VALUATION OF TREE CANOPY ON PROPERTY VALