park.
- Violent crime rates are positively associated with park density (people/park acre) and negatively with operational expenditure per acre of park.
- Poverty is lower when park % as city area is higher.

- Obesity rates are negatively associated with park density, park acres as percentage of city acres, motor vehicle theft, income per capita, and positively associated with violent crime rates.
- Income per capita is positively related with operational and capital expenditure, and negatively related with park density and motor vehicle thefts.
    - The curvature in park density has a point associated with a maximum of income per capita at 49.11 persons per acre of park.
- Rank analysis confirms that cities near 49.11 persons per acre of park, with lower violent crimes tend to have lower obesity and higher income per capita.
- The quartile analysis on violent crimes confirms that cities with similar park densities, percentage of park acreage, and expenditure per acre of park vary substantially on obesity rates and income per capita. Violence seems to be a factor that may control the benefits parks may generate.

Discussion and Implications

The findings and literature presented suggest that the levels of crime in cities may influence the relationship between parks quantity, expenditure and quality, and their possible benefits. The tradeoff between types of expenditure on parks and quantity of park may need to be understood to better take advantage of park benefits and resources expended on them.

For example it might not be adequate to increase recreational expenditure when a city faces high crime and obesity rates. In this case it may be better to address crime and increase operational expenditure so people can be safer, feel safer, and have the opportunity to derive more benefits from parks.

The main relationships between park variables suggest that maintenance increases with park density and with less park percentage of city area. A decision to expand the city acres of parks or expend more on maintaining those acres because of population density increases represents a tradeoff. Land prices probably represent a decisive cost benefit

criterion that determines where to expend the money, on more parks or on maintaining the current ones.

The general findings and the discussion of virtuous or vicious cycles regarding the relationships between expenditure, crime, poverty and park benefits suggest that it may not be wise to cut expenditure on parks, especially in recessions. Urban parks may provide basic services to inhabitants that can mitigate several negative effects of economic downturns, such as rising cost of living, personal or psychological problems and others.

Obesity

To maximize parks' potential to reduce obesity, higher park densities may be required along with more park acreage as percentage of city acreage. These findings suggest that cities could achieve higher densities in built land acreage and dedicate more area for parks and this balance could create safer environments, healthier communities and increase access to parks.

Obesity rates are also correlated with income per capita but the effect of a one percent change on income per capita on obesity is less than a 1% change on park density, on operational expenditure or on violent crimes. This may imply that higher income individuals can substitute exercising in private settings, but that for the large majority urban parks may play an important role in lowering the body mass index. It is important to point out that I do not expect that parks may increase exercising only due to the presence of the park amenities, but also because they create a more walkable and welcoming environment in the surrounding areas.

The findings regarding the relationship between higher densities and lower obesity rates suggest that proximity to parks, social engagement in urban park activities and safer feeling from more people on an area may be factors through which parks are related with lower body mass indexes. Adding the finding that higher percentages of park area are associated with lower obesity rates suggest that distribution and proximity to parks may play an important role on reducing body mass. On the other hand, results

suggest that improving parks in a high violent crime environment might limit the reduction of body mass in that population.

Decision-makers may need to focus on lowering crime rates in setting with high violent crime rates, and this study suggests that it may be appropriate to allocate recreational programming expenditure to programs that reduce crime. Since parks, crime and their potential benefits including the lowering of obesity may be part of a virtuous or vicious cycle it may be important to utilize adaptive management techniques with parks and to have a constant active management with multiple goals.

The results of this study suggest that obesity rates are lower with more people per acre of park but this study cannot confirm how the number of people per acre of park that is optimal, nor why these results occur. One possibility is that parks that are more crowded may feel safer to users, prompting greater use and, in turn, lower obesity rates. However, in a safe city the effect of higher park densities on less obesity would be diminished, therefore making it viable to have less park densities without affecting the perception of safety and therefore obesity rates.

Crime

The findings presented that indicate higher park operational costs are associated with lower violent crime rates are consistent with previous studies that correlate urban vegetation with lower crimes since. Also I find that, on average, higher park densities are related with higher violent crime rates. At this moment it is difficult to separate the relationship of violent crime with population density and population density on parks. However, the results of this study suggest that future research on violent crimes should include park-related variables.

More important to this study is the finding that violent crimes may be related to the relationship of parks to obesity and income. Urban park managers need to pay close attention to crime in parks and dedicate considerable efforts on design and implementation of elements and strategies than enhance and promote a virtuous cycle.

Income / Poverty

Higher park percentages and lower park densities along with higher expenditures in operational and capital areas are correlated with higher income per capita when crimes are low. When crimes are high we find that cities with similar park variables have considerably lower income per capita. This may suggest that the combination of safe and well-maintained and distributed urban parks may attract a higher paid workforce and influence the quality of life that a city offers.

The relation between income per capita, higher housing values and parks might also create negative consequences like gentrification and higher crime in other areas of the city. The finding reported by others that proximity to parks increase housing values suggests that unequal distribution of parks may create gentrification and more income segregated neighborhoods. This may also contribute to crimes and a possible deeper negative effect generating a vicious cycle. Extreme poverty was found in this study to be associated with lower park percentages, and in cities with higher crime rates.

The finding that poverty is lower in cities with more park percentage suggests that an unequal distribution of parks may have a gentrification effect, which could be related to higher poverty rates. Ideally, with a greater percentage of parks the closer the city would be to a homogeneous park distribution. Such a distribution could eliminate the effect of parks on housing values therefore reducing the gentrification effect and possibly poverty effect from that gentrification on parks.

Future Studies

Because park indicators in US cities are so variable it is important to search for elements that may suggest certain standards. Future research needs to address the possibility of standards by further examining the relationships between parks and their benefits. Two methods I suggest to further explore this relationships are time series analysis to determine if there is an step by step process in the relationship and bi-directional models to explore the nature of these intricate, causal relationships.

I expected higher income per capita and obesity to be associated with higher investments in park amenities, acreage and maintenance. I did not expect to find that recreational expenditure is not associated with any of the dependent variables. It is important to analyze if recreational programming expenditures create any benefits on cities. One possibility is that people who participate in these programs already engage in other sports therefore the obesity reduction from this type of expenditure may be low.

The relationship of park percentage with poverty in US cities might be explained by land prices and recreation costs substitution. Further study is needed to examine if park acreage as percent of city acres is associated with housing prices and if homogeneous park distribution in a city would eliminate the effects of parks on housing prices.

Another issue that may be important to explore is the relationship between desirable cities and unemployment. For instance, one could hypothesize that people in more livable cities can accept to wait more time to find a job. The analysis here can be limited to park effects on unemployment or widening the scope to include more quality of life indicators.

To summarize, future studies in the field should include the following variables: city size, regional controls, age distribution, idle population, racial composition, city population, male population and male unemployment.

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