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Assessing the Effect of Parks on Surrounding Property Values Using Hedonic Models and Multilevel Models

I-Hui Lin
University of Wisconsin-Milwaukee

ASSESSING THE EFFECT OF PARKS ON SURROUNDING PROPERTY VALUES USING HEDONIC MODELS AND MULTILEVEL MODELS

by

I-Hui Lin

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ABSTRACT

ASSESSING THE EFFECT OF PARKS ON SURROUNDING PROPERTY VALUES USING HEDONIC MODELS AND MULTILEVEL MODELS

by

I-Hui Lin

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The various kinds of park benefits have been extensively discussed in the literature in order to suggest a better living environment for urban residents. Among them, the economic benefit has been suggested as the crucial one to support park development and management. A number of studies have been studied the economic impact of parks on surrounding property values and suggested that park proximity brings increment in property values. Some studies further considered park characteristics. The general suggestion from the literature was that parks primarily for passive recreation tend to have a positive impact on nearby property values and parks mainly for active recreation are more likely to introduce disturbance and therefore a negative impact on adjacent property values. However, studies on how individual park facilities influence property values are rarely found. While park facilities are essential for providing diverse recreational opportunities, their economic impacts should also be considered when designing a park system. A more detail analysis on the impacts of the diverse features in parks can be suggested in order to better understand the differences among the many kinds of park features. Therefore, the first objective of this study is to examine the impacts of many park facilities on neighboring residential property values within the City of Minneapolis, Minnesota, United States. This study followed the literature and applied the hedonic pricing model to examine the impact of park facilities on nearby property values.

However, since the data are not from the single level (i.e. properties are individuals at a lower level while the parks are the contextual effect at a higher level), it is suggested that such single-level model may not be appropriate. A multilevel approach has been suggested when the hierarchical data is employed and to avoid error may result from aggregating or disaggregating data from one level to another. Therefore, the second objective of this study is to apply the multilevel approach as an alternative to examining the impact of park facilities on adjacent property values. Results suggested that the general guideline suggested in literature can be followed, but significantly different impacts are associated with different park facilities.

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1. Introduction

Rapid urbanization has brought environmental problems (e.g., flooding, urban heat-island effect and air pollution) and reduced the accessibility to nature and physical exercises in the urban area, and therefore adversely affects the health of both city residents (physical and mental) and urban environment. To address many of these issues, numerous studies have suggested urban greenery, such as parks, to mitigate the environmental problems and to provide the space and recreation opportunities for healthy people and society (Arvanitidis, Lalenis, Petrakos, & Psycharis, 2009; Baur & Tynon, 2010; Chalkias et al., 2013; Cohen et al., 2007; Garvin, 2011; Gies, 2006, 2009; Han, Cohen, & McKenzie, 2013; Sherer, 2006; Woolley, 2003).

However, the benefits of parks on addressing environmental problems and public and social health are not strong enough to make parks stand out from the decision makers' lists, especially with the strict condition of recent public funding opportunity. In order to be more persuasive, it is suggested to understand the economic benefit of parks, which includes both saving money and bringing revenues to the communities and governments (Harnik & Crompton, 2014). A number of studies and reports have been making the effort to relate park benefits to economic values. For example, studies have reported the economic value of parks on reducing environmental related spending on such as reducing the cost for stormwater treatment and air pollution reduction (Gies, 2009; Harnik & Welle, 2009). Scholars also argued that parks support activities for relaxation and better health, and therefore help to reduce expenses for health-related treatment (Cohen et al., 2007; Gies, 2006). In addition, by making urban neighborhoods more livable, park advocates believe that parks help to attract residents, businesses, and tourists, which bring revenues in the forms of taxes (e.g., property and sale taxes), economic development and job opportunities, and park-related spending (Crompton, 2001a; Haigood & Crompton, 1998; National Recreation and Park Association, 2015b; Sherer, 2006).

By recognizing the diverse benefits of urban parks, private and non-profit sectors promote the development of such green amenities. For example, the Trust for Public Land (TPL), a nonprofit organization founded since 1972, has worked with government agencies and local communities to create and renovated parks and open spaces for people to enjoy. With funding sources primarily from individuals, foundations, and corporations, TPL has assisted with hundreds of city park projects and studies (The Trust for Public Land, 2015a, 2015b). Similarly, the National Recreation and Park Association (NRPA) holds the value of "conservation, health and wellness, and social equity" to assist community recreation and park projects and to support legislation and policy for park funding and park development (National Recreation and Park Association, 2015a).

However, the lack of park provision still is an issue in many US cities. In the past decade, as the results from the annual survey report by TPL (Center for City Park Excellence, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2014, 2015) (Figure 1), many cities, particularly those with high population densities, cannot reach the minimum of 10 acres of park space per 1,000 residents suggested by the National Recreation and Park Association (NRPA).

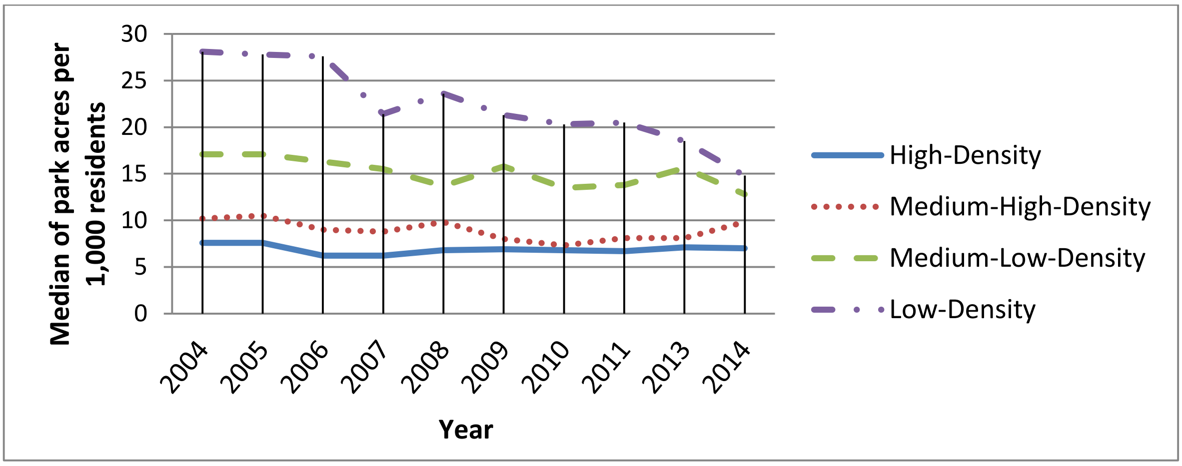

Figure 1[1]**.** Median of park acres per 1,000 residents

[1] Data for FY2012 is not available.

Less than one-quarter of cities with high population densities had parkland larger than 10 acres per 1,000 residents, and there are about one-third of them with less than 5 acres of parkland per 1,000 residents. For cities with medium-high population densities, there is about half of them with less than 10 acres per 1,000 residents. In addition, there also exists a trend of decreasing parkland availability for all four population density levels, especially those with medium-low and low population density.

With the economic difficulty in recent decades, lack of funding has been one of the major problems that make park development difficult. In particular, financial supports from the public sector, especially at federal level, are not promised. Local elected officials have kept pushing the federal government to support urban park programs with promised funding, namely the Urban Park and Recreation Recovery Program (UPARR) and the Land and Water Conservation Fund (LWCF) (The United States Conference of Mayors, 2014). The UPARR program was established by the Public Law in 1978 to fund recreational facilities in distressed urban communities. By 2002, the UPARR program had funded 1,461 grants with nearly $272 million; however, the program has not been funded since then (National Park Service, 2015b). The LWCF, on the other hand, was established in 1965 to preserve and develop outdoor recreation space and facilities using funding primarily from the leasing of offshore oil rights. Places from large national parks to small local community parks can benefit from this funding. In 2014, $43 million was distributed from LWCF for public outdoor recreation projects nationwide (National Park Service, 2015a). However, the amount and use of LWCF funding are questioned (Ernst, 2015). The funding provided is far less than authorized level of $900 million per year. Even if the $900 million was fully distributed, it is argued that the amount is much less than the $9 billion per year generated from oil and gas leasing. It is argued that the Congress had redirected such limited funding for other uses. Park advocates and elected officials have continuously requested the Congress to permanently reauthorizing and securing the funding by seeing the benefits of federal funding for public recreation in large urban areas, which therefore help to stimulate area development.

Without promising support from the federal level, local governments, therefore, and indeed, play an important role in financing, especially, local park development and maintenance. Tax revenue, property taxes, in particular, is one of the crucial financial sources for local governments and therefore park departments/agencies (Garvin, 2011). For example, property taxes contributed about 75 percent in an average of the annual revenue for the operations of the Minneapolis Park and Recreation Board during the past decade from 2007 to 2014 (Minneapolis Park & Recreation Board, 2007a, 2008, 2009, 2010a, 2011, 2012, 2013, 2014). However, parks have to compete with many other public services over the limited local government budget, and often time parks are not ranked at the top of the list. For example, scholars have studied on US local governments' spending on 10 public services including parks and recreation and found that the share of total spending on parks was about 2.2-2.6 percent which was only higher than libraries and correction (Kaczynski & Crompton, 2006).

To make parks stand out in decision makers' agenda, the various contributions of parks have to be understood. As mentioned earlier, a number of scholars have examined the link between parks and different benefits. Given that the role of urban parks in early days was provided as an escape from urban chaos to a countryside-like natural landscape, natural scene and aesthetics of parks were mostly provided and valued. The value of the natural landscape of urban parks was commonly supported and believed to be the major contributor to the positive proximate effect to nearby property values. It is not until the early 1900s that active recreation gained attention, and was largely added into park design, and until mid-1900s, scholars again interested in studying park impact on property values and with the consideration of not just aesthetics of parks but also the active recreation that a park can provide. However, natural landscapes in parks remain important in many studies on park impact on property values, while facilities for active recreation are not being fully studied.

This research follows the trend on studying the economic benefit of parks and focus on both passive and active recreation facilities. This research realizes that there are diverse facilities served in parks. Given that local governments and park agencies are often under intense pressure to provide diverse recreation opportunities to the people, it is important to have a better understanding of the nature and scope of any potential impact that these facilities may have on surrounding property values. The economic influence of individual facilities in parks on property values in nearby neighborhoods is therefore examined. A better understanding of this issue can also suggest measures for enhancing positive and mitigating negative implications through better design, planning, and programming by those involved in park planning and development. To examine the impact of park facilities on nearby property values, the commonly used hedonic regression model is first applied. Three questions asked at here, include 1) how do individual park facilities affect the values of proximate properties?, 2) what is the magnitude and geographic scale of such effect?, and 3) How do individual park facilities in different sized parks affect the values of proximate properties?.

Although the hedonic model is commonly applied in park literature, such single level model has been questioned when dealing with data in a hierarchical structure. Given that data of social studies such as park and property values in this present research is usually in a hierarchical structure, it is suggested to take such data structure into account when building models for analysis. Therefore, in addition to the traditional single-level hedonic model, this study also adopted the multilevel approach in order to measure the impact of park facilities on property values in a more realistic way. In multilevel models, how individual park facility affects the values of nearby properties is examined again, but here the park facilities are included in the model at two additional scales other than the scale of individual properties.

Further, with the ability of multilevel model on allowing lower level coefficients to be varied and be explained by variables at higher levels, whether park proximity effect is varied across park neighborhoods and whether the variation is influenced by park attributes are also examined.

2. Literature Review

2.1. Parks and Property values

During the past thirty years, the financial issues have been the most challenging problem for public park practitioners, especially after the tax revolt movement in the early 80s (Crompton, 1999). Besides tax limitation laws took place in many states in the 80s, the suburbanization movement also eroded tax base for the local governments. To further exacerbate the condition, the reduction of grants and special programs funded by the federal government due to the financial deficit forced the local governments to be more cautious on reviewing their budgets. Unfortunately, parks were always not on the priority list. Researchers have suggested that to have the parks stand out on the agendas, it is necessary to convince legislators, investors and the general public that parks not only provide leisure spaces but are also profitable investments (Crompton, 1999; Fox, 1990; Pine, 2009). Therefore, besides many other kinds of park benefits, economic benefits that a park provides become crucial, especially under current economic conditions (Pine, 2009).

It is believed that parks can be the economic booster benefiting the whole neighboring community not merely its direct users. Its economic benefits including attracting tourists, businesses/jobs, and retirees, enhancing real-estate values/tax base, stimulating urban revitalization, and reducing the cost of public services (safety, environmental protection, and public health care) (Crompton, 1999). Scholars have been trying to quantify the various economic benefits of parks, and the increase of property value is the one commonly studied topic to quantify the economic benefit of parks (Harnik & Welle, 2009). The impact of parks on property values have been examined by many studies, and, indeed, evidence can be found as early as in the 1800s in the US and European countries (Crompton, 2001a, 2001c, 2005; Danzer, 1987; Woolley, 2003).

2.2. The Proximate effect

To examine the economic effect of parks on surrounding property values, the concept used in these studies is based on the proximate principle. Given that people are willing to pay more to live close to parks, the proximate principle is defined as the process of capitalization of parks into increased property values due to close to parks, and therefore leads to the increase of tax revenue to be generated from those properties, and the increased tax revenue can be used to pay off the cost of park development and maintenance (Crompton, 2004).

In the U.S., the most mentioned example is the project of Central Park in New York City by Frederick Law Olmsted in mid-1800s. He adopted the concept of the proximate principle that illustrates the process of capitalization of attractive amenities into the value of nearby properties to convince the decision-makers of New York to support his park project (Crompton, 2001a). After 18 years of the construction of the Central Park, Olmsted reported a dramatic change in property values in the surrounding three wards. Without the park, Olmsted suggested that the surrounding property values, like other wards in the city, would have the increment of 100 percent during the 18 years of park construction; however, the actual value of surrounding properties showed an increase of about 800 percent (Fox, 1990). Such success was spread out to nearby communities in New York and shared by many other US cities from late nineteenth century to twentieth century (Crompton, 2001c, 2005). Such increment of surrounding property value was assumed to enhance the tax revenue and to retire the bonds used for parkland purchases and developments. Researchers had calculated and analyzed evidence to support this assumption. The theoretical concept was illustrated by comparing the cost of acquisition and development of a 50-acre natural park and the annual property tax revenue attributed to the park (Crompton, 1999). The result from such illustration showed that the incremental tax income attributable to the park exceeded the annual debt charges for acquisition and development. Empirical studies found that the excess ranged from about $300,000 to over $4 million annually (Crompton, 1999; Fox, 1990; Hagerty, Stevens, Allen, & More, 1982; More, Stevens, & Allen, 1988). Therefore, it is suggested that park investments would not be a long-term burden for the local government and could be even better to support other public services. In addition, it has been criticized that local governments would lose tax money from replacing other land uses such as residential development by acquiring the lands for parks. However, taking residential development for instance, it has been suggested that expenses of public services provided for those occupants usually surpass what they paid in tax (Crompton, 1999). Therefore, Parks should not reduce the revenue of local governments, and as a comment in the New York Times made after the construction of the Central Park, "Central Park has not only paid, but it has been a most profitable investment…. Those who want a reduction in the tax rate and those who favor the movement for its effect on real estate were now certain to support the development of future parks" (Crompton, 2001b, p.9).

Later studies also suggested the significant impact of parks on property values. As the proximate principle assumed, by within a certain distance from a park, the proximity to parks can benefit the adjacent property values. Park proximity can be measured by continuing distance or by defining specific distance zone(s). By measuring the continuing distance (straight line distance or street distance) from each property to the diverse park and recreation spaces (Correll, Lillydahl, & Singell, 1978; Hagerty et al., 1982; Hammer, Coughlin, & Horn IV, 1974; Morancho, 2003; Nicholls & Crompton, 2005; Sander & Polasky, 2009), the results mostly suggested an inverse relationship between the property values and the distance from parks to properties. That is, with the distance from the property to its nearest park increased the value of the property decreased, and the magnitude of the effects can be varied by the park's characteristics. When buffer zone(s) (single or a series of consecutive zones) are created around parks, dummy variables were applied to reflect the residential units that were in the buffer zone(s) (Bolitzer & Netusil, 2000; Espey & Owusu-Edusei, 2001; Lutzenhiser & Netusil, 2001). The increment of property values can be found when the properties are within park's buffer zone(s).

The significant influence of parks on property values are mostly found when the properties are located within 1,500 feet (Bolitzer & Netusil, 2000; Espey & Owusu-Edusei, 2001; Lutzenhiser & Netusil, 2001), or up to five city blocks (Hagerty et al., 1982; Hammer et al., 1974; Hendon, 1971; Kitchen & Hendon, 1967; Lutzenhiser & Netusil, 2001; Morancho, 2003; Weicher & Zerbst, 1973) The literature also suggested that the park influence mainly experienced within 500-600 feet. However, the influence of parks can be found sometimes up to 2,000 feet or even 3,000 feet from parks, especially when parks are large in size (Crompton, 2001c; Hagerty et al., 1982; Hammer et al., 1974; More, Stevens, & Allen, 1982; More et al., 1988; Netusil, 2005).

Some scholars, on the other hand, interested in looking at the values of properties immediately close to the park. Weicher and Zerbst (1973) and Hammer et al. (1974) studied the effect of the nature of adjacency between parks and properties (e.g., back onto the parks and side to parks), and found that lack of privacy and disturbance (e.g., noise and congestion) can be the concern. Others emphasized the value of view (Benson, Hansen, Schwartz, & Smersh, 1998; Luttik, 2000; Sander & Polasky, 2009), and they found that the property values were benefited from the view of parks and nature amenities with the view of open water being the most beneficial one.

2.3. Park characteristics and property values

In general, park literature suggested that parks can contribute to nearby property values. However, the impact of parks can be influenced by their characteristics such as size and type of parks and features in parks. Park size varies and may range from less than one acre to over a hundred acres, different effects of parks with different sizes can be assumed. Bolitzer &

Netusil (2000) found that park size is positively related to proximate property values. By combining parks' size and attractiveness, Espey and Owusu-Edusei (2001) found that "attractive" parks, both with small and medium sizes, have positive impacts on property values but the impact of small parks is particularly large. Basic parks with both small and medium sizes, on the other hand, have negative impacts on property values, but the negative effect of medium parks is relatively higher.

Given the diverse type of parks and the various features in parks, the impacts of parks on property values vary, and both positive and negative impact can be associated with those characteristics. The literature mostly suggests that parks constructed primarily for passive recreational uses are more likely to have strong and positive impacts, while parks intensively used for active recreational purposes have relatively weak or possibly negative impacts (Bolitzer & Netusil, 2000; Crompton, 2004; Hammer et al., 1974; Lutzenhiser & Netusil, 2001; More et al., 1988; Weicher & Zerbst, 1973). For example, Lutzenhiser and Netusil (2001) studied the impact of 201 open spaces on the values of nearby properties in Portland, OR. They categorized the open spaces into five groups, and the two major groups were the urban parks, which have more than 50 percent of the park is developed for recreation not depend on natural resource, and natural area parks, which have more than 50% of the park is preserved for natural vegetation and serve recreation activities such as hiking and wildlife viewing that are directly linked to natural resource. Their results suggested that open spaces had statistically significant effect on home values; however, the effects were different depending on open space types and the distance to the open spaces. Using mean open space size of each open space type, they found that, being within 1,500 feet, property values benefited the most at $10,648 when the nearby open space is a natural area park, and property values benefited the least at $1,214 when the nearby open space is an urban park.

Noise and disturbance, for example, associated with active recreation in parks were commonly suggested as the cause of such negative impact of parks on the surrounding neighborhoods. However, active recreation facilities in parks can still benefit neighboring property values due to the accessibility to recreation opportunities. Therefore, be expected while the properties are close to a park with active recreation facilities comparing to the values of properties without a park nearby. If the negative impacts of active parks on property values are suggested, the magnitude of such negative impacts should decrease quickly associated with the increase of the distance from parks, and up to a certain distance positive effect can be expected (Crompton, 2004).

However, knowing the impact of parks mainly for passive or active recreation may not be enough, especially when deliberating the provision and design of diverse types of park and park features in order to meet the diverse recreational demands. A number of scholars examined the impacts of certain types of parks and open spaces and the impact of certain features in parks on nearby property values. Some of them focus on linear green spaces such as greenways/trails and greenbelts. It was suggested that unlike the extended view to be provided by other types of natural-based parks, the advantage of such narrow corridor is mostly associated with the accessibility to the trails, especially in less densely populated areas (Crompton, 2001b). In order to examine how those linear green spaces may influence nearby property values, some studies applied surveys to investigate the opinion of owners of homes adjacent to greenways on whether the values of their properties changed due to the greenways (See Crompton, 2001b for the review). The survey results suggested that linear green spaces have positive or no impact on adjacent property values. Such results are supported by other studies using hedonic regression models (Correll et al., 1978; Lindsey, Man, Payton, & Dickson, 2004; Nicholls & Crompton, 2005).

Water body as an open space or one of park features is mostly suggested to significantly contribute a positive impact on the values of nearby properties. The values of properties immediately close to water body are suggested to benefit from not only the aesthetic view of the water but also, when applicable, the advantages of providing recreational amenities such as private boat dock (Benson et al., 1998; Luttik, 2000; Sander & Polasky, 2009). Even for those properties not at the front row but within a short distance from the water body, water body can be beneficial to their values (Cho, Bowker, & Park, 2006; Sander & Polasky, 2009). Although water body can benefit nearby property values, its impact can be different by its characteristics. Sander and Polasky (2009) and Anderson and West (2006) suggested that lake contributes higher increment on nearby property values than does streams/rivers. Cho et al. (2006) suggested that the impact of water body vary by its size; a large water body is better comparing to a small creek, lake or pond. However, Anderson and West (2006) found the opposite result suggesting that the proximate effect of the lake dropped while the size of the lake increased possibly due to the noise of water activities.

Beyond the above types and features of parks or related open spaces, studies of impacts of other park types and park features are relatively rare. Voicu and Been (2008) studied the impact of community gardens on property values and found, like other natural-based parks, the significant and positive impact on adjacent property values. Although such result helps to understand the impact of gardens, the community garden can be valued differently than botanical gardens in parks. Facilities related to active recreation such as ball play are often not included as variables in the analysis to directly study their impacts on adjacent property values. Burton and Hicks (2007) included playgrounds and tennis courts in their analysis of the impacts on property values, but no significant impact was found in their results. They suggested that small sample size and policy on wide provision of playgrounds in the study area might explain the insignificant result. More studies on these facilities and many others are needed and suggested in order to provide further insight of their impact on nearby neighborhoods (Bolitzer & Netusil, 2000; Hagerty et al., 1982; More et al., 1988).

2.4. Approaches to studying parks and property values

2.4.1. Early studies and the use of hedonic models

In early days, park advocators, such as Frederick Law Olmsted, believed that people are willing to pay more to live close to parks. With such assumption, early studies estimated the economic impact of parks on nearby property values by directly comparing the values of properties located close to parks to the values of properties further away from parks, and the differences in the property values were believed to be contributed by parks (Fox, 1990). Although such approach gave a simple way to understand how parks would introduce increment of surrounding property value to pay for the park expenses and to further increase tax revenue for other services, it can be too optimistic. Such approach was later believed to be "naïve", suggesting the possibility of overestimating the impact of parks on surrounding property values (Crompton, 2001a, p.12). It is because early studies accredited the increase of property values to parks regardless of other possible factors influencing real estate prices.

Mathematical methods were therefore suggested to provide a more scientific estimation. An early attempt was the work by Herrick (1939) on studying the effect of parks on property values in Washington, D.C. from 1911 to 1937 based on a general equation built from the study of 85 largest US cities in 1929 with the population density and the percentage of city's land in the park. He found that there is an increase of $1.46 per acre per person to land value with an additional one percent of park land added into the city's park system. Such increment was then multiplied by the tax rate at that time to obtain the taxes that could be collected in the 27 years under studied, and the result suggested tax revenue of $68,833,314 contributed by parks. By comparing this tax revenue to the total cost for parks and recreation ($44,540,229) during the same period, Herrick suggested that there were $24,293,085 of tax revenue from parks left to be used for other municipal services. Although Herrick attempted to use mathematical approach for assessing park impacts on property values with the consideration of other factors, his work was still questionable because there are only two attributes included in his model. To rectify the defect of early studies, more attributes that can possibly influence property values are suggested to be included in the model.

The hedonic regression model with the inclusion of many attributes in the estimation was therefore suggested and then widely applied. In the study of the contribution of park and recreation amenities to property values, the hedonic regression model became a common approach (Benson et al., 1998; Bolitzer & Netusil, 2000; Correll et al., 1978; Espey & Owusu-Edusei, 2001; Hagerty et al., 1982; Luttik, 2000; Lutzenhiser & Netusil, 2001; Morancho, 2003; Nicholls & Crompton, 2005; Sander & Polasky, 2009; Weicher & Zerbst, 1973). The hedonic model views the property value as a function of a package of attributes (Freeman III, 2003). The package can include property structural and location attributes (characteristics of the neighborhood in which the property is located and other location-specific environmental facilities) while studying their impacts on property values. As Freeman suggested, the price (rental or purchase price) of the jth property can be modeled as a hedonic function of the structural (Sj), neighborhood (Nj), and environmental (Qj) characteristics of that property, and it can be written as below (Freeman III, 2003, p. 357):

$$R_{hj} = R_h (S_j, N_j, Q_j) \quad (1)$$

Or, when solved in linear relationship, the model can be expressed as below:

$$R_{hj} = \beta_0 + \beta_1 S_j + \beta_2 N_j + \beta_3 Q_j + \varepsilon_j \quad (2)$$

The structure characteristics of the properties, for example, often include size and age of the property, number of rooms, the number of bathrooms, and the number of garages. The location characteristics usually include the condition of the neighborhood (e.g., demographic composition), distance to diverse amenities (e.g., school, transportation, and shops) and their characteristics. In related to the interest of studying the proximate effect of parks on property values, distance from the individual property to park and recreation amenities are included by using either continuing distance (e.g., Morancho, 2003) or buffer zones (e.g., Bolitzer & Netusil, 2000). In addition to park proximity, some other park characteristics such as park size (Bolitzer & Netusil, 2000), attractiveness (Espey & Owusu-Edusei, 2001), overall design (passive and active) (Lutzenhiser & Netusil, 2001), types of primary usage (e.g., cemetery, golf course, community garden) (Bolitzer & Netusil, 2000; Crompton & Nicholls, 2006; Lutzenhiser & Netusil, 2001; Voicu & Been, 2008), and types of ownership (public and private) (Bolitzer & Netusil, 2000) are also used in some of the hedonic models to estimate the impact of those characteristics on property values. However, as mentioned earlier, the inclusion of detail park features is rarely found. Therefore, this study adds selected park features into hedonic models in order to provide a further understanding of the economic impact of those park features on nearby property values.

2.4.2. The multilevel approach

In many social studies both individual effect and contextual effect are important and the variability of the effects between individuals and between contexts is suggested to be analyzed (e.g. Jones & Duncan, 1996). However, it has been argued that data for such analysis often has inherent hierarchical structure, which must be treated accordingly (Brown & Uyar, 2004; Goodman & Thibodeau, 1998; Hox, 2010; Jones, 1991; Kreft & de Leeuw, 1998; Orford, 2000, 2002; Raudenbush & Bryk, 2002; Snijders & Bosker, 2012; Steenbergen & Jones, 2002). As the example from housing literature, Orford (2002) suggested that houses should be treated as the individual level units grouped by streets as the second level and therefore influenced by street level characteristics. The nesting structure can be further expanded to the third and higher levels. For example, houses located at different streets but in the same community are grouped together at the community level, which is the third level, and can be influenced by the community characteristics. Following Snijders and Bosker (2012), such three-level structure can be illustrated as in Figure 2. The housing values at the level of individual housing units will be influenced, at the same time, by the characteristics of each individual housing unit at the same level, of the streets where each of the houses located, and of the community where each of the houses belongs.

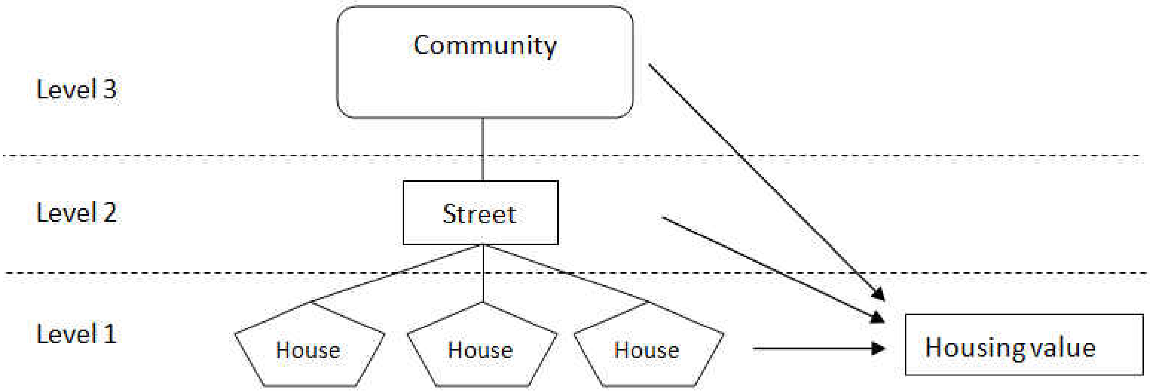

Figure 2. Illustration of a three-level data structure

However, data in the structure as described above are usually not modeled as where they are; instead, they are usually either disaggregated or aggregated into one of the other levels. However, such approaches can be problematic (Hox, 2010; Jones, 1991; Kreft & de Leeuw, 1998; Rocconi, 2013; Snijders & Bosker, 2012). To aggregate data means the lower level data are aggregated to be the measure of higher level, such as an average for each higher level group. For example, individual houses are ignored and their attributes are aggregated (e.g., average value of building size) to become attributes of the community. One single value (usually the average) of the properties is used to represent the entire community. What needs to be careful about aggregating data is that the meaning of data no longer represents the individual level unit and neither do the relationship between the individual units and the outcome, and the ecological fallacy can, therefore, be easily made when interpreting the result from aggregating data to a higher level (Hox, 2010). By aggregating the data, the model answers a different question, and much information of the original data is lost due to the ignorance of the differences among individual units. Statistically, since data of many lower level units are aggregated to fewer higher level units, the sample size is reduced and therefore the statistic power reduced.

By disaggregating data, for example, properties at a lower level that are belonging to the same higher level group receive the same values of the group's characteristics. For example, the community is ignored and the same set of community attributes (demographic composition, household income level, etc.) becomes the attributes of every house in that community. The atomistic fallacy can be made if the result from disaggregated data at a lower level is used to make the conclusion at the higher level (Hox, 2010). From the statistical view, individuals grouped in the same context are more similar to each other because they are sharing the same characteristics of the context, and therefore, they are duplications of each other, which results in an inflation of sample size (Kreft & de Leeuw, 1998). This can raise the possibility of type I error when studying contextual effect between groups, which it is more likely to suggest a significant relationship while it is not necessarily true (Snijders & Bosker, 2012).

In order to deal with data in the hierarchical structure, scholars suggest the use of the multilevel approach. For examples, multilevel models have been used in the studies in such as education (Rocconi, 2013), political science (Steenbergen and Jones, 2002), and housing market (Orford, 2002). The advantage of using multilevel approach is that the variance in the outcome variable at the individual level can be explained by the characteristics of context at the context level, rather than disaggregate the contextual variables to an individual or aggregate the individual variable to the context level. To do this, the multilevel model has the group effect and individual effect being separated into their own level by decomposing the variation in the outcome variable to each of the group and individual levels, and therefore the variance at each level is allowed to be explained at its own level (Orford, 2002). That is, unlike the single level hedonic regression model in equation (2) that use one single error term to represent the variance in the outcome variable, the multilevel model allows each of the levels modeled to be random. In the case that the value of property i in community j ($Value_{ij}$) can be influenced by the structure attributes of the property ($HouseAttribute_{ij}$) and the community where it belongs ($CommunityAttribute_{j}$), as suggested by Raudenbush and Bryk (2002), a two-level model can be used and written as below:

$$\text{Level-1: } Value_{ij} = \beta_{0j} + r_{ij} \quad (3)$$

$$\text{Level-2: } \beta_{0j} = \gamma_{00} + u_{0j} \quad (4)$$

As in equation (3) and (4), the error term in equation (2) is now decomposed to be r_{ij}, which represents the variance in the outcome variable among individual housing units at level 1, and u_{0j}, which represents the variance in property values across level-2 groups (park neighborhoods, for example) at level 2. Since the variance in the property value is now decomposed to each of the two levels, attributes at each of them can now enter the model to explain the variance at their original levels. That is, equation (3) and (4) can become:

$$\text{Level-1: } Value_{ij} = \beta_{0j} + \beta_{1j} HouseAttribute_{ij} + r_{ij} \quad (5)$$

$$\text{Level-2: } \beta_{0j} = \gamma_{00} + \gamma_{01} CommunityAttribute_{j} + u_{0j} \quad (6)$$

The above equations show the macro-to-micro relation as described by Snijders & Bosker (2012). That is, the multilevel model analyzes not only the micro-level relation, which is the effect of individual attributes (e.g., housing attributes) on the outcome at the individual level (e.g., individual housing value), but also the macro-to-micro level relation, which is the effect of the group-level attributes (e.g., community attributes) on the outcome at the individual level. In addition, they also point out that the macro-to-micro relation is not limited to the relationship between the group attributes at the context level and the outcome at the individual level as in equation (6). The multilevel model allows also the influence of macro-level attributes on the micro-level relation, and such influence can be illustrated in Figure 3 as shown by the red arrow. As commonly found in social science studies, the relationship between individual variables and the outcome can also vary across contexts. That is, the micro-level relation may not be fixed across different groups; instead, it may interact with certain macro-level attributes. Examples of such Macro-to-micro relation can be found in housing studies. Orford (2000) found that the micro-level relationship between floor area and property value became steeper in the community of higher social class. Similarly, when studying the impact of park proximity on property values, Anderson and West (2006) found that the value of proximity to parks vary across areas and depends on neighborhood characteristics such as distance to central business district, population density, median income, and crime rate.

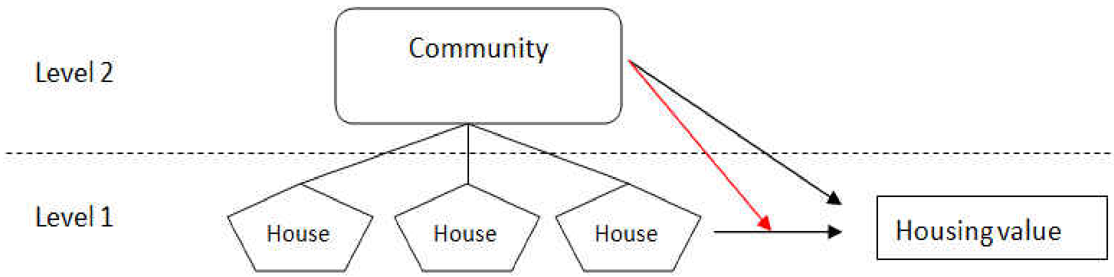

Figure 3. Illustration of the impact of context effect on micro-level relation

In order to take such cross-level interaction into account, an additional macro-micro relation in the multilevel model is to allow the micro-level relation to be random at the macro-level with macro-level variables to explain the variation. To do this, one additional equation can be added into the model at level 2 to represent the cross-level interaction, and it can be written as:

$$\beta_{1j} = \gamma_{10} + \gamma_{11}ParkAttribute_j + u_{1j} \quad (7)$$

The parameter of β_{1j} in equation (5) represents the effect of a housing attribute of house i in park neighborhood j on its value, and it is now being explained by park attributes at level 2 as in equation (7). Given the above advantages of using the multilevel model on analyzing individual and contextual effects at their original levels and on including the cross-level interaction, this study applied the multilevel approach in addition to the traditional hedonic regression model.

3. Study Area and Data

3.1. Study area

The City of Minneapolis, MN, United States is selected as the study area (Figure 4). Minneapolis is often touted as having one of the best park systems in the United States. Minneapolis's park system has been ranked as the first among the 50 largest U.S. cities in 2013 by the Trust for Public Land based on park access, park size, and services and investment (The Trust for Public Land, 2013). Minneapolis had started building its park system since the late 1800s. Its park system includes a number of different types of parks regarding size, function and equipment/facility, etc. Having the parks in mind, Minneapolis, unlike most of other cities seeing parkland as spaces for future developments, believes that parks can introduce benefits to its surrounding neighborhoods (Harnik, 2000).

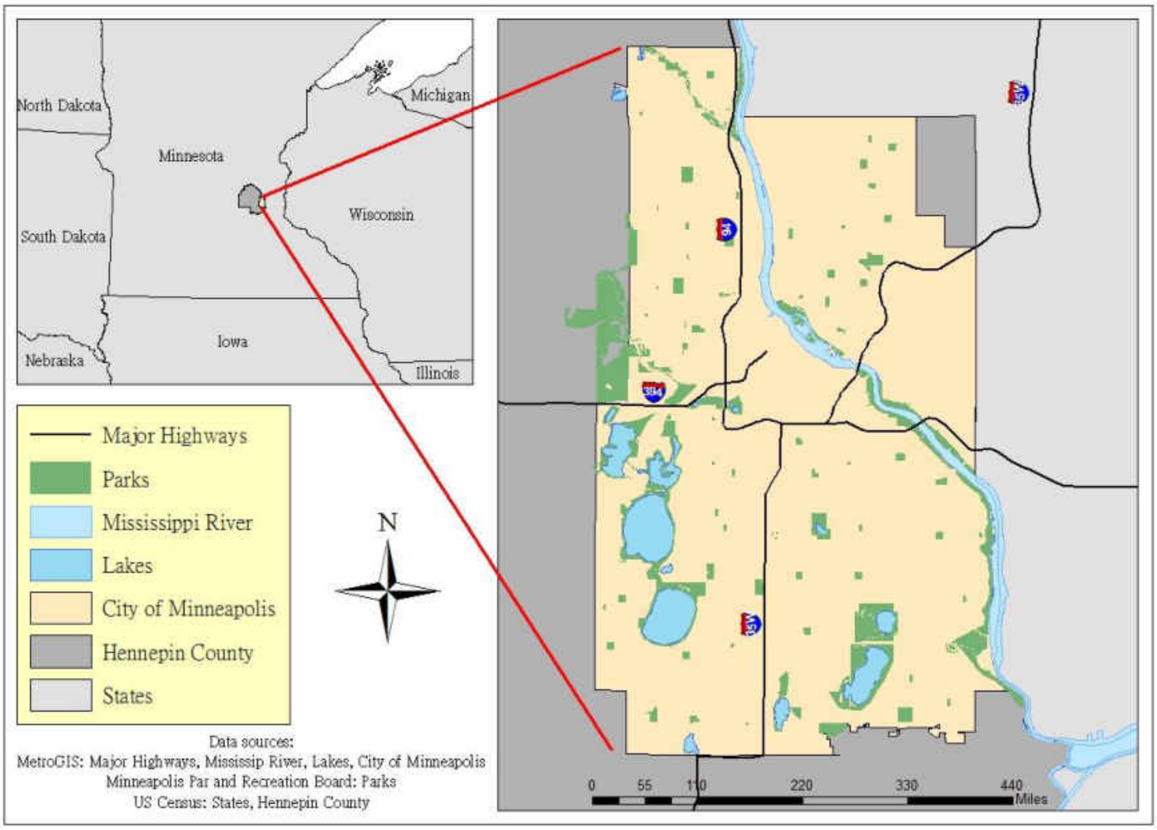

Figure 4. Study area

Among its over one hundred parks, Minneapolis park system includes several regional parks which are mostly large in size serving the city and the region, community and neighborhood parks for their close neighborhoods, and those less-than-one-acre parklands throughout the city. Together, those parks attract more than 14 million visitors a year (Minneapolis Park & Recreation Board, 2007b). The Chain of Lakes (Figure 5 and Figure 6) at the southwest part of the city is comprised a number of parks and lakes providing the beautiful nature scene of the water body and green recreation spaces. The Chain of Lakes was named as one of the most visited 50 U.S. parks by the Center for City Park Excellence of the Trust for Public Land (Center for City Park Excellence, 2008, 2009, 2010, 2011, 2012, 2014, 2015) attracting about 5 million local and regional visitors a year for activities such as walking, biking, boating, swimming, and playing on the beach. Other large parks such as Diamond Lake Park, Lake Nokomis and Hiawatha Park in the southeast and Theodore Wirth Park in the northwest were also provided as natural scene and recreation spaces. The park board also noticed the benefit of using the riverfront and creeks to provide natural and recreation spaces. Spaces along the Mississippi River, Minnehaha creek, and Shingle Creek were preserved and partially developed for recreational use.

Figure 5. View from the northwest corner of Lake Harriet

Figure 6. Beach located at the northwest corner of Lake Calhoun

As the former superintendent of Minneapolis' Park and Recreation Board, Mary Merrill Anderson, believed in "playing for life" (Smith, 2008, p.221), providing recreation facilities/programs to meet the needs of all ages in every community was also the goal for the park board. Most of the neighborhood/community parks in Minneapolis serve different facilities for active recreations (Figure 7). Among the largest 50 U.S. cities, Minneapolis was

Figure 7. An example of neighborhood/community parks that can include ball fields/ball diamond (left, in distance), basketball/tennis courts (left), small green space (right), and children's playground (right, in distance) (In picture: Linden Hill Park)

continuously ranked highly on providing ball diamonds (for example, ranked as #2 in 2013 with total of 185 diamonds or 5 diamonds per 10,000 residents) and tennis courts (for example, ranked as #2 in 2013 with total of 181 courts or 4.6 per 10,000 residents), and it was also one of the top ten cities on providing skateboard park (for example, ranked as #9 in 2013 with total of 6 facilities or 1.5 per 100,000 residents) as skateboarding became popular in recent years (Center for City Park Excellence, 2014). Given that the winter in Minneapolis is long and cold, the park system offers various opportunities for winter recreation such as cross-country ski, ice skating, and ice fishing, and there are also several year-round recreation centers for indoor recreation and programs.

The success of Minneapolis's park system is often believed to be because of its independent park board. In 1883, Minneapolis citizens voted to approve the creation of an independently elected, semi-autonomous Board of Park commissioners (now, the Minneapolis Park and Recreation Board) to manage, maintain, and develop the park system in Minneapolis (Smith, 2008). As Smith (2008) concluded in his book, the independence of the park board allows it to stay in the same direction as what it was in 150 years ago that focuses on acquiring and preserving the city's land for current and future recreation, and, as elected directly by the people, the perception and demand of the city's residents are always the major concerns of the elected park board.

The two major revenue resources to support the park board's operations are the property tax and the Local Government Aid (LGA). The vote in 1883 also gave the park board its independent property tax levy in order to cover its operation cost, and the property tax has been the most important funding to support the park board's operations. From 2007 to 2014, the park board's annual budget reports presented that property taxes accounted for about 75 percent of annual revenue in average for the park board's operations, followed by the LGA which accounted for 15 percent of annual revenue in average for its operations (Minneapolis

Park & Recreation Board, 2007a, 2008, 2009, 2010a, 2011, 2012, 2013, 2014). The property tax levy did increase annually by about 3.4 percent during the same time period; however, the reports also pointed out that the increase of cost was even more, and therefore the park board had to reduce services and delayed basic maintenance if additional revenue cannot be located. The Local Government Aid (LGA) is a program created by the State of Minnesota to fund its cities, and the city of Minneapolis has been sharing this funding with the park board (City of Minneapolis, 2015). However, while it served as the second major funding for park board's operations, the biggest issue associated with the LGA funding is its uncertainty. In response to the state's budget imbalance in 2008, the LGA funding to cities was reduced, and such reduction continued in the following years, which resulted in a loss of over $70 million for the city of Minneapolis as total or in a loss of $8.6 million to the park board in particular from 2008 to 2011 (City of Minneapolis, 2015; Minneapolis Park & Recreation Board, 2012). The uncertainty of the LGA funding due to the state's budgetary issue makes the park board rely more on its property tax levy and other revenues. Therefore, although Minneapolis's park system does not need to compete with other public services for property tax revenue that park agencies in many other U.S. cities have to, it still has to work on showing the benefit of its park system to Minneapolis' residents and decision makers in both public and private sectors at different levels in order to maintain its independence, to secure current funding, and to seek additional revenue resources.

3.2. Data

In order to examine the influence of parks on property values, information of parks and properties are needed. In this research, the estimated market values (EMVs) of single family residential properties located within the park influence area are used. The EMVs of single family properties in 2009 were obtained from the MetroGIS database. The EMVs are used instead of property transaction values in this research mainly because the EMVs are available for free through the MetroGIS database when the data was collected. The use of EMVs is considered appropriate in this study for three reasons. First, the EMVs in Minneapolis are frequently estimated and adjusted through the analyses of property sales. Second, the purpose of this study is to find out how park facilities impact the values of properties, and therefore affect tax revenue that can support park development. Third, although it is argued that the assessors may not see the benefit of parks and include it in the assessed values, scholars, by comparing the results from both assessed values and sale prices, found that the assessors tend to recognize the negative effect of parks and to reflect it in the assessed values (Weicher & Zerbst, 1973). Therefore, the results from using assessed values remain helpful to suggest concerns for future park development. The locations of these properties are also obtained from the same database to display in ArcGIS software for later analysis. Among the over a hundred parks in Minneapolis, only parks with over one acre in size are considered in this research, considering the impact of those small parks is minimal and can be difficult reflect in the model estimate[2]. The locations of parks were obtained from the Minneapolis Park and Recreation Board (MPRB) to display in ArcGIS software.

As suggested in the literature that are studying property values, the structure characteristics of each individual property are important and essential factors to control the property values in models and therefore are needed to be included in the models. Those structure characteristics were obtained from the MetroGIS database and the City of Minneapolis Assessor's Office.

Besides the structure variables, a number of studies have also suggested including locational attributes in studying property values. The locational variables can include the neighborhood condition (e.g., census data) and the accessibility from each property to certain places (e.g., distance to central business district or parks). In this research, the neighborhood

[2] The final selection of parks is different for each of the two sections (hedonic models and multilevel models) in this dissertation. The specific selection criteria and result for each section are described later.

condition is percentages of non-Hispanic African-American, non-Hispanic Asian, and Hispanic population of the census block to which the property belong, and the data was obtained from the MetroGIS database. The measures of accessibility include the distances from each property to the nearest bus stop, the nearest major highway, the central business district, and the nearest park, and they are measured using the NEAR function in ArcMap software.

Given that the particular interest in this research is the impact of diverse park facilities, individual facilities in parks are selected and included in the models. The presence and the number of park facilities were identified using the asset documents obtained from the Minneapolis Park and Recreation Board (MPRB), MPRB's website and publication (Smith, 2008), and via Google Map.

4. Methodology

4.1. The Hedonic models

As suggested in the literature, property values are closely associated with housing structure, neighborhood, and park related attributes and can be modeled as a hedonic function of these attributes as follows:

$$Vi = f\,(Hi, Ni, Pi) \qquad (8)$$

Where Vi is the EMV of property i, Hi is a vector of housing structural attributes, including Lotsf, Garage, rmstot, FBathtot, and Build_Age, of property i, Ni is a vector of demographic and accessibility attributes, including PctB, PctA, PctH, DBus, DHway, and DPark, and Pi is a vector of park facility attributes, including PctPassive, Water, Garden, NDiamond, NField, NBasketball, NTennis, NVolleyball, SkateP, Winter, Indoor, and Play. Details of each variable are listed in Table 1 and their descriptive statistics are presented in Table 2. In this study, the semi-log model (Vi is natural logarithm transformed) was adopted to examine the relationship between property values and park facility attributes. With this model, the estimated coefficients represent the percent change in the property values associated with one unit change in the attributes. The models were estimated using ordinary least squares regressions and analyzed using SPSS software. Multicollinearity was identified using Variance Inflation Factor (VIF), and independent variables with high VIFs were dropped from the models.

Table 1. Explanatory variables of hedonic regression models

Type of variables	Variable	Description
Housing structural	Lotsf	Lot area (square footage)
	Garage	Number of garage stalls
	Rmstot	Total number of rooms
	Fbathtot	Total number of full bathrooms
	Build_Age	Number of years since the unit was built
Demographic and accessibility	DBus_ft	Direct distance to the nearest bus stop (in feet)
	DHWay_ft	Direct distance to the nearest major highways (in feet)
	DPark	Direct distance to the nearest park (in feet)
	PctB	Percent of non-Hispanic African American population (2010) of the census block group
	PctA	Percent of non-Hispanic Asian population (2010) of the census block group
	PctH	Percent of Hispanic population (2010) of the census block group
Park facilities (Passive)	PctPassive	Percent of passive recreation space in the park (e.g. spaces for walking, picking, site seeing and people watching, etc.)
	Water	Presence of water body (e.g. river, creek, and lake) in the park
	Garden	Presence of garden in the park
Park facilities (Active)	NDiamond	Number of diamond fields (e.g. Softball and baseball) in the park
	NField	Number of ball fields (e.g. football and soccer) in the park
	NBasketball	Number of basketball court in the park
	NTennis	Number of tennis court in the park
	NVolleyball	Number of volleyball court in the park
	SkateP	Presence of skate park in the park
	Winter	Presence of winter recreation (e.g. ice rink and cross country skiing trail) in the park
	Indoor	Presence of indoor facility (e.g. craft room, meeting room, and gymnasium) in the park
	Play	Presence of children's play area in the park (playground and wedding pool)

Table 2. Statistics of explanatory variables for the hedonic models

Variable	Mean	Standard Deviation	Min	Max
Lotsf	5964.81	1965.17	1020	61470
Garage	1.49	0.70	0	6
Rmstot	6.70	1.65	2	21
Fbathtot	1.13	0.38	0	6
Build_Age	80.86	22.18	1	202
Dbus_ft	579.50	343.27	39.49	2292.89
DHWay_ft	3724.95	2198.66	68.69	11579.49
Dpark	749.12	357.40	17.89	1319.83
PctB	13.28	17.77	0	100
PctA	4.89	7.79	0	69.23
PctH	7.88	11.25	0	86.47
PctPassive	65.68	25.85	13.07	100
Water	0.33	0.47	0	1
Garden	0.31	0.46	0	1
NDiamond	3.02	3.24	0	11
NField	1.27	1.64	0	6
NBasketball	0.70	0.54	0	2
NTennis	2.07	2.75	0	10
NVolleyball	0.17	1.43	0	3
SkateP	0.10	0.30	0	1
Winter	0.50	0.50	0	1
Indoor	0.64	0.48	0	1
Play	0.92	0.27	0	1

There were three sets of hedonic models built in this study. The various types of park facilities are the major park variables in all of the models in order to examine the impact of those facilities on property values. The impacts of park facilities were then further examined over the distance from the residential properties to their nearest parks and over different park sizes. Each of these three sets of models is further explained below.

4.1.1. The impact of park facilities on proximate residential property values

The first set of models was built to examine the impacts of diverse park facilities on the values of properties within the park influence area. To do this, parks need to be identified and the park influence area needs to be defined. There is a total of seventy-six parks in Minneapolis with sizes ranging from one to over one hundred acres that were used. The park influence radius was defined as a quarter mile (402m/1,320 ft) from a park. This is equivalent to the acceptable walking distance and in the range of the commonly suggested maximum influence radius (457m 1,500 ft) and the minimum influence distance (183m /600 ft) suggested in the literature (Murray, 2001). The single family units were selected according to this influence distance, and there are 35,280 units selected.

Given that the average property values and demographic composition vary across the city, there is more than one model built in order to take such differences into account. The average values in 2009 of these four sectors vary significantly (Table 3).

Table 3. Descriptive statistics of 2009 estimated market values (EMVs) of single family houses within the park influence area

Sector	No. of Single family houses	Mean (US $)	Standard Deviation (US $)	Min (US $)	Max (US $)
All	35,280	230,772	184,756	20,000	3,825,000
NE	4,212	184,901	40,711	47,500	596,000
NW	7,934	125,963	46,311	20,000	625,000
SE	14,774	206,508	74,692	45,000	1,173,700
SW	8,360	396,233	302,356	70,000	3,825,000

The average value of single family properties in the SW sector ($396,223) is significantly higher, for instance, than the average for the city ($230,772), while the average values in the other three sectors are below the city average, with the NW having the lowest average property value ($125,963). Therefore, the city is considered to be divided into four sectors, each representing the sub-markets of northeast (NE), northwest (NW), southeast (SE), and southwest (SW) that are divided by highway system and the Mississippi River. The downtown area was excluded because of the limited number of single family properties. Using this park influence radius described above, one city-level model and four sub-market models were then built. The city-level model was constructed including all single-family houses within 402 m (1,320 ft) of any park. The four sub-market models were constructed with the same approach but applied to individual sectors to examine the impacts of park facilities on property values specifically for each sector.

Population compositions also vary from sector to sector (Figure 8). In SW, almost all of the studied blocks are inhabited by non-Hispanic White population. In NW, on the other hand, many blocks are inhabited by non-Hispanic African American population, and a couple of blocks have more than 10 percent Asian population. In the remaining two sectors, the non-Hispanic White population is the majority, mixed with non-Hispanic African American and Hispanic populations, particularly in the center of the NE and the northwest portion of the SE quadrant.

4.1.2. The impact of park facilities over distance zones

The second set of models was constructed to examine the impacts of park facilities on property values over distance. The park influence area (a radius of 402 m /1,320 ft) was divided into four distance zones with 101 m (330 ft) (a typical residential block in Minneapolis) each. For each distance zone, a city-level hedonic model was constructed to examine the impacts of park facilities within that zone. As a result, four city-level hedonic models were built, one for each distance zone. The same approach was applied to build the sector-level models, and with sixteen sector-level models were constructed in total.

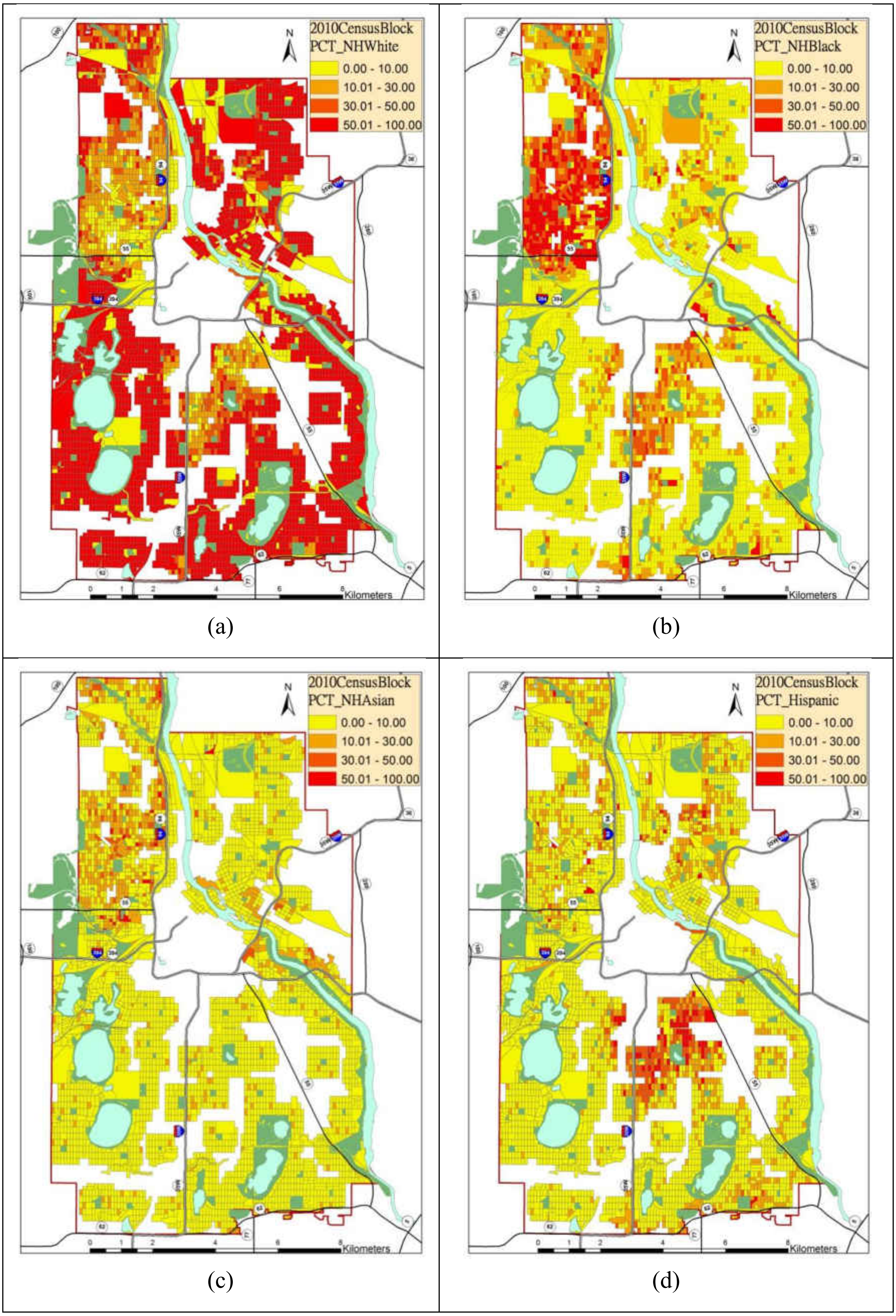

Figure 8. Population distributions by race/ethnicity

4.1.3. The impact of park facilities by park sizes

The final set of models was developed to examine whether the impacts of park facilities on nearby property values changed among different park size levels. Here, parks were based on the design standard of the Minneapolis Park and Recreation Board and the National Recreation and Park Association (Mertes & Hall, 1995) into three groups: neighborhood parks (0.004-0.040 km^2 /1-10 acres), community parks (0.040-0.202 km^2 / 10-50 acres), and urban parks (over 0.202 km^2/ 50 acres) (Table 4). Each hedonic model was built to examine the impacts of a particular size of the park. As an example, the impact of neighborhood parks was evaluated independently through analyzing all the residential properties within the neighborhood parks' influence areas. To implement this, three city-level models (e.g. neighborhood parks, community parks, and urban parks) were constructed. Similarly, twelve sector-level models were developed subsequently.

Table 4. Statistics of parks for the hedonic models

	N of Parks	Mean Park Size km^2 (acres)	SD km^2 (acres)	Minimum km^2 (acres)	Maximum km^2 (acres)
All Parks	76	0.242 (59.72)	0.571 (141.06)	0.005 (1.15)	2.996 (740.29)
Urban Park	15	1.064 (262.8)	0.897 (221.55)	0.209 (51.56)	2.996 (740.29)
Community Park	18	0.084 (20.69)	0.041 (10.19)	0.040 (10.00)	0.183 (45.16)
Neighborhood Park	43	0.021 (5.22)	0.010 (2.59)	0.005 (1.15)	0.037 (9.23)

4.2. The multilevel models

In the second part of this research, the multilevel approach is adopted. When studying park impact on nearby property values, the concept of hierarchical data structure can be illustrated as in Figure 9; houses (black) within a certain distance from the same park

Figure 9. Illustration of houses and parks in hierarchical data structure

(dark green) should be treated as individuals grouped by that park. This forms a park neighborhood (light green area with the black circle as the park influence boundary), and the park is the contextual effect at the neighborhood level and influence similarly to the values of houses within this park neighborhood. When there is more than one park, more than one park neighborhood can be defined to include houses within their influence areas. While focusing on the level of individual properties, the values of individual houses are various among houses within the same park neighborhood because of different packages of housing attributes for each house. While looking at the park neighborhood level, the situation can be that the housing values do not vary across park neighborhoods because they are all close to a park (Figure 9 (A)). If there are no differences between park neighborhoods, there is actually no need of using multilevel models because the park neighborhood level can be ignored and a single level model at housing level is appropriate. However, parks can be different from each other, just like houses are different from each other, according to their own characteristics such as size of the parks and facilities in the parks (Figure 9 (B)), and therefore property values can be varied across park neighborhoods depending on the characteristics of their closest park. It is to assume that the values of properties within the same park neighborhoods are more likely to be similar to each other than the values of properties in a different park neighborhood. Therefore, the multilevel approach is appropriate to model both the differences among houses within the same park neighborhood and the differences among park neighborhoods.

In this study, five three-level models are built to analyze the impact of park facilities on property values. Parks and single family properties are assigned to each of the three levels as listed in Table 5. The single-family residential properties are used as the lowest level (level-1) assuming their values are influenced by the parks at higher levels within the influence radius. The small to medium sized neighborhood-community parks are at the second level, which is assumed to influence the property values at level-1, and are grouped by urban-regional parks at level-3. Besides examining the impact of neighborhood-community parks on adjacent property values, this study also examines the influence of nearby large-size urban-regional parks on property values, and therefore these large-size parks are at the third level considering their broader influence radius.

Table 5. Statistics of Parks and Single Family Properties for the multilevel models

Level	Object	Number (Selected)	Mean	Min. Property value/Park size (Selected)	Max. Property value/Park size (Selected)
Level-1 (Lowest)	Single family properties	6,387	$253,723	$25,000	$2,729,000
Level-2	Neighborhood/ community parks	42	9.14	1.15 acres	45.16 acres
Level-3 (highest)	Urban/ Regional parks	12	273.98	65.88 acres	810.55 acres

Attributes used in multilevel models can be found in Table 6 and descriptive statistics of them can be found in Table 7.

Table 6. Explanatory variables of multi-level models

Type of variables	Variable	Description
Housing structural (Level-1)	Lotsf	Lot area (square footage)
	Garage	Number of garage stalls
	Rmstot	Total number of rooms
	Fbathtot	Total number of full bathrooms
	Build_Age	Number of years since the unit was built
Accessibility (Level-1)	DBus_ft	Direct distance to the nearest bus stop (in feet)
	DHWay_ft	Direct distance to the nearest major highways (in feet)
	D_CBD	Direct distance to the downtown area (in feet)
	NCP_33	Properties located with 330 feet in direct distance from the nearest Neighborhood-Community park
Demographic (Level-2)	PctB	Percent of non-Hispanic African American population (2010) of the census block group
	PctA	Percent of non-Hispanic Asian population (2010) of the census block group
	PctH	Percent of Hispanic population (2010) of the census block group
Neighborhood/ Community Park facilities (Level-2)	Garden	Presence of garden in the park
	Water	Presence of water body (e.g. river, creek, and lake) in the park
	NDiamond	Number of diamond fields (e.g. softball and baseball) in the park
	NField	Number of ball fields (e.g. football and soccer) in the park
	NBasketball	Number of basketball court in the park
	NTennis	Number of tennis court in the park
	SkateP	Presence of skate park in the park
	Indoor	Presence of indoor facility (e.g. craft room, meeting room, and gymnasium) in the park
	Play	Presence of children's play area in the park (playground and wedding pool)
Urban/ Regional Park facilities (Level-3)	URPGarden	Presence of garden in the park
	URPMissR	Presence of Mississippi River in or adjacent to the park
	URPLake	Presence of lake in the park
	URPNDiamond	Number of diamond fields (e.g. softball and baseball) in the park
	URPGolf	Presence of golf course in the park

Table 7. Statistics of explanatory variables for the multi-level models

Variable	Mean	Standard Deviation	Min	Max
Level 1				
Lotsf	6146.60	2055.11	1023	48809
Garage	1.47	0.71	0	6
Rmstot	6.80	1.82	2	18
FBathtot	1.15	0.44	0	7
Build_Age	80.10	21.15	2	128
D_Bus	630.57	384.94	37.40	1982.02
D_Hway	4152.67	2674.54	180.92	11312.11
D_CBD	14958.53	6426.31	179.73	26253.14
NCP_33	0.38	0.49	0	1
Level 2				
Pct_B	14.80	17.35	0.48	62.04
Pct_A	4.55	3.80	1.34	15.96
Pct_H	8.22	9.47	0.22	46.88
NDiamond	1.76	2.04	0	10
NField	0.45	0.50	0	1
NBasketall	0.60	0.60	0	2
NTennis	1.25	1.56	0	6
Garden	0.19	0.39	0	1
SkateP	0.02	0.15	0	1
Indoor	0.45	0.50	0	1
Play	0.81	0.39	0	1
Water	0.07	0.26	0	1
NCP_Size	9.14	10.44	1.15	45.16
Level 3				
URPGarden	0.5	0.5	0	1
URPMissR	0.17	0.37	0	1
URPLake	0.67	0.47	0	1
RPNDiamond	1.92	3.17	0	11
URPGolf	0.25	0.43	0	1

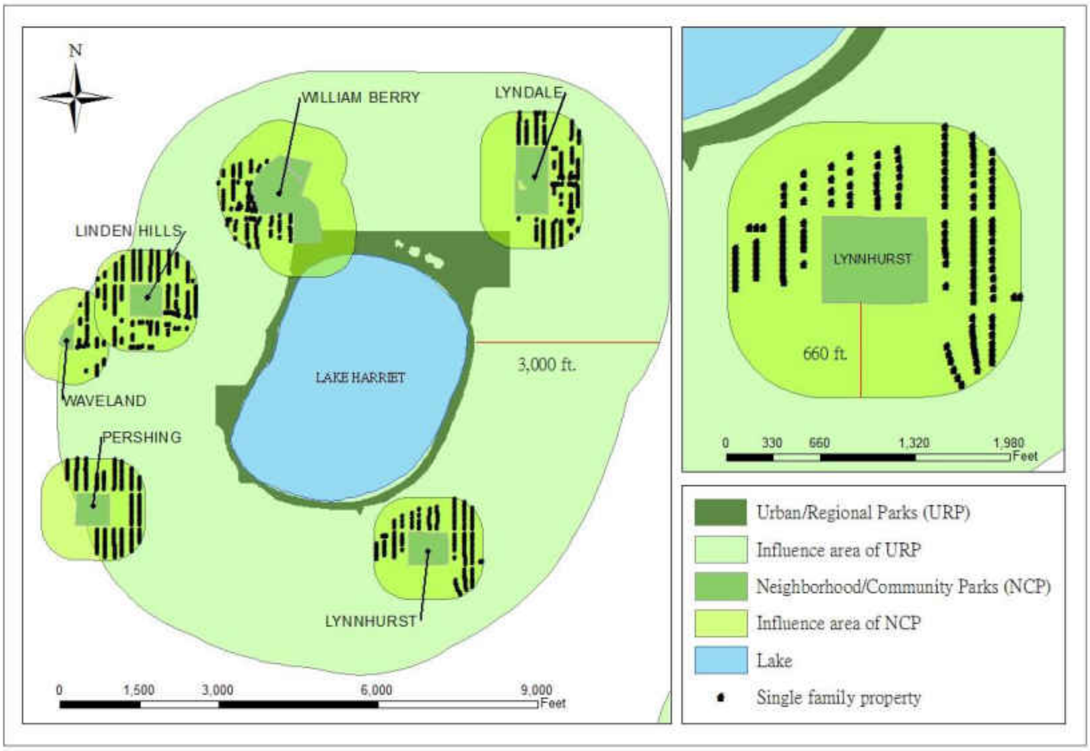

Figure 10. Example of properties within park influence areas in the study area

4.2.1. The park influence area and the selection of properties and parks

Given that multilevel models are built based on the nested data, a defined area is needed to identify which lower level units are nested within a higher level unit. An illustration of the selected properties at a lower level within park influence areas at higher levels is provided in Figure 10. To begin with, there are 12 urban-regional parks selected at level 3[3]. They are large in size ranging from 66 acres to over a hundreds of acres. When defining the influence area of large urban-regional parks, a larger influence radius of 3,000 feet is used, and

[3] The Central Mississippi Riverfront Regional Park, the Loring Park and the Parade Park are included. They are not selected for the hedonic models because they are right next to the CBD, and relatively few single family properties are immediately close to these parks. Here, for multilevel models, they are not directly used to select single family properties and are used to group neighborhood/community parks located within their influence area. The data obtained from the MPRB contained few small park parcels for the Central Mississippi Riverfront Regional Park, and they includes the Boom Island, the Father Hennepin Bluffs, the main street, and the Nicollet Island, and they are join to be one single record to represent the Central Mississippi Riverfront Regional Park. The Loring Park and the Parade park (includes the Minneapolis Sculpture Garden, the Parade Athletic Fields, and the Parade Ice Garden) are two adjacent parks connected by a pedestrian bridge across the highway, and are treated as one single park at here. Similarly, the Theodore Wirth Park and the Bassett's Creek Park are adjacent to each other and are treated as one single park at here.

neighborhood-community parks within this radius of each urban-regional park are grouped together. Although most of the literature suggests the strongest influence of parks appears within 660 feet from parks, a significant impact of parks on property values can remain further than that distance, and can be up to over 2,000 feet. Especially when the park is large in size (ex., 50 acres), like the urban-regional parks used in this research, an influence radius of 3,000 feet can be assumed (Crompton, 2001c). With the influence area of urban-regional parks (level-3) defined, neighborhood-community parks (level-2) can be identified accordingly. There are 42 neighborhood-community parks selected.

Similarly, to select single family properties at level-1 needs to have the influence area of neighborhood-community parks at level 2 defined. An influence radius of 660 feet from each neighborhood-community park is used following the suggestion in the literature that the strongest park influence to the nearby property values is mostly found within this distance from parks, and also matching to the length of a typical city block of Minneapolis (330-660 feet). That is, the selected properties have to be within 660 feet from their nearest neighborhood-community park. All the selected properties are also within the 3,000 feet influence area of the urban-regional parks. Two additional criteria are used in order to minimize the influence from other parks. First, urban-regional parks are considered when finding the nearest park for the properties. This avoids those properties that are very close to an urban-regional park (e.g., the front row from urban-regional parks) and therefore receive stronger influence from the urban-regional park instead of from the neighborhood-community park. Second, properties that are within more than one neighborhood-community park influence areas are dropped to prevent the influence from multiple parks.

The data is prepared in ArcGIS software. By using the selected parks and properties at above, prior examinations of OLS regression has been made in SPSS to examine the proximate effect of the selected neighborhood-community parks and urban-regional parks in this section. The results support significant proximate effects of the selected neighborhood-community parks and urban-regional parks. That is, the selected parks have a significant impact on the values of properties located within 660 feet from a neighborhood-community park or within 3,000 feet from an urban-regional park comparing to the values of properties further than 660 feet or 3,000 feet from neighborhood-community parks or urban-regional parks, respectively.

4.2.2. The unconditional model (Model 1)

Following Raudenbush & Bryk, (2002), multilevel models built for this study are described in this and the following sections, and the models are estimated by using HLM 7 software. In HLM 7 for three-level models, the Empirical Bayes estimates are used for the level-1 and the level-2 coefficient and the maximum-likelihood estimates is used for the level-3 coefficients as well as for the variance-covariance components.

The first model to be built is the fully unconditional model, and it is served to help decide whether or not the multilevel models are more appropriate instead of the single-level hedonic model. In the model, the total variance in the outcome variable (i.e., property values at here) is decomposed to be variance at each level. With the variance decomposed at each level, the intra-class correlation then can be calculated. The intra-class correlation indicates the existence of intra-context dependency (Kreft & de Leeuw, 1998). Given that individuals within the same groups are sharing common attributes from the context, the intra-context dependency may present and therefore leads to the violation of the assumption of independent observations in the traditional OLS single-level regression. The intra-class correlation is defined as the proportion of the variance in the outcome that is between contexts. The higher proportion of the variance in the outcome between contexts means that the outcome variables is more different between contexts than within context and therefore suggests the existence of the intra-context dependency.

In the unconditional model, the intercept is set to be random at all levels; that is, decomposing the total variance to each level. Given that the purpose here is to obtain the variation at each level in order to calculate intra-class correlation, the explanatory variables at all levels are not included at here. The model can be written as separate equations as follow:

Property level (Level-1): $\text{ln\_EMV}_{ijk} = \pi_{0jk} + e_{ijk}$ (9)

Neighborhood-Community Park Level (Level-2): $\pi_{0jk} = \beta_{00k} + r_{0jk}$ (10)

Urban-Regional Park Level (Level-3): $\beta_{00k} = \gamma_{000} + u_{00k}$ (11)

Or, in the combined form:

$$\text{ln\_EMV}_{ijk} = \gamma_{000} + r_{0jk} + u_{00k} + e_{ijk} \quad (12)$$

where

i = 1, 2,…, n_{jk} properties within neighborhood-community park area j in urban-regional park area k;

j = 1, 2,…, J_k neighborhood-community park area in urban-regional park area k;

k = 1, 2,…, K urban-regional park area;

ln_EMV_{ijk} is the property value of property i in neighborhood-community park area j and urban-regional park area k;

π_{0jk} is the mean property value of neighborhood-community park area j in urban-regional park area k;

e_{ijk} is a random property effect, representing the deviation of the value of property ijk from the mean value of neighborhood-community park areas, and is assumed to be normally distributed with a mean of zero and variance σ^2, $e_{ijk} \sim N(0, \sigma^2)$;

β_{00k} is the mean property value in urban-regional park area k;

r_{0jk} is the random neighborhood-community park effect, representing the deviation of the neighborhood-community park area jk's mean from the mean value of the urban-regional park areas, and is assumed to be normally distributed with a mean of zero and variance τ_{π}, $r_{0jk} \sim N(0, \tau_{\pi})$;

γ_{000} is the grand mean of property value; and

u_{00k} is a random urban-regional park effect, representing the deviation of the urban-regional park area k's mean from the grand mean, and is assumed to be normally distributed with a mean of zero and variance τ_{β}, $u_{00k} \sim N(0, \tau_{\beta})$.

The variance at each level obtained from the model is the variability among properties within a neighborhood-community park area at level-1, σ^2, among neighborhood-community park areas within an urban-regional park area at level-2, τ_{π}, and among urban-regional park area at level-3, τ_{β}. Given the total variability in Y_{ijk} has now divided into three components, σ^2, τ_{π}, and τ_{β}, the proportion of variance at each level can be calculated as follow:

$$\sigma^2/(\sigma^2 + \tau_{\pi} + \tau_{\beta}) \quad (13)$$

$$\tau_{\pi}/(\sigma^2 + \tau_{\pi} + \tau_{\beta}) \quad (14)$$

$$\tau_{\beta}/(\sigma^2 + \tau_{\pi} + \tau_{\beta}) \quad (15)$$

The non-zero values from equation (14) and (15) indicate the presence of intra-class correlation, and therefore, the multilevel approach can be suggested and the context effect (e.g., park attributes) can be included at its own level to explain the variance at that level.

4.2.3. The Basic model (Model 2)

After the preliminary examination on the data by using the unconditional model and the intra-class correlation, the model can then be expanded by adding explanatory variables in an attempt to explain the variance at each level. Therefore, the second multilevel model built in this study is the basic model to include explanatory variables. As suggested by scholars that property's structure attributes and neighborhood attributes are important to control property values, these attributes are added into the basic model in order to predict the property values. The basic model does not include park attributes at the park neighborhood levels because it is served as the baseline model and will be used for comparison with later models in order to suggest whether the addition of park attributes in later models can efficiently explain the variability of property values. The basic model and variables included are described below.

At level 1, the structure attributes are used including Lotsf, Garage, Rmstot, FBathtot, and Build_Age. In addition, the accessibility attributes, D_Bus, D_HWay, D_CBD, and NCP_33 are also included. With the inclusion of structure and accessibility attributes into the model, the level-1 equation in unconditional model, equation (9), is re-written as:

$$\text{ln\_EMV}_{\text{ijk}} = \pi_{\text{0jk}} + \pi_{\text{pjk}} a_{\text{pijk}} + e_{\text{ijk}} \qquad (16)$$

where, a_{pijk} (p=1,2,…, p) are structure and accessibility attributes at level-1 that predict property values, and π_{pjk} (p=1,2,…, p) are the corresponding level-1 coefficients indicating the relationship between each structure and accessibility variable, a_{pijk}, and the value of property i in park area jk.

The demographic attributes[4] (Pct_B and Pct_H) are included in an attempt to explain the variation in property values at level 2. It is more appropriate to be treated as contextual variable at a higher level because such census data was not distributed at the individual property level. Population data of census blocks that are covered by the neighborhood-community park areas are used to calculate the percentage of non-Hispanic African-American population (Pct_B) and the percentage of Hispanic population (Pct_H). Given that Pct_B and Pct_H are new added into the model, equation (10), is re-written to be:

[4] The percentage of non-Hispanic Asian population (PCT_A) was considered at first, but removed after examining the correlation between the variables due to highly correlated (0.819) with PCT_B in this data set.

$$\pi_{0jk} = \beta_{00k} + \beta_{0qk}X_{qjk} + r_{0jk} \tag{17}$$

where, X_{qjk} (q=1,2,…,q) are demographic attributes (Pct_B and Pct_H) that predict π_{0jk}; β_{0qk} (q=1,2,…,q) are the corresponding coefficient indicating the relationship between each of the demographic attributes, X_{qjk}, and the mean property value, π_{0jk}.

There are no explanatory variables introduced at level 3 to explain the variation in property value in this basic model, and therefore,equation (11) from the unconditional model remains the same. In addition to the above equations, there are three additional equations needed. Given the addition of explanatory variables at level 1 and level 2, the parameters of these variables need to be defined at higher levels. Since the basic model is not intended to explain the variance of slopes (i.e., the relationship between explanatory variables and property values), level-1 slope is set to be fixed at level-2 and level-3 as below:

$$\text{Level-1 slope at level 2: } \pi_{pjk} = \beta_{p0k} \tag{18}$$

$$\text{Level-1 slope at level 3: } \beta_{p0k} = \gamma_{p00} \tag{19}$$

Similarly, the level-2 slope in equation (17) is set to be fixed at level-3 as below:

$$\beta_{0qk} = \gamma_{0q0} \tag{20}$$

Again, although the model is described as separate equations above, they can be written into a mixed model as below:

$$\text{ln\_EMV}_{ijk} = \gamma_{000} + \gamma_{0q0}X_{qjk} + \gamma_{p00}a_{pijk} + r_{0jk} + u_{00k} + e_{ijk} \tag{21}$$

By estimating the model, the effect of the explanatory variables to the property values can be found. With the provision of variance component, the variance can be compared with the previous model to calculate the proportion of variance reduction, which is the proportion of variance explained by the explanatory variables added in this current model.

Test on model improvement is also suggested. It is the hope that the model helps explain the most of the variance in the outcome variables by adding the explanatory variables. However, as suggested by scholars (e.g., Hox, 2010; Kreft & de Leeuw, 1998), a large model that is with many variables can easily result in model instability due to, for example, multicollinearity, and keep the model simple with only efficient variables or include only particularly interested variables is therefore recommended. In order to examine whether the alternative model (i.e., a model with additional explanatory variables) is significantly improved from the simpler model, comparing the deviance of two models is suggested. For example, here, the basic model can be compared to the unconditional model to examine if the housing structural and accessibility variables and neighborhood demographic variables improved the model significantly. Ideally, the model with smaller deviance indicated a better model fit and therefore is preferred. The likelihood-ratio test can be performed to test the significance in the change of deviances. To be significantly improved, the difference between deviances in two models is suggested to be at least twice as large as the difference in the number of estimated parameters. This comparison test can be set and generated in HLM 7 software when running the model.

4.2.4. The influence of neighborhood-community parks on property values (Model 3)

After the property's structure and neighborhood variables have added in the basic model, the focus now turns to the interests of this study, which are the impacts of park facilities on property values. The influences of the facilities in neighborhood-community parks are first examined and included in model 3. The specification of and the variables added into the neighborhood-community park model are described below.

To examine the impact of the facilities in neighborhood-community parks on property values, a number of park attributes are added into the model. They include NDiamond, NField, NBasketall, NTennis, Garden, SkateP, Indoor, Play, and Water, as listed in Table 1.[5] Besides to the park facilities, park size (NCP_Size) is also included since the size of neighborhood parks and community parks varies. Given the addition of the park variables, the level-2 intercept equation (17) in the basic model is then re-written as:

$$\pi_{0jk} = \beta_{00k} + \beta_{0qk}X_{qjk} + \beta_{0sk}Z_{sjk} + r_{0jk} \tag{22}$$

where, Z_{sjk} (s=1,2,…, s) are the attributes of neighborhood-community parks; β_{0sk}(s=1,2,…,s) is the corresponding coefficient indicating the relationship between each of Z_{sjk} and the mean property value, π_{0jk}. The slopes, β_{0sk}, is set to be fixed at level-3. That is, the effects of neighborhood-community parks are not varied across urban-regional park areas. The equation for β_{0sk} at level-3 is written as:

$$\beta_{0sk} = \gamma_{0s0} \tag{23}$$

In this neighborhood-community park model, only the variables of neighborhood-community parks at level-2 are added into the model to explain the variance of mean property value (intercept), no additional variable is added at both level-1 and level-3 for intercept, and therefore, level-1 equation (16) and the intercept equations for level-3 (11) remain the same as what they were in the basic model. Similarly, no explanatory variables are added to explain level-1 slope at level-2 (18) and level-3 (19) and level-2 slopes at level-3 (20), and therefore, they remain the same as what they were in the basic model. The mixed form of model 3 is written as:

[5] The number of volleyball court (NVolly) and winter sport facility (Winter) were not included because they are correlated with other variables with *r* higher than .6 in this data set. Since the tolerance and VIF value that usually used to evaluate multicolleanarity in OLS regression are not provided in the multilevel result, examining the potential of multicolleanarity before the analysis through correlation between variables is suggested (Kreft & de Leeuw, 1998).

$$\text{ln\_EMV}_{ijk} = \gamma_{000} + \gamma_{p00} a_{pijk} + \gamma_{0q0} X_{qjk} + \gamma_{0s0} Z_{sjk} + r_{0jk} + u_{00k} + e_{ijk} \quad (24)$$

Given that the park attributes are added, a reduced, or explained, variance in property values, especially at level-2, is expected, and can be obtained by comparing to the result from the basic model. The model fit is also tested with likelihood-ratio test by comparing to the deviance of basic model.

4.2.5. The influence of urban-regional parks on property values (Model 4)

After the inclusion of neighborhood-community park attributes, model 4 is built to examine the effect of urban-regional park attributes at level-3 on property values. Here, garden (URPGarden) and water features are included. For water features, two dummy variables are used. One is for parks next to Mississippi River (URPMissR), and the other is for parks with a lake (URPLake). Among the active park facilities, correlation is an issue between the variables and only the number of ball diamonds (URPNDiamond) is therefore used. In addition, the presence of golf course (URPGolf) in the parks is also included in model 4. With those park variables added, equation (11) is rewritten as below:

$$\beta_{00k} = \gamma_{000} + \gamma_{00h} W_{hk} + u_{00k} \quad (25)$$

where, W_{hk} (h=1,2,…, h) are the attributes of urban-regional parks; γ_{00h}(h=1,2,…,h) is the corresponding coefficient indicating the relationship between each of W_{hk} and the mean property value, β_{00k}. In model 4, all other equations from model 3 remain the same. The mixed form of model 4 is then written as:

$$\text{ln\_EMV}_{ijk} = \gamma_{000} + \gamma_{p00} a_{pijk} + \gamma_{0q0} X_{qjk} + \gamma_{0s0} Z_{sjk} + \gamma_{00h} W_{hk} + r_{0jk} + u_{00k} + e_{ijk} \quad (26)$$

Given the inclusion of park variables at level-3, a reduced variance in property values at level-3 is expected and can be found by comparing to model 3. The likelihood-ratio test is performed by comparing the deviance of model 4 and the deviance of model 3 for model fit.

4.2.6. The influence of neighborhood-community parks on park adjacency (Model 5)

Given that the effect of park adjacency can be influenced by park attributes, this study also attempts to look at how park attributes influence the relationship between park adjacency and property values. Model 5 is therefore served for this purpose. To do this, the slope of park accessibility variable (NCP33) is set to be random at level-2. That is, the effect of NCP33 on property values at level-1 is now permitted to be different across all neighborhood-community park areas at level-2, instead of being fixed. Park attributes are then added to explain the difference in the variance of NCP33 at level-2. To avoid confusion, the level-1 equation (16) is re-written with NCP33 being separated from the rest of level-1 variables as below:

$$\mathrm{ln\_EMV}_{\mathrm{ijk}} = \pi_{\mathrm{0jk}} + \pi_{\mathrm{pjk}} a_{\mathrm{pijk}} + \pi_{\mathrm{(NCP33)jk}} NCP33_{\mathrm{ijk}} + e_{\mathrm{ijk}} \tag{27}$$

With the NCP33 being random and varying at level-2, $\pi_{\mathrm{(NCP33)jk}}$ is regressed by park attributes at level-2 as below:

$$\pi_{\mathrm{(NCP33)jk}} = \beta_{\mathrm{(NCP33)0k}} + \beta_{\mathrm{(NCP33)sk}} \mathrm{Z}_{\mathrm{sjk}} + r_{\mathrm{(NCP33)jk}} \tag{28}$$

In this equation, part of the variation of the NCP33 slope, $\pi_{\mathrm{(NCP33)jk}}$, can be predicted by park attributes, $\mathrm{Z}_{\mathrm{sjk}}$ (s=1,2,…, s), but part of the variation can remain unexplained and is indicated in $r_{\mathrm{(NCP33)jk}}$. The intercept and slope in equation (28) are set to be fixed at level-3, and are written as below:

$$\beta_{(NCP33)0k} = \gamma_{(NCP33)00} \quad (29)$$

$$\beta_{(NCP33)sk} = \gamma_{(NCP33)s0} \quad (30)$$

The rest of level-1 slope remain fixed at level-2 as in equation (18), and the level-2 intercept remains the same as in equation (22). The slopes of the rest of level-1 and level-2 explanatory variables and the level-3 intercept also remain the same as in model 4. The mixed form of model 5 is therefore as below:

$$\begin{aligned} \text{ln\_EMV}_{ijk} = {} & \gamma_{000} + \gamma_{p00} a_{pijk} + \gamma_{(NCP33)00} NCP33_{ijk} + \gamma_{0q0} X_{qjk} \\ & + \gamma_{0s0} Z_{sjk} + \gamma_{(NCP33)s0} NCP33_{ijk} Z_{sjk} + \gamma_{00h} W_{hk} + r_{0jk} \\ & + r_{(NCP33)jk} NCP33_{ijk} + u_{00k} + e_{ijk} \end{aligned} \quad (31)$$

5. Results and Discussion

5.1. Hedonic models

5.1.1. The impacts of park facilities on proximate residential property values

With the first set of models, the impacts of park facilities on the values of properties located within the park influence area were examined. Specifically, the city-level model was built to examine the overall impacts of park facilities on property values, and four sector-level models were developed to examine variations among sectors. The estimated coefficients for housing structure and neighborhood variables were presented in Table 8, and those for park facility variables were reported in Table 9. The results with the city-level model and four sector-level models suggested that newly constructed properties with large lot square footage, more garage stalls, more rooms, and more of full bathrooms have higher values. Three distance variables had significant but very small impacts on property values in the defined park influence area in all models. Three demographic variables (e.g. percent of African American population, percent of the Asian population, and percent of the Hispanic population) had significant negative impacts on property values, but they only slightly influenced the property values in all models.

Table 8. Estimated Coefficients for the structural, demographic, and accessibility variables

	City β(SE[1])	NE β(SE)	NW β(SE)	SE β(SE)	SW β(SE)
(Constant)	11.619*** (0.013)	11.528*** (0.032)	11.186*** (0.030)	11.546*** (0.014)	11.561*** (0.020)
Lotsf	4.072E-5*** (0.000)	2.185E-5*** (0.000)	1.493E-5*** (0.000)	4.057E-5*** (0.000)	4.336E-5*** (0.000)
Garage	0.043*** (0.002)	0.044*** (0.003)	0.074*** (0.004)	0.048*** (0.002)	0.035*** (0.003)
Rmstot	0.118*** (0.001)	0.069*** (0.002)	0.085*** (0.002)	0.087*** (0.001)	0.107*** (0.001)
FBathtot	0.069*** (0.004)	0.046*** (0.007)	0.056*** (0.008)	0.037*** (0.004)	0.043*** (0.005)
Build_Age	-0.001*** (0.000)	-0.001*** (0.000)	-0.003*** (0.000)	-0.003*** (0.000)	-0.001*** (0.000)
DBus_ft	-3.149E-6 (0.000)	3.201E-6 (0.000)	2.426E-5*** (0.000)	7.959E-5*** (0.000)	0.000*** (0.000)
DHWay_ft	1.701E-5*** (0.000)	-5.760E-6*** (0.000)	-3.935E-6*** (0.000)	1.483E-5*** (0.000)	4.800E-5*** (0.000)
DPark	-2.697E-5*** (0.000)	1.457E-5** (0.000)	1.266E-5** (0.000)	-5.746E-5*** (0.000)	-7.161E-5*** (0.000)
PctB	-0.010*** (0.000)	-0.003*** (0.000)	-0.004*** (0.000)	-0.003*** (0.000)	-0.005*** (0.000)
PctA	-0.009*** (0.000)	1.442E-5 (0.001)	-0.005*** (0.000)	-0.002*** (0.000)	0.000 (0.001)
PctH	-0.007*** (0.000)	-0.002*** (0.000)	-0.005*** (0.000)	-0.005*** (0.000)	-0.004*** (0.000)

Note: [1] SE = standard error; [2] Variable was dropped due to high VIF;; *, **, and *** denote significance at 90%, 95%, and 99% level, respectively.
Dependent Variable: Ln_EMV
Adjusted R Square: City: 0.736; NE: 0.524; NW: 0.520; SE: 0.700; SW: 0.832.

Table 9. Modeling coefficients for individual park facilities at the city-level and sector-level in Minneapolis, MN, U.S.A.

		City β(SE[1])	NE β(SE)	NW β(SE)	SE β(SE)	SW β(SE)
Park Facilities (passive)	PctPassive	--[2]	0.001*** (0.000)	0.001*** (0.000)	--	--
	Water	0.064*** (0.004)	-0.006 (0.014)	--	0.023*** (0.005)	0.198*** (0.011)
	Garden	-0.060*** (0.004)	0.066*** (0.008)	--	0.004 (0.005)	-0.132*** (0.006)
Park facilities (active)	NDiamond	-0.007*** (0.001)	--	--	0.007*** (0.001)	-0.029*** (0.002)
	NField	0.026*** (0.002)	-0.023*** (0.002)	0.081*** (0.005)	0.003** (0.002)	--
	NBasketball	-0.040*** (0.003)	0.085*** (0.009)	0.037*** (0.010)	0.025*** (0.004)	--
	NTennis	--	--	0.013*** (0.003)	--	-0.014*** (0.002)
	NVollyball	-0.023*** (0.004)	--	0.019 (0.013)	0.182*** (0.006)	-0.058*** (0.012)
	SkateP	-0.136*** (0.005)	-0.009 (0.014)	-0.053*** (0.014)	-0.013** (0.006)	
	Winter	0.033*** (0.004)	0.109*** (0.009)	0.047** (0.007)	--	0.004 (0.010)
	Indoor	0.080*** (0.004)	0.013 (0.009)	-0.201*** (0.012)	-0.009* (0.005)	--
	Play	-0.359*** (0.007)	-0.155*** (0.020)	NA[3]	-0.082*** (0.009)	-0.075*** (0.008)

Note: [1] SE = standard error; [2] Variable was dropped due to high VIF; [3]N/A: Not identified in the parks or identified in all parks; *, **, and *** denote significance at 90%, 95%, and 99% level, respectively.
Dependent variable: Ln_EMV.

From Table 9, a general impression can be obtained that passive facilities are likely to bring about positive impacts while active facilities tend to be associated with insignificant or negative impacts. A detailed examination of the results, however, suggests that individual facilities, either passive or active, have significantly different impacts on neighboring property values. For passive facilities, the presence of a water body has a significantly positive impact on neighboring residential property values, and the value of a property adjacent to a park with water bodies is likely to be significantly higher (e.g. 6.4 percent at the city level, and 19.8 percent in SW). Moreover, the percent of passive recreation areas in parks was also positively related to property values but with very weak magnitudes. On the contrary, the impacts of gardens in parks were mixed. At the city level, the presence of gardens has a negative impact (-6.0 percent) on neighboring property values. At the sector level, the impact of gardens was negative in SW (-13.2 percent), insignificant in NW and SE, and positive in NE (6.6 percent).

Active facilities were generally associated with negative impacts on adjacent property values as they introduced negative externalities such as noise and disturbance to the neighborhoods. In particular, skate parks and children's play areas were the two active facilities negatively impacting neighboring property values in both city-level and sector-level models. However, not all active facilities did consistently introduce negative impacts to adjacent property values. Winter recreation centers were positively related to property values in both the city- and sector-level models, but the effects were small in magnitude or failed to reach statistical significance. Other active facilities were not consistently introducing negative or positive impacts to property values in all models. These active facilities mostly introduced positive impacts to property values in the NW and SE while they were negatively related to property values in the other sectors. It should not be surprising to find that some active facilities have positive impacts since accessibility to these facilities may still be beneficial to the neighborhood and such a benefit may exceed the negative effect of these facilities. Even though a positive effect can be suggested, however, the magnitude should be small. From the results, most of the positive effects of active facilities were less than 9 percent except for the high coefficient (18.2 percent) of volleyball courts in SE. One exception is indoor recreation centers, which had negative impacts on nearby property values in NW and SE.

5.1.2. The impacts of park facilities over distance zones

The second set of models was developed to examine the effect of park facilities in each of the four successive 101-meter-distance zones from parks, and results are illustrated in Figure 11, Figure 12, and Figure 13 respectively. Among passive facilities (see Figure 11), water features remained as the one strongly and positively related to property values. A strong positive impact of water features can be found in the first zone, especially in SW (34.9 percent), and, as expected, the magnitude of the positive effect reduced in outer zones. The other two passive facilities, percent of passive space and gardens, however, had relatively small changes over distance zones. The percentage of passive space in parks had a positive but small impact on property values over distances. The impacts of gardens remained as mixed over distance. For the entire city and the SW sector, gardens were negatively related to property values over distances. In addition, although gardens were positively related to property values in the NE, the impact in the first zone is insignificant, which might be because the positive effect of gardens was offset by negative externalities in the first zone.

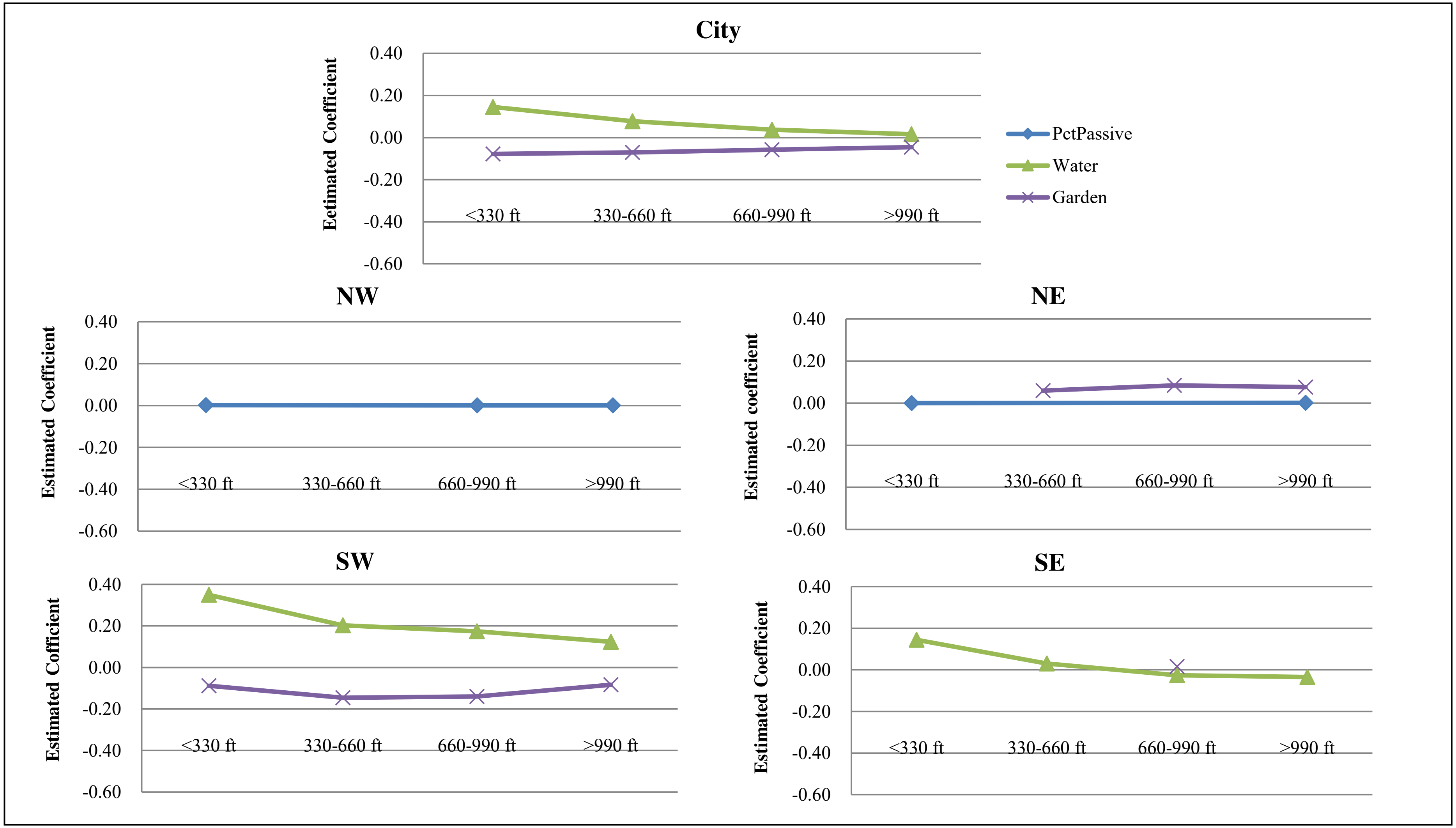

Figure 11. Impacts of passive facilities on the property values over distance zones

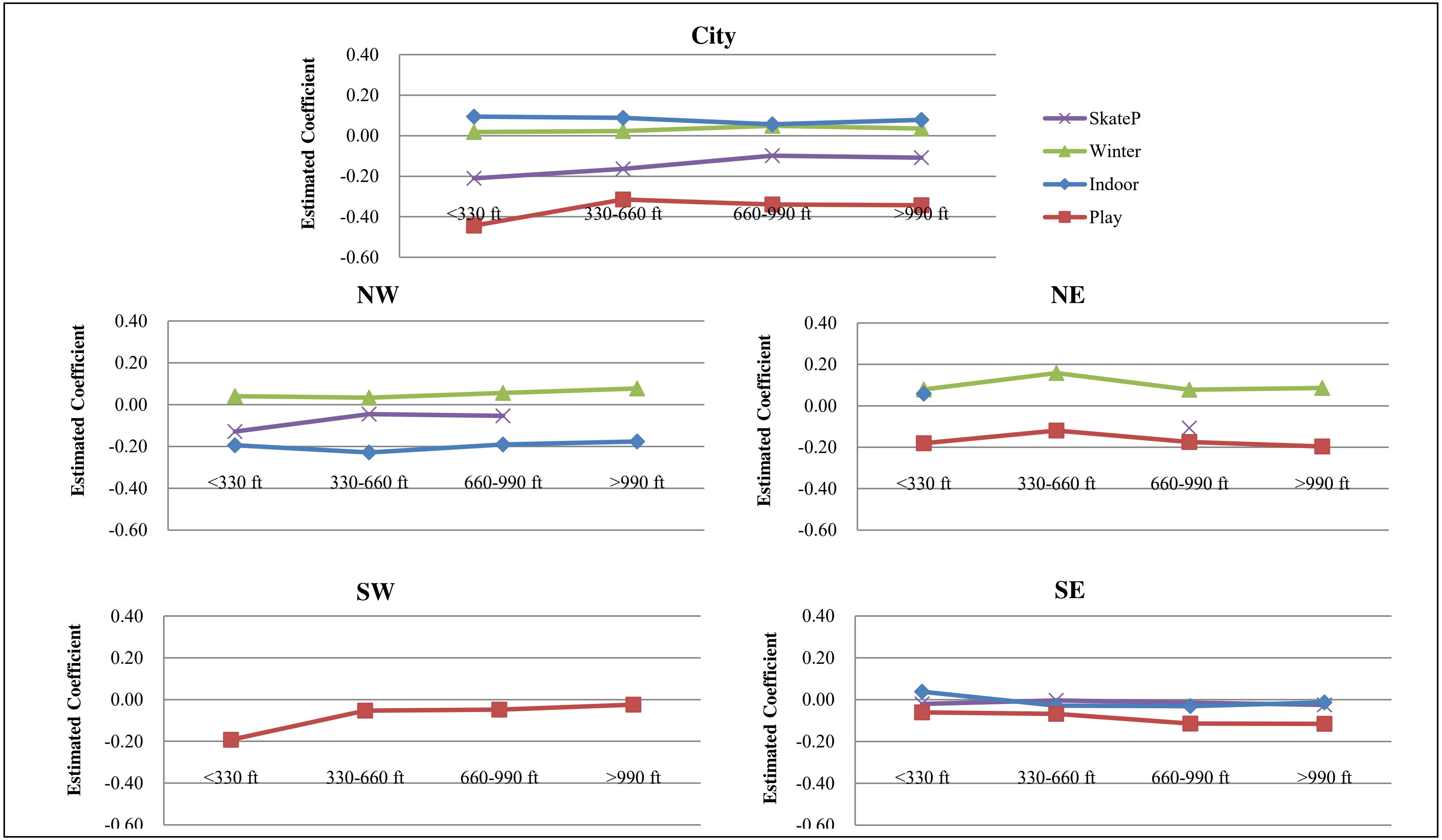

Figure 12. Impacts of active facilities (I) on the property values over distance zones

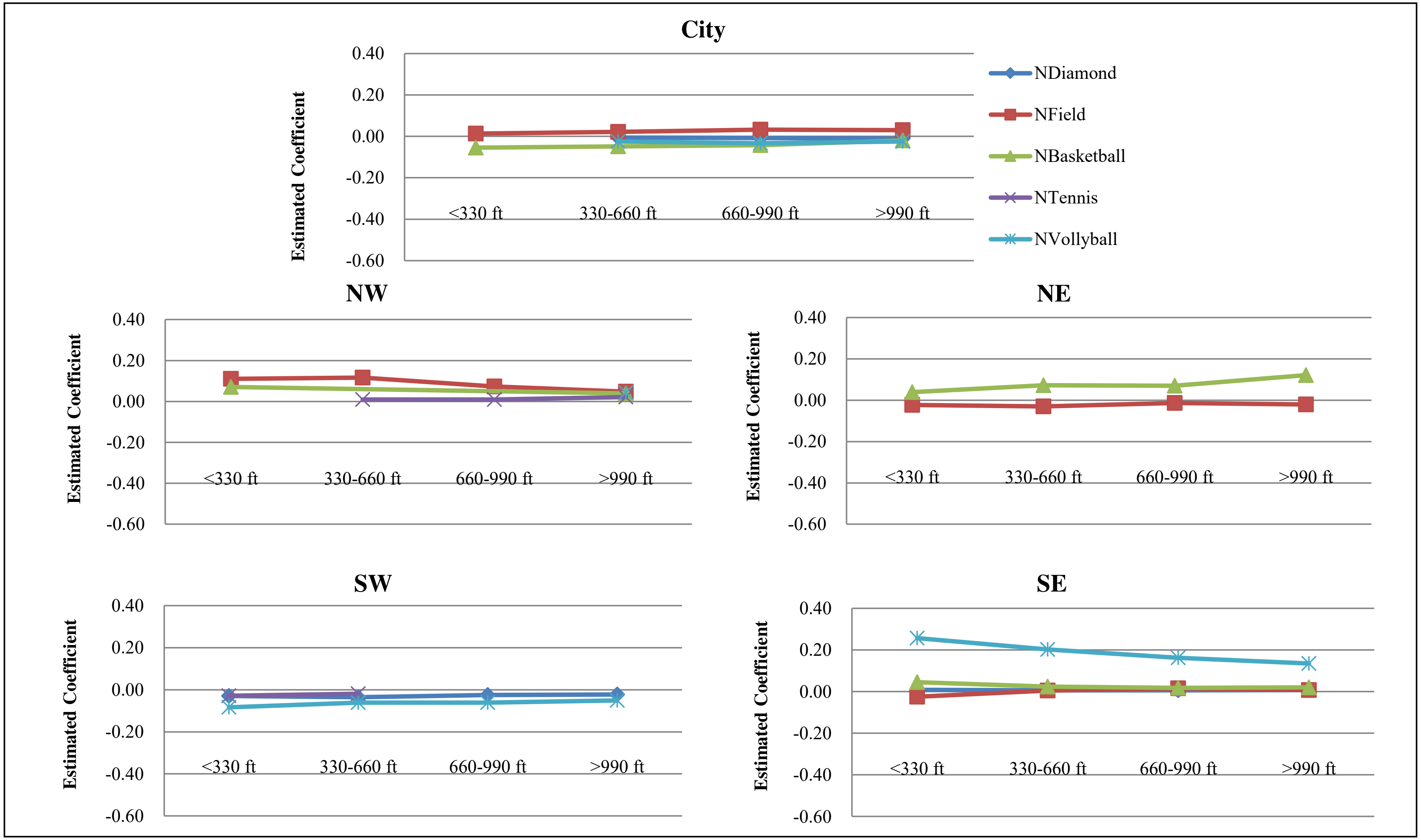

Figure 13. Impacts of active facilities (II) on the property values over distance zones

Figure 12 and Figure 13 show that, in general, negative externalities linked with active facilities decline as distance from the park increases. Specifically, the negative impacts of skate parks and children's play areas are highest in the first zone, and then level off in outer zones. As an example, at the city level, the value of a property located within 101 m from skate parks and children's play areas would decrease approximately 20 percent and 40 percent respectively, probably due to congestion and noise. An exception, however, was found in the SE where skate parks only had a very weak impact on property values over distance zones, and children's play areas only had a small negative effect in the first two zones from parks. The most consistent results over the city-level and sector-level models were for the winter recreation facilities. Winter recreation had a weak positive effect in the first zone, and its positive impact increased with distance. That is, the values of properties immediately adjacent to parks with winter recreation may still suffer from some potential negative externality due to the use of the facility. For other active facilities (see Figure 13), the changes of impacts over distance zones were mostly minor, likely due to the insignificant impacts of these facilities on nearby property values. Exceptions, however, were found in the NW and SE that positive effects of ball fields, basketball courts, and volleyball courts diminished in outer zones.

5.1.3. The impacts of park facilities by park sizes

The third set of hedonic models were built to examine whether park sizes play a role in the impacts of park facilities on neighboring property values, and results are illustrated in Figure 14. Results suggest that among passive facilities, only the impacts of water features and the presence of gardens had noticeable variations across park size levels, while the effect of passive space was negligible. In large urban parks, water features were significantly and positively related to property values, and the estimated values of such properties could be over 60 percent higher. Water features in medium sized community parks were also positively related to property values, but with relatively smaller magnitude (approximately 20 percent). The positive effect of water features disappeared, however when located in small neighborhood parks. For gardens, the results were opposite when compared to water features. Gardens were negatively related to property values when found in large urban parks but were positively related to property values when situated in community parks and neighborhood parks.

Comparatively, most active facilities were more likely to have positive impacts on property values when located in small neighborhood parks, and they included ball fields (NW and SW), basketball courts (City and SE), tennis (City), and indoor facilities (City), while their effects decreased or became negative in larger parks. Skate parks, on the other hand, were negatively related to property values in both small and large parks, but results also suggested that the negative impact of skate parks in neighborhood parks was smaller when compared to large parks. However, not all active facilities tended to be more beneficial in small parks. Winter recreation amenities in small neighborhood parks were negatively related to property values while they were positively related to property values in large parks. This could be due to the different types of winter recreation facilities provided in different parks. Winter recreation in small neighborhood parks can include ice (hockey) rinks that are linked to noisy group activity while cross-country skiing in a large park trail is considered a quiet passive activity. Children's play areas were another example; play areas were negatively related to property values in both small and large parks, but the negative impact was much larger in small parks. Additionally, ball diamonds were negatively related to property values, and the negative effect was slightly larger in small parks.

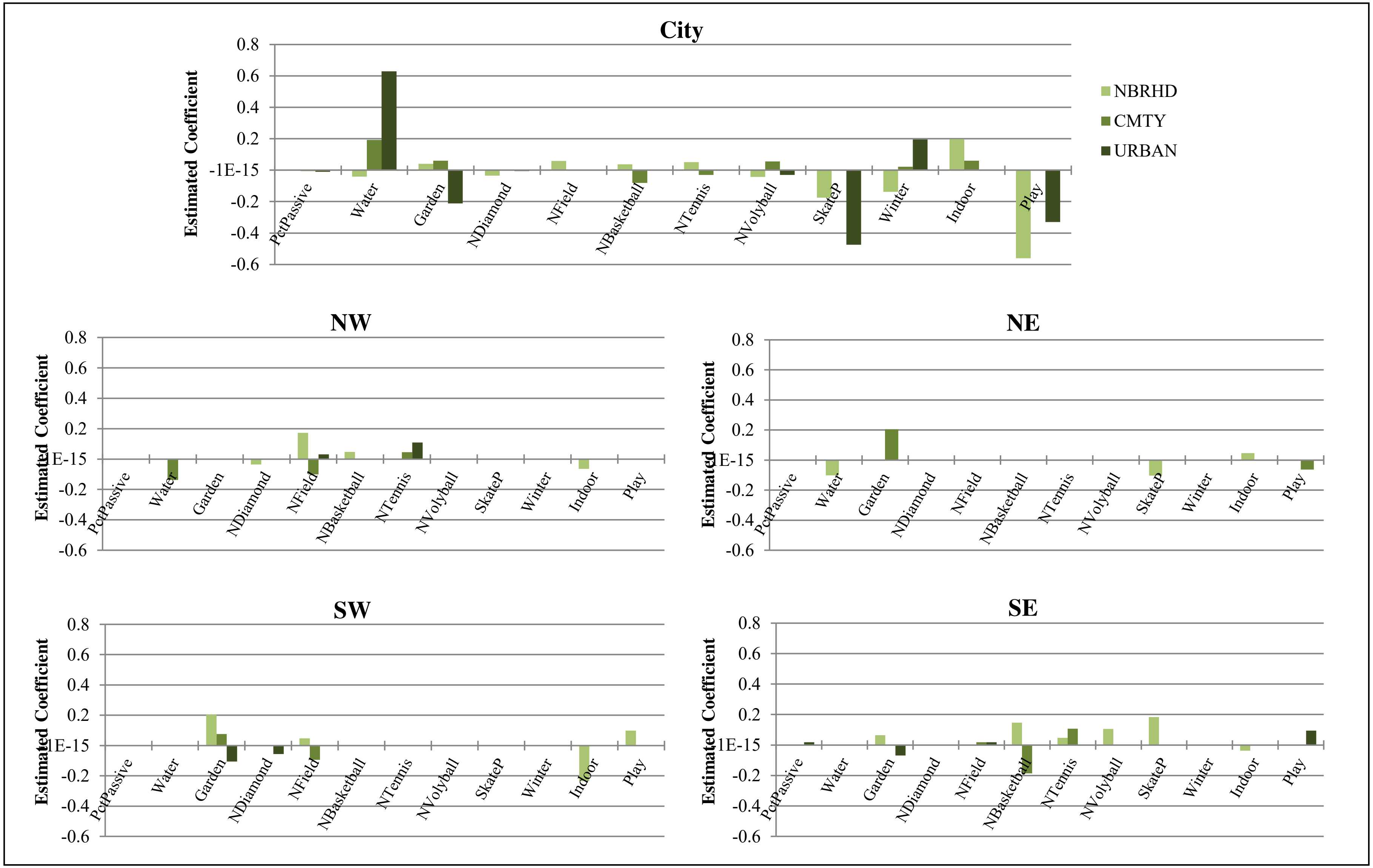

Figure 14. Impact of park facilities on property values by park size levels

5.1.4. Discussion

While a general guideline suggests that parks primarily offering passive recreation tend to have strong and positive impacts on proximate property values when compared to parks offering active recreation, the characteristics of individual park facilities may also have specific impacts. As a result, the general guideline may not be universally applicable in all cases, and the impact of individual facilities, either active or passive, should also be considered.

Water features in the study area have been identified as the most promising park facilities benefiting neighboring property values. The impact of water features in the SW is much higher in magnitude when compared to other sectors, and their effect in the NE is insignificant. It appears that the size of water features plays an important role in the study area. Water features in parks identified in SW are mostly large lakes (four out of five were over hundred acres in size), in particular, the Chain of Lakes, and the view of large water bodies may result in higher property values, especially for front-row houses. Preserving a large parcel for parks with a large water body can be difficult in an urban setting, but park planners should have the impact of large water body in mind, especially when the park development is likely to enhance the city's revenue. In contrast, Marshall Terrace Park in the NE sector is bordered by the Mississippi River, but the riverfront has not yet been developed, and the water not visible from the front row buildings. This may explain why an insignificant effect was found in the NE. Indeed, a project to reclaim the riverfront along Marshall Terrace Park was at an early stage when the study was being conducted, and it is anticipated that future access to the river will result in a positive effect. The results lend economic support to ongoing efforts by the city to reclaim green space and promote green infrastructure along the Mississippi river and other water bodies throughout Minneapolis.

As suggested in the literature, heavily used active parks are more likely to be associated with negative externalities such as noises and congestion, an impact also observed at popular gardens in the study area. Gardens in the two southern sectors, including the Lyndale Park gardens and the Longfellow garden, were described by the MPRB as popular gardens attracting visitors from the entire city of Minneapolis and served not only as an aesthetic landscape but also for social events such as weddings. Therefore, negative or insignificant impacts of gardens in these two sectors may be due to the negative externality generated by large groups of visitors. Gardens themselves can still be considered as one of the passive facilities benefiting neighboring property values (Voicu & Been, 2008), and this was supported by the positive effects found when they were located in neighborhood and community parks and primarily utilized by local residents as a pleasing natural space.

When negative externalities such as noise and congestion are introduced, the impact of passive facilities was found to be similar to those of active facilities (e.g., skate park and children's play area in this study) and may not provide benefits to neighboring property values. However, if these negative externalities were generated due to the high demands from local neighborhoods or the region, it is infeasible to remove such facilities in order to benefit the local housing market. Instead, a park planner would need to identify alternative means to reduce the impact of these negative externalities, such as employing landscape treatments to screen out disturbance (More et al., 1988).

Consistent with the results from the literature, active facilities were more likely to introduce negative externalities to adjacent properties, especially to those closest to the parks. Specifically, skate parks and children's play areas were consistently introducing negative impacts to adjacent property values in all areas. A concern may be that playground area were with strong negative impacts (-35.9 percent) on nearby property values with the city-level model, while the magnitude of the negative effects was reduced significantly in sub-sector models. Since most of the parks without children's play areas were located in the two southern sectors, especially in the SW which had much higher average property values, results from the city-level model may be misleading. Therefore, the negative impact of children's play areas may not be as bad as suggested in the city-level model, and a negative effect of about 8 percent may be more appropriate.

Other active facilities were more likely to positively impact the values of adjacent properties in the NW and SE. By examining the racial composition of these two sectors (See Figure 8) and recreation preferences of different racial groups suggested by scholars, the preferences of racial groups over different types of recreation activities may be able to explain the differences among sectors. That is, as suggested, non-White population such as African American and Hispanic prefer active recreation with open views when compared to the White population (Dwyer, 1993; Gobster, 2002; Ho et al., 2005; Payne, Mowen, & Orsega-Smith, 2002; Shinew, Floyd, & Parry, 2004). However, scholars have also found that African Americans prefer indoor recreation (Shinew et al., 2004) when compared to the White population, and this is not consistent with the results found for indoor recreation centers in the NW and SE. This result may, therefore, suggest that the park board review the design and services of the indoor recreation centers.

5.2. Multilevel models

5.2.1. The unconditional model (Model 1)

The unconditional model was first analyzed in order to estimate the variation in the property values within and between park influence areas and therefore to suggest the use of multilevel models. In the unconditional model, the total variance in the property values is decomposed to each of the three levels, and no explanatory variables at all levels are included. The results of the unconditional model are presented in Table 10. From the results of the variance component, the significant variations at neighborhood-community park level

(level-2) and urban-regional park level (level-3) suggest the use of multilevel models in this study. At level 2, the variation between neighborhood-community park areas is 0.077, and it is statistically significant, $\chi^2 = 4671.811$ with 30 *d.f.* ($p<0.001$). At level 3, the variation between urban-regional park areas is 0.274, and it is also statistically significant, $\chi^2 = 131.026$ with 11 *d.f.* ($p<0.001$).

Table 10. Results of Unconditional Model (Model 1)

Main Effect		Coefficient	se	
Intercept, γ_{000}		12.426112***	0.158044	
Random Effect	Variance Component	*d.f.*	χ^2	p-Value
Properties (Level-1) e	0.04799			
Neighborhood-community park areas (Level-2) r_0	0.07738	30	4671.81119	<0.001
Urban-Regional park areas (Level-3) u_{00}	0.27378	11	131.02610	<0.001
Deviance = -1022.200535				
Number of estimated parameters = 4				
Proportion of Variance (Percentage by Level)				
Level-1	12.02			
Level-2	19.39			
Level-3	68.59			

Note: *, *, and *** denote significance at 90%, 95%, and 99% level, respectively.

The proportions of variance in the property values at each of the three levels were calculated using equations (13) to (15) and are also shown in Table 10. The substantial percentage of variance at level-2 and level-3 further support the use of the multilevel model for the analysis. The result shows that the largest percentage (69%) of the variance in the average property value is between urban-regional park areas (level-3). By looking at the housing market in the study, such large variation at level-3 can be expected. As shown in Table 2, although not an exact match to the grouping used here, there are sub-markets in the study area with very different mean property values in each of them. At level-2, it shows that a significant, although much smaller, the percentage of variance (19%) of the total variance of the property values is between neighborhood-community park areas. The percentage of variance between properties within neighborhood-community park areas at level 1 is the smallest (12%). This result shows that the property values vary significantly between park areas at level-2 and level-3, which implies that the possibility of sub-groups and therefore that the multilevel models are appropriate in order to estimate the group effects at the group levels.

5.2.2. The basic model (Model 2)

Given the significant variation in the property values within and between park areas found from Model 1, the explanatory variables were then added in an attempt to explain the variation at each of the three levels. To start with, the basic model is first built before adding park attributes at level-2 and level-3. The basic model contains the structure attributes of each individual property, the accessibility measures to public amenities and downtown, and the population composition of the neighborhood-community park areas. With this basic set of explanatory variables, the basic model here serves as the base for comparison to later models with park attributes added. One park-related variable in this basic model is the park accessibility attribute (NCP_33) representing the properties located within 330 feet from the nearest neighborhood-community parks. The results of this basic model are shown in Table 11.

From the main effect, the results are mostly as expected. The estimation of the intercept[6] shows the average property value of 12.34, or $229,458 for an average property in the dataset. For the structure variables at level-1, the result shows that a newer property with bigger lot

[6] In multilevel analysis, scholars (e.g., Raudenbush & Bryk, 2002) often suggest centering the variables to make the intercept be more meaningful, and therefore the explanatory variables (with continuous values) were centered by the grand mean.

Table 11. The results of the basic model (Model 2)

Main Effect	Model 2			Model 2.1		
	Coefficient		se	Coefficient		se
Grand mean, γ_{000}	12.343474***		0.085070	12.359077***		0.090276
Pct_B, γ_{010}	-0.012819***		0.003709	-0.013649***		0.003485
Pct_H, γ_{020}	-0.005840		0.005714			
Lotsf, γ_{100}	0.000027***		0.000001	0.000027***		0.000001
Garage, γ_{200}	0.038222***		0.002868	0.038212***		0.002868
Rmstot, γ_{300}	0.079095***		0.001438	0.079159***		0.001437
FBathtot, γ_{400}	0.028339***		0.005165	0.028517***		0.005163
Build_Age, γ_{500}	-0.002062***		0.000108	-0.002054***		0.000108
D_HWay, γ_{600}	-0.000016***		0.000004	-0.000016***		0.000004
D_Bus, γ_{700}	0.000077***		0.000007	0.000078***		0.000007
D_CBD, γ_{800}	-0.000004		0.000003			
NCP_33, γ_{900}	0.008012**		0.004061	0.007870*		0.004059
Random Effect	Variance Component	*d.f.*	χ^2	Variance Component	*d.f.*	χ^2
Level-1, e	0.02409			0.02410		
Level-2, r_0	0.03542***	28	5111.48928	0.03493***	29	4777.38267
Level-3, u_{00}	0.07338***	11	86.36361	0.08599***	11	98.97442
Deviance	-5433.022798			-5430.641372		
Number of estimated parameters	15			13		
Note: *, *, and *** denote significance at 90%, 95%, and 99% level, respectively.						

size, more garages, and more rooms and full bathrooms have significantly higher property values. Distances to major highway and bus stop have opposite influence on property values. That is, close to a major highway has a significant positive impact while close to bus stop has significant negative impact on property values. Accessibility to Central Business District in this data set has a negative impact on property values, but the result failed to reach statistic significance. The only park-related variable, NCP_33, in this model, has the expected result showing that properties have significantly higher property values when located within 330 feet from the nearest neighborhood-community park comparing to the values of properties located further than 330 feet but within 660 feet park influence area. The two population variables at level-2 both have negative impacts on property values, but only the Pct_B is statistically significant.

By adding the structure, accessibility, and population composition variables, the variance at all levels has reduced, although still significant, especially for the urban-regional park level (level-3). Although there is no urban-regional park variable included in this model, the largest reduction happens at level-3 by 73 percent ((0.27378-0.07338)/0.27378). As suggest by Orford (2002), such result suggests that the large variation in property values between higher level units (e.g. urban-regional park areas in this study) in the unconditional model is mainly caused by the difference in housing stock. Similarly, there is also a substantial amount of variance declined at the level of neighborhood-community parks by 54 percent. Since most of the explanatory variables added in this basic model are at the property level, a considerable amount of decline in the variance can be expected at this level, and it is found that the included structure and the accessibility variables have explained about 50 percent of the level-1 variance in property values.

The model fit was estimated by comparing the deviance of this basic model to the deviance of the unconditional model as shown in Table 10, and the result of the likelihood-ratio test shows that the reduction in deviance (4410.82) with 11 *d.f.* is significant at 99percent level, suggesting that the explanatory power is significantly improved by adding these explanatory variables in this basic model. Although model 2 is significantly improved, there are two variables with the insignificant results. As suggest by scholars, in order to avoid an unstable model with issues such as multicollinearity after adding more variables, it is good to keep the model simple. Therefore, an additional model (model 2.1) is built and estimated with the insignificant variables (D_CBD and Pct_H) removed, and the results of this model have presented also in Table 11.

5.2.3. The impact of neighborhood-community parks on property values (Model 3)

Given the interest of this study is to find out how park attributes may influence the values of nearby properties, park attributes were added into the multilevel models in this and the following sections. Based on the basic model (model 2.1), the attributes of neighborhood-community parks at level-2 were added and examined at here in model 3. The results of model 3 are presented in Table 12. The estimations of the structure and environment variables are similar to the results from model 2.1 with only slight difference in the magnitude of the effects for some variables. In this model, the size of neighborhood-community parks is also included, but the result suggests an insignificant impact on property values.

As expected, the influence of park facilities on property values vary, and sports facilities, which are usually associated with disturbance, can still positively influence property values. However, among those park attributes, only the impact of children's playground (Play) is statistically significant having the property value decreased by 31 percent with a playground present in the nearest neighborhood-community park. Although most of the park variables are not statistically significant to explain the variance in property values, by adding those park variables, the variance at the neighborhood-community park level (level-2) is reduced from 0.035 in the basic model to 0.019 in this neighborhood-community park model. Given that many of those park variables are not significantly influencing property values, it is not surprised that the variance in property values at level-2 remains significant. In addition, with many insignificant variables, it is possible that this model is not an efficient one to be used for further analysis. By comparing the deviance of this current model to the deviance of the basic model (M2.1), the result shows that the difference between deviances is 15.31 with 10 *d.f.*, suggesting that the model is not significantly improved with all those additional park attributes. As suggested, a simpler model is therefore preferred.

Table 12. The results of the neighborhood-community park model (Model 3)

Main Effect	Model 3			Model 3.1		
	Coefficient		se	Coefficient		se
Grand mean, γ_{000}	12.562381***		0.117739	12.550208***		0.108504
Pct_B, γ_{010}	-0.009529**		0.003387	-0.010642***		0.003215
NCP_Size, γ_{020}	0.003657		0.004347			
NDiamond, γ_{030}	0.004828		0.023745			
NField, γ_{040}	0.014966		0.028825			
Garden, γ_{050}	0.171837		0.126538			
SkateP, γ_{060}	-0.014711		0.198286			
Indoor, γ_{070}	-0.074093		0.123880			
Play, γ_{080}	-0.308422**		0.121941	-0.232046***		0.071178
Water, γ_{090}	-0.1956760		0.151651			
NBasketball, γ_{0100}	0.034319		0.062801			
NTennis, γ_{0110}	0.024877		0.028215			
Lotsf, γ_{100}	0.000027***		0.000001	0.000027***		0.000001
Garage, γ_{200}	0.038239***		0.002868	0.038226***		0.002868
Rmstot, γ_{300}	0.079166***		0.001437	0.079156***		0.001437
FBathtot, γ_{400}	0.028475***		0.005163	0.028512***		0.005163
Build_Age, γ_{500}	-0.002055***		0.000108	-0.002054***		0.000108
D_HWay, γ_{600}	-0.000016***		0.000004	-0.000017***		0.000004
D_Bus, γ_{700}	0.000078***		0.000007	0.000078***		0.000007
NCP_33, γ_{800}	0.007841*		0.004059	0.007840*		0.004059
Random Effect	Variance Component	*d.f.*	χ^2	Variance Component	*d.f.*	χ^2
Level-1, e	0.02410			0.02410		
Level-2, r_0	0.01944***	19	2671.84623	0.02531***	28	3377.98664
Level-3, u_{00}	0.10670***	11	188.21305	0.09220***	11	138.34211
Deviance	-5445.955867			-5439.743122		
Number of estimated parameters	23			14		
Note: *, *, and *** denote significance at 90%, 95%, and 99% level, respectively.						

To make the model simple, instead of using the basic model without any park variable at level-2, model 3.1 was built with only the significant park attribute, Play, remaining in the model. The result of the model 3.1 is also presented in Table 12. The coefficients of variables in model 3.1 were similar to the coefficient of variables in model 3, except the effect of children's playground on property values reduced from negative 31 percent to negative 23 percent. The change can be because of the multicollinearity resulted by too many variables in the previous model. Although children's playground is not highly correlated with other park variables, but as indicated by Kreft and De Leeuw (1998) multicollinearity could still happen after modeled even high correlation between variables is not present in the prior examination. From the variance component, with only the variable of Play added into the model, the variance at level-2 still reduced from 0.035 in the basic model to 0.025, which is, about 29 percent of the variance in property values at level-2 is explained by adding this variable alone. The difference in deviance ($\mathcal{X}^2$ =9.10175, *d.f.* 1) of model 2.1 and model 3.1 suggests model 3.1 is now significantly improved from model 2.1.

5.2.4. The impact of urban-regional parks on property values (Model 4)

In this section, the impacts of urban-regional park variables on property values were estimated. Develop from model 3.1, four urban-regional park variables at level-3 are added in model 4 to examine the impacts of those park variables on property values. The results are presented in Table 13. The results suggest that only lakes (URPLake) have a positive impact on property values while the other three are negatively relating to property values. Among them, only the coefficients of URPLake and URPNDiamond are statistically significant at 95 percent level. Lakes in urban-regional parks, as expected, have a strong impact on property values, increasing property values by 42 percent. The number of ball diamonds, on the other hand, introduces some negative impact on property values, having property values decreased by 4 percent with each additional ball diamond present in the park.

Table 13. The results of the urban-regional park model (Model 4)

Main Effect	Model 4			Model 4.1		
	Coefficient		se	Coefficient		se
Grand mean, γ_{000}	12.388037***		0.144035	12.334599***		0.102617
URPLake, γ_{001}	0.421413**		0.132075	0.454971***		0.100505
URPNDiamond, γ_{002}	-0.040715**		0.016776	-0.049879***		0.015094
URPGolf, γ_{003}	-0.143696		0.128465			
URPMissR, γ_{004}	-0.037517		0.167054			
Pct_B, γ_{010}	-0.013171***		0.002502	-0.013656***		0.002491
Play, γ_{020}	-0.236836***		0.071900	-0.232176***		0.072544
Lotsf, γ_{100}	0.000027***		0.000001	0.000027***		0.000001
Garage, γ_{200}	0.038213***		0.002868	0.038219***		0.002868
Rmstot, γ_{300}	0.079130***		0.001437	0.079129***		0.001437
FBathtot, γ_{400}	0.028486***		0.005163	0.028506***		0.005163
Build_Age, γ_{500}	-0.002056***		0.000108	-0.002056***		0.000108
D_HWay, γ_{600}	-0.000017***		0.000004	-0.000017***		0.000004
D_Bus, γ_{700}	0.000078***		0.000007	0.000077***		0.000007
NCP_33, γ_{800}	0.007846*		0.004059	0.007824*		0.004059
Random Effect	Variance Component	*d.f.*	χ^2	Variance Component	*d.f.*	χ^2
Level-1, e	0.02410			0.02410		
Level-2, r_0	0.02717***	28	3854.78232	0.02767***	28	3935.03932
Level-3, u_{00}	0.01570***	7	34.28964	0.01704***	9	35.31693
Deviance	-5454.533479			-5453.290416		
Number of estimated parameters	18			16		
Note: *, *, and *** denote significance at 90%, 95%, and 99% level, respectively.						

The result of random component shows that the inclusion of urban-regional park variables had largely reduced the variance in property values at level-3. With the four park variables added into the model, the variance in property values at level-3 has been reduced from 0.0922 in model 3.1 to 0.01570, which is, about 83 percent of the variance in property values at level-3 has been explained by these park variables. However, the result also suggests that there is still significant variance unexplained. To examine the model fit, the deviance of model 4 was compared with the deviance of model 3.1, and the result suggests the model fit is significantly improved ($\chi^2 = 14.79036$, *d.f.* 1, p-value=0.005) with the addition of urban-regional park variables.

Again, in order to keep model simple for further analysis, model 4.1 was built with the insignificant variables in model 4 removed, and the result of model 4.1 is also presented in Table 13. The coefficients of URPLake and URPNDiamond are changed slightly in model 4.1, which are increased in the magnitude from 0.42 to 0.45 and from -0.04 to -0.05, respectively. This change can be because of the correlation between these variables and the removed variables. With only the two park variables, URPLake and URPNDiamond, in the model, the variance in property values at level-3 still remained largely reduced by 82 percent. The explain power is about only 1 percent reduced by removing URPGolf and URPMissR suggesting the impact of these two variables are negligible. To examine whether the model is significantly improved with the inclusion of only UPRLake and URPNDiamond, the deviance of model 4.1 was compared with the deviance of model 3.1, and the result suggests a significant improvement ($\chi^2 = 13.54729$, *d.f.* 2, p-value=0.002).

5.2.5. The impact of neighborhood-community parks on park adjacency (Model 5)

After analyzing the impacts of park attributes at the neighborhood-community park level and the urban-regional park level on property values in the above two sections, this section presents the results of analyzing the influence of park attributes on the relationship of property values and park adjacency. That is, instead of being included in intercept equations to influence property values, park variables were used in model 5 to explain the variance in NCP33 slope at level-1. The results suggest that sports facilities can undermine the positive impact of park adjacency (NCP33) on property values when the significant estimation is found.

Before using park attributes to explain the variance in the slope of park adjacency, whether there is variance in NCP33 exist to be explained was examined. To do this, the NCP33 slope at level-1 was set to be random at level-2 as shown in equation (28), but no park variables (Z_{sjk}) were entered into the equation at this point. That is, the impact of NCP33 is no longer fixed across neighborhood-community park areas as in previous models. The result of variance component of model 5 can be found in Table 14. By setting the NCP33 slope as random at level-2, the variance of the slope is now provided. The result suggests that there is significant variance in NCP33 slope at level-2. That is, being located within 330 feet of the nearest neighborhood-community park can have a different influence on the value of the property across neighborhood-community park areas. By comparing the deviances of model 4.1 and model 5, the result ($\chi^2 = 43.21401$, *d.f.* 2, p-value<0.001) shows a significant change in deviance, which suggests an improvement in model fit with the switch to be the random slope for NCP33 variable.

Table 14. The result of random park adjacency at level-2 (Model 5)

Main Effect	Model 5		
	Coefficient		se
Grand mean, γ_{000}	12.2817711***		0.091864
URPLake, γ_{001}	0.449268***		0.086039
URPNDiamond, γ_{002}	-0.044250***		0.012779
Pct_B, γ_{010}	-0.015379***		0.002226
Play, γ_{020}	-0.185455**		0.070411
Lotsf, γ_{100}	0.000028***		0.000001
Garage, γ_{200}	0.038939***		0.002855
Rmstot, γ_{300}	0.078876***		0.001434
FBathtot, γ_{400}	0.029016***		0.005141
Build_Age, γ_{500}	-0.002036***		0.000108
D_HWay, γ_{600}	-0.000019***		0.000004
D_Bus, γ_{700}	0.000078***		0.000007
NCP_33, γ_{800}	0.013635*		0.007927
Random Effect	Variance Component	*d.f.*	χ^2
Level-1, e	0.02377		
Level-2, r_0	0.02840***	28	2520.55694
NCP33 slope, r_8	0.00166***	41	145.62285
Level-3, u_{00}	0.01040***	9	27.44402
Deviance	-5496.504423		
Number of estimated parameters	18		
Note: *, *, and *** denote significance at 90%, 95%, and 99% level, respectively.			

Table 15. The results of the influence of neighborhood-community park on park adjacency

Main Effect	Model 5.1			Model 5.2		
	Coefficient		se	Coefficient		se
Grand mean, γ_{000}	12.299911***		0.087639	12.287657***		0.087174
URPLake, γ_{001}	0.441590***		0.078551	0.454453***		0.078424
URPNDiamond, γ_{002}	-0.044922***		0.011597	-0.041761***		0.011517
Pct_B, γ_{010}	-0.015519***		0.002088	-0.015904***		0.002080
Play, γ_{020}	-0.203933***		0.070552	-0.205916***		0.071197
Lotsf, γ_{100}	0.000028***		0.000001	0.000028***		0.000001
Garage, γ_{200}	0.038832***		0.002854	0.038856***		0.002854
Rmstot, γ_{300}	0.078783***		0.001434	0.078871***		0.001434
FBathtot, γ_{400}	0.029096***		0.005139	0.029041***		0.005139
Build_Age, γ_{500}	-0.002038***		0.000108	-0.002036***		0.000108
D_HWay, γ_{600}	-0.000019***		0.000004	-0.000019***		0.000004
D_Bus, γ_{700}	0.000078***		0.000007	0.000078***		0.000007
NCP_33, γ_{800}	0.031062***		0.010229	0.031376***		0.010777
NDiamond, γ_{810}	-0.008264**		0.003314			
NBasketball, γ_{810}				-0.027704**		0.011956
Random Effect	Variance Component	*d.f.*	χ^2	Variance Component	*d.f.*	χ^2
Level-1, e	0.02378			0.02378		
Level-2, r_0	0.02980***	28	2513.27164	0.03029***	28	2716.50135
NCP33 slope, r_8	0.00139***	40	130.80401	0.00148***	40	137.98893
Level-3, u_{00}	0.00736***	9	23.57513	0.00721***	9	23.23390
Deviance	-5502.037399			-5501.349389		
Number of estimated parameters	19			19		
Note: *, *, and *** denote significance at 90%, 95%, and 99% level, respectively.						

Given the significant variance found in NCP33 slope in model 5 as shown in Table 14, the neighborhood-community park variables were then used to explain the variance. Two park variables, NDiamond, and NBasketball were found to have a significant influence on the NCP33 slope, and only these significant results are presented in

Table 15. In model 5.1, NDiamond was used to explain the variance in NCP33 slope. The coefficient of the interaction between NDiamond and NCP33 is -0.008. It is small but statistically significant, and the negative sign indicates that with more ball diamonds in the neighborhood-community parks the increment in property values due to being within 330 feet from the park is reduced slightly. From the variance component, the variance in NCP33 slope was compared to the result in model 5, and the variance is reduced from 0.00166 in model 5 to 0.00139 in model 5.1, but a significant variance still remains to be explained. The deviance of model 5.1 was compared to the deviance of model 5, and it suggests that with NDiamond added to explain the NCP33 slope, the model fit ($\chi^2 = 5.53298$, *d.f.* 1, p-value=0.018) is significantly improved.

When NBasketball was used to explain the variance in NCP33 slope, the similar impact was found. In model 5.2, the coefficient of the interaction of NBasketball and NCP33 is -0.028. Similar to the impact of the number of ball diamonds, being within 330 feet from a park with more basketball courts, the property value is less benefited from proximate effect. The variance in NCP33 slope has been partially explained by NBasketball, and the variance reduced from 0.00166 in model 5 to 0.00148 in model 5.2, but, again, significant variance remains to be explained. The comparison of deviance of model 5 and model 5.2 ($\chi^2 = 4.84497$, *d.f.* 1, p-value=0.026) indicates the improvement in model fit with NBasketball added to explain the NCP33 slope. Each of the other facilities in neighborhood-community parks was used to explain the variance in NCP33 slope, but the impact of those facilities fail to reach statistical significance at least 90 percent level.

5.2.6. Discussion

The results from the multilevel models suggest the similar trend of the park impact on property values as the results from the hedonic models suggest. That is, facilities primarily for passive recreation are more likely to benefit nearby property values while facilities tended to serve primarily for active recreation are more likely to introduce negative impact on nearby property values because those activities are conventionally believed to be more likely to introduce noise and disturbance to the neighboring properties. The results also suggest similarly that exception can be found such as the ball fields and the ball courts in neighborhood-community parks show a positive impact on property values, but many of the estimations fail to reach statistical significance.

Similar to the findings from the single-level hedonic models, water body has a strong impact on property values, but it depends on size and type of water body. In the multilevel model, water body, particularly lakes or ponds, is examined at either neighborhood-community park level or at the urban-regional park level. Lakes in neighborhood-community parks show no significant effect on nearby property values, but lakes in urban-regional parks show the strong and significant effect on nearby property values. This can be because those in neighborhood-community parks are lake and ponds very small in size while those in urban-regional parks are very large lakes ranging from about 10 acres to over hundred acres in size. This finding confirms the suggestion by Cho et al. (2006) that large water body is relatively more beneficial to the property values. In addition to lakes, a separate variable is used to represent the Mississippi River which runs through two urban-regional parks, but the river shows no significant impact on property values. The insignificant result is also found in the single-level hedonic model, the model of the northeast sector in specific, which could be because the riverfront development by Marshall Terrace Park was still in the initial stage and therefore has not yet the contribution to nearby property values. However, this may not be the case at here because the two parks in the multilevel models which have Mississippi River adjacent to them are Central Mississippi Riverfront Regional Park next to downtown and Mississippi Gorge Regional Park at south of downtown, and their riverfront had been acquired and developed since the 1970s and are already popular destinations for recreational use. The Central Mississippi Riverfront Regional Park especially is one of the major tourist sites of the city. However, their popularity may possibly, therefore, introduce a disturbance to its immediate neighborhoods and therefore explain the insignificant result. As Crompton (2001b, p.116) stated that greenway (e.g. along riverfront as the case at here) is different from other types of parkland (e.g. parks with large lakes) because the major benefit of greenways is more likely to be the access to the trail rather than "the extended tranquil view", and therefore the proximate effect of greenway is debatable, especially when there is concern of disturbance from non-local users. It is quite interesting however that similar effect seems not an issue for lakes in urban-regional parks. As indicated in Minneapolis Park and Recreation Board's annual report (Minneapolis Park & Recreation Board, 2010b), those urban-regional parks with big lakes, Chain of Lakes in specific, are the most popular recreational destination in the city attracting millions of local residents as well as out-of-town visitors. However, the positive impacts of those lakes on property values remain strong and significant. It may, therefore, worth to further study such differences for future planning and design, especially for riverfront developments.

Among the facilities primary for active recreation in neighborhood-community parks, only children's play area has a significant impact on nearby property values. As the findings from the single-level model, the results from the multilevel model again suggests that children's play areas are strongly and negatively influencing the values of nearby properties especially those immediately adjacent to the parks. As described by Weicher and Zerbst (1973), children's playgrounds are usually heavily used and close to the properties adjacent to the park, and therefore noise can easily annoy the residents live in those properties. Therefore, the best assumption is that children's play usually introduces noise to the adjacent properties and therefore causes the negative impacts on their values. The children's play areas can be an essential element in especially a neighborhood-community park. However, such facility may be mostly appreciated by those families with small children. For the rest of the residents, children's play areas may just an area in the park that they are not going to use, and they often time can introduce noise to the neighbors.

The effect of golf courses in urban-regional parks may be understood in a similar way. Non-golf players may not view golf courses as much beneficial as golf players view it. However, it can be different from the case of children's playground in another way. People may not have to actually use the park and any of its facilities to feel such place is a benefit to the neighborhood and therefore the property values. The residents who live in the adjacent properties but not actually be using the golf courses for recreation but can still be benefited by having the view of open space and the greenery. This can be quite different from the landscaping of children's playground, which has more man-made equipment and less open grassy space and aesthetic landscaping. In addition, golf play generates less noise, comparing to children's play. Both of these can possibly explain the insignificant result of golf courses.

For the rest of active facilities, the same assumption may be applied. While they are mainly served for sports activities, some of them (e.g., ball diamond and ball field) can provide benefit more than just for ball play. Unlike facilities mostly with concrete building and paved surface, the grassy area of these facilities provide an open view of green space for especially non-sport players, including those who live right next to the park but not actually using the park and those who use the park for passive activities such as walking and viewing. Such assumption can be supported by the significant results from model 5, which basketball courts has a stronger negative impact on the effect of being close to a neighborhood-community park, comparing to the impact of the ball diamond.

In terms of methodology, the purpose of using the multilevel approach in addition to the single-level hedonic model is under the assumption that the multilevel approach is more appropriate to deal with data in the hierarchical structure. The insignificant results from the multilevel models suggest that the impacts of those facilities can be minimal to be not important, but many of them are different from the findings of the single-level hedonic models, especially when comparing to the results of the city model in Table 8. Scholars have indicated that significant results in a disaggregated model can be because the sample size was enlarged because the value of an attribute from the higher level was disaggregated to the lower-level units that all belong to the same higher level group (Rocconi, 2013; Snijders & Bosker, 2012). However, while multilevel approach is believed to be more appropriate and therefore suggested when dealing with data in hierarchical structure, scholars such as Rocconi (2013) did not make a conclusion saying that the results from multilevel model represent the true estimates over the results of hedonic model because the true estimate cannot be known from empirical data estimation. Such differences, in this specific study, can also be simply because the data included are slightly different. While studies of other cases can be conducted to further suggest if the differences are really the result of different model specifications, such differences in this study suggest one consider the statistical issues when using hierarchical data.

In addition, even if the real effect is that those park facilities have no significant impact on nearby property values as found in multilevel models, such result may then suggest that the benefits of those facilities are not fully appreciated and therefore not reflected in the nearby property values. It can also be possible that positive effects of those facilities are even out by their negative effects. Either one of these raises the question of how to make the benefit of those facilities be seen. If those facilities are necessary to be installed and are used by park visitors, the goal is to keep them in the parks even that they are not viewed as a benefit in economic term. The task needs to be done next then is to find out ways to mitigate the possible negative effects or to increase the positive value of those facilities, and therefore, benefit both users and non-users who live in nearby neighborhoods.

Another benefit of using multilevel approach is that it allows the lower level slopes to be varying and explained by attributes at higher levels. That is, one can add the cross-level interaction to explain how higher level attributes interact with the relationship between lower level attributes and the outcome variable. In this study, by adding cross-level interaction to study whether park facilities play a role in influencing the impact of park proximity on property values, the results confirm the suggestions from literature. Being within 330 feet from parks, the values of properties is higher than the values of properties located further than 330 feet but still within the 660 feet park influence area. However, by defining the park proximity variable being vary and random in different neighborhood-community park areas, the results suggest that ball diamonds or basketball courts in the closest neighborhood-community parks reduce the magnitude of the positive effect of park proximity. This result is not a surprise since sports facilities like these two are usually associated with noise, and they, therefore, tend to negatively influence the value of being close to parks. Other neighborhood-community park facilities were also added in the model as cross-level interaction effect but found to be not statistically significant. However, this may ask for further studies on these facilities as suggested by Kreft and De Leeuw (1998) that the insignificant result of cross-level effect can be because the effect is too small and/or the sample size is too small.

Given the ability of multilevel models on allowing lower level slopes to be random and varying across higher level groups, the additional contextual effects can be considered for future studies. This study included ethnicity in the model to explain the variation of property values. However, as Jones and Duncan (1996) suggested that there can be many different contextual effects to be considered. Other demographic and socio-economic characteristics of a region can be considered as contextual effects. Especially as discussed previously for hedonic model results, people with different background may view parks and park facilities differently, and such differences can influence park effect on nearby property values.

In relation to the inclusion of diverse neighborhood characteristics, future studies can also consider expanding the present models by using more than one type of defined higher level units. The models built in this study were following the strict hierarchical grouping assumption. That is, all individual-level units within the same higher-level group belong to that same group and only one group. However, this way of defining groups may not be always true, especially when the contextual effects are more appropriate in different contexts. Housing units located within the same park influence area as defined in this study may be located in different defined areas that are used for collecting the demographic and socio-economic characteristics. In this current study, ethnicity was included in the multilevel model, but the data was actually aggregated from census block groups within each of the neighborhood-community park areas. Although such treatment of ethnicity was adopted because the focus of this study is on the impact of park-related attributes, one can consider including different contextual effect based on their inherent context in future studies to avoid aggregation error. For example, the cross-classified multilevel model as described by scholars such as Raudenbush and Bryk (2002) is a more advanced multilevel model to be considered for cases that may use different defined areas as higher level units. Like the multilevel model used in this study, the cross-classified multilevel model allows cross-level interaction to be examined, and attributes from different contexts entered the model can have the influence on the effect of lower level attributes on the outcome variable.

6. Conclusion

This dissertation focused on the economic impact of urban parks on their adjacent neighborhoods and found that different park facilities can have different impacts on the values of adjacent properties. As parks and other similar kinds of public open space are popularly advocated in order to develop a better living environment for urban residents and to promote the value of the urban ecological environment, the multiple values of urban parks have been explored ranging from environmental, to social, and to economic values. The economic value of parks, in particular, has viewed as a crucial element for not only facilitating local development but also supporting the provision and maintenance of the park system itself, especially under the financial constraint for park development in recent decades. A number of studies have studied the impact of parks on the property values in the nearby neighborhoods, and the diverse types of parks and the recreation activities that they served have been studied. However, the individual facilities in parks were not specifically used in the models to understand their different impacts on nearby property values. In order to fill the gap, this study, therefore, examined the impacts of diverse park facilities on proximate residential property values by using the hedonic regression model and the multilevel model. The findings generally followed the suggestions from previous empirical literature. However, exceptions were also found.

Park features mainly for passive recreation were likely to have positive impacts on property values with the exception of gardens and rivers in the study area. Lakes, when large in size, in particular, were the most promising feature in parks to benefit nearby property values. Facilities mainly for active recreation (e.g., skate park and children's play area) tended to introduce negative externalities and, therefore, negative impacts to adjacent property values. However, positive impacts of active facilities such as winter recreation and ball fields/courts can still be found, especially in the NW and SE quadrants of the study area, although with a smaller magnitude. In addition, children's playground was found to have the surprisingly strong negative impact; however as mentioned earlier, this result should be understood carefully. It was estimated that children's playground reduces property values by 36 percent in the hedonic model at the city-level and reduces property values by about 23 percent in the multilevel model. However, one needs to keep in mind that the city-level hedonic model is a pool model without considering the potential difference among sub-markets, and the results from the sector-level model proved that such effect can influence the results, and the magnitude of the negative effect of children's playground was much smaller in the sector-level models at about 8 percent. On the other hand, the strong negative effect from the multilevel model can be because children's playground was the only neighborhood/community park facility remained in the model. Although the model was improved by removing the insignificant variables, with children's playground became the only one remain in the model, the result may need further study to confirm because there were too few factors included in the current model to better separate the effects of children's playground and those of other park and neighborhood characteristics. Therefore, an 8 percent of the reduction in property values as found in the sector-level models can be more appropriate to suggest before the further study is made. Although the results from those models show the differences in magnitude, they all suggest the negative impact of children's playground on nearby property values, and this requires park official's attention. Based on a survey of Minneapolis's residents, among different active recreation facilities, children's playground was ranked as the most and frequently used one and the most important facility to invest in neighborhood parks (Minneapolis Park & Recreation Board, 2015). The survey results suggest that the negative effect of children's playground was unlikely due to the lack of usage or demand. Therefore, further studies should be made to better understand the cause of such strong negative impact of children's playground on property values.

The impacts of facilities on property values over distance zones from parks further support the findings in the literature. The positive impact of passive facilities, water features in specific, can be found in the very first distance zone from the parks, and the magnitude of the effect was the largest in the first zone and decreased when moving away to the further zones. For active facilities, they usually had a stronger negative effect in the first distance zone from the parks or had a smaller positive effect if a positive effect was suggested, and they usually became more beneficial to properties that were located further away from the parks. The negative effect of active park facilities on the values of the closest properties from the park was also found in the results of multilevel models, which ball diamonds or basketball courts can reduce the magnitude of the positive effect of park proximity. In addition, the impacts of facilities on property values were different with different park sizes. That is, gardens and most active facilities were more likely to be beneficial in small parks while water features tend to introduce the largest positive impact when located in large parks.

As suggested, parks, especially public parks, are provided as public goods usually without charging for user fees, and such public amenities, therefore, rely largely on public funding, which remains primarily from tax revenue, property tax in particular. That says a sound park design requires the consideration of both users and non-users. While park users are more likely to evaluate a park according to whether the facilities in the parks meet their recreation demand, non-users are more likely to appreciate a park if there is a pleasing view from their window (Weicher & Zerbst, 1973). This is supported by the results of this study and others (e.g. Sander & Polasky, 2009) that park features associated with open, grassy, and large water view are preferred. Park facilities with a paved surface and concrete structure, on the other hand, are more likely to have a negative impact on property values, and this can be because they are not introducing a view much different from the rest of the city. Therefore, some designs that make those spaces look beautiful by such as planting nature landscape can be suggested. For example, Figure 15 shows the example of three different designs for the ball courts in Minneapolis parks. The concrete and iron fence in the image at the top may not introduce a pleasing view from the houses across the street; while the moderate vegetation landscaping in the bottom two images helps to block the activities in the courts from the neighbors and at the same time provide still the greenery for an aesthetic view.

Figure 15. Images of ball courts in the Windom Park (top), the Brackett Park (bottom left), and the Longfellow Park (bottom right)

Given the findings of this study and the literature, potential disturbance that are introduced by park activities and users is a major factor that influences the effect of park and park facilities on nearby neighborhoods. This is especially true for those who are not directly using parks for recreation activities. It can be a dilemma for park planners (More et al., 1988). Park facilities should be included in the parks if they are demanded by the people, and the goal is to encourage people come to the park and use the facilities. However, while there are more park users, it also means traffic, congestion, and noise, and this can be an issue for the adjacent residents. Nature landscaping has been suggested not only to decorate the unpleasing spaces but also to block disturbance from the neighbors. However, it is important to include only an appropriate amount of landscape in and at the edge of the park. While landscapes help to block disturbance from adjacent neighborhoods, it may also block the open view of the grassy fields, and more importantly, it may result in the concern of safety (Forsyth & Musacchio, 2005). The thick shrubs or a densely wooded area, for example, may successfully segregate park activities from the neighbors, but it may also completely block the surveillance from the street and the adjacent properties and therefore encourages unwanted activities in the parks.

The second objective of this study is to include the multilevel models in studying park impact on property values. In addition to the commonly used hedonic model, this study illustrates that the multilevel approach can be considered to estimate park impact on property values when the data is in the hierarchical structure. The results from the multilevel model show that there are more insignificant effects of the park facilities on property values. Although such results can be expected because type I error may be introduced when disaggregating the values of higher level attributes to lower level units as performed in single level models, the results from these two types of models in this study may not be perfect for direct comparison because the data sets were slightly different. This study does not attempt to compare these two types of models and to suggest either one of them to provide an accurate result. Rather, this study aims to fill the gap of park and recreation studies by introducing the multilevel models as an alternative approach to consider, especially when the hierarchical data are employed.

This study has limitations in terms of including individual park facilities in the models. Although using individual park facility can help to value each facility instead of merely valuing the park as a whole, the difficulty was found when putting all of them in the same model. Interaction among facilities and park's overall characteristics can still be expected, and some facility variables had to be dropped due to the issue of multicollinearity, and therefore the comparison among models can be difficult when variables were not all included in all models.

Moreover, as found in the results of sector-level hedonic models, there are differences among the results from different sectors. It has been suggested that neighborhood characteristics (e.g. population density, crime rate, etc.) may influence how local residents and park users view the parks (Anderson & West, 2006; Troy & Grove, 2008). People with the different socio-economic backgrounds can have different preferences on park design and use and therefore value the park and park facilities differently. As the literature suggested, some groups of people are interested in seeing more nature landscaping for the aesthetic view, while the others may want to use the parks for sports activities. This study had included some housing structure and neighborhood variables, as suggested by the literature, into the models and considered the difference among the four city sectors by using separate hedonic models for each of them. However, the neighborhood characteristics have not been used in the models in order to explain how the neighborhood characteristics may influence the impact of park proximity and park facilities on nearby property values. It is, therefore, worth to include these factors into future studies in order to suggest appropriate park design and management that specifically fit the local demand of both users and non-users, and to generate the maximum benefit of the park.

In relating to the consideration of people's preference, it will be also helpful to expand the research to include different groups of residents. When studying park impact on property values, single-family residential properties are mostly used. However, it is also worth to analyze how parks and their facilities may influence the values of other types of residential properties (e.g., multi-family properties and apartment buildings), as well as commercial properties.

It is difficult to make a general conclusion on the relationship between park characteristics and property values as suggested by scholars due to the diverse types of parks and the neighborhoods in which the parks belong. Many factors interact together and it is somewhat difficult to separate one from the rest, and the outcome can also change from one place to another. This study provides an example using park facilities to measure the impacts of parks on proximate property values to help park authorities and designers identify the potential consequences of a specific park facilities. However, as mentioned, other factors that can influence the outcome of the effects need to be incorporated in future research. More applications in other cities and towns can help increase sample size and provide more precise suggestions on the impact of park facilities on property values and how neighborhood characteristics such as demographic status influence these impacts. That said the study also points to flaws in the oversimplified rules of thumb often employed by park officials in terms of which facilities do or do not add value, and where. As municipal and park budgets tighten, it is clearly important that park officials and designers consider ways of limiting negative consequences and maximizing positive ones, in an effort to ensure that such spaces add as much as possible to economic value as they do to neighborhood quality of life.

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Woolley, H. (2003). *Urban Open Spaces*. New York, NY: Spon Press.

8. Curriculum Vitae

EDUCATION

- **Ph.D.** in Geography, August 2016, University of Wisconsin-Milwaukee, USA
  Dissertation: Assessing the Effect of Parks on Surrounding Property Values Using Hedonic Models and Multilevel Models

- **M.S.** in Urban Studies, May 2006, University of Wisconsin-Milwaukee, USA
  Master's Thesis: The Impacts of Urban University on Neighborhood Housing Value.

- **B.M.S.** in Land Management, June 2003, Feng Chia University, Taiwan
  Bachelor's Thesis: Allocation of Taichung City Fire Brigades and Research Analysis of Fire Control Energy.
  Awards: National Science Council Fellowship (awarded to outstanding collegial theses and researches)

TEACHING INTEREST

Geographic Information Science (GIS), Spatial Analysis, Urban Geography, Economic Geography, World and Regional Geography

RESEARCH INTEREST

Applications of Geographic Information Science (GIS), spatial analysis, and web mapping; Park and recreation planning; Neighborhood planning

TEACHING EXPERIENCE

Aug 2014 – May 2016: Instructor Department of Geography, University of Wisconsin-Milwaukee

Apr – Jul 2014 & May – Jul 2015: Instructor Department of Urban Planning, University of Wisconsin-Milwaukee

Aug 2007 – May 2013: Teaching Assistant Department of Geography, University of Wisconsin-Milwaukee

OTHER EXPERIENCE

Jan – May 2011: Public Relation Assistant Department of Geography, University of Wisconsin- Milwaukee

Aug 2005 - May 2006: Project Assistant Urban Studies Program, University of Wisconsin-Milwaukee

Sep 2001 – Feb 2002: Project Assistant GIS Research Center, Feng Chia University, Taiwan

Jul – Aug 2001: Summer Intern GIS Research Center, Feng Chia University, Taiwan

PUBLICATION

Lin, I-Hui, Wu, C., & De Sousa, C. (2013). Examining the economic impact of park facilities on neighboring residential property values. *Applied Geography*. 45: 322-331

CONFERENCE AND WORKSHOP PRESENTATIONS

Lin, I-Hui. Field Data Collection: Collector for ArGIS. University of Wisconsin at Milwaukee, GISDay 2014. (Workshop)

Lin, I-Hui. Analyzing the influences of park attributes on nearby property values using multilevel models. *The 110th Annual Meeting of the Association of American Geographers.* Tampa, FL, April 8-12, 2014.

Lin, I-Hui. Examining the impacts of park attributes on nearby property values using three-level models. *The 109th Annual Meeting of the Association of American Geographers.* Los Angeles, CA, April 9-13, 2013.

Lin, I-Hui. Examine the impact of park spaces on nearby property values: a multi-level modeling approach. *The 108th Annual Meeting of the Association of American Geographers.* New York, NY, February 24-28, 2012.

Lin, I-Hui. Analyzing an Urban Park System Using Statistical Models. *The 107th Annual Meeting of Association of American Geographers*. Seattle, WA, April 12-16, 2011.

Lin, I-Hui; Changshan Wu; Christopher De Sousa. Urban parks and surrounding property values. *The 106th Annual Meeting of the Association of American Geographers.* Washington, DC, April 14-18, 2010.

Lin, I-Hui. Examining park accessibility: a case study in Milwaukee, Wisconsin. *The 105th Annual Meeting of the Association of American Geographers.* Las Vegas, NV, March 22-27, 2009.

AWARDS

2014	Mary Jo Read Travel Fund ($1,080 for conference travel) *Geography Department, UW-Milwaukee*
2013	Mary Jo Read Travel Fund ($1,080 for conference travel) *Geography Department, UW-Milwaukee*
2012	Chancellor's Graduate Student Awards ($249) *UW-Milwaukee*
2012	Mary Jo Read Travel Fund ($1,400 for conference travel) *Geography Department, UW-Milwaukee*
2011	Mary Jo Read Travel Fund ($1,000 for conference travel) *Geography Department, UW-Milwaukee*
2010	Mary Jo Read Travel Fund ($525 for conference travel and $520 for research travel) *Geography Department, UW-Milwaukee*
2009	Mary Jo Read Travel Fund ($300 for conference travel) *Geography Department, UW-Milwaukee*
2007	Mary Jo Read Scholarship ($5,000) *Geography Department, UW-Milwaukee*
2002	National Science Council Fellowship (awarded to outstanding collegial theses and researches) *National Science Council, Taiwan*

PROFESSIONAL MEMBERSHIPS

American Association of Geographers (AAG), 2008-present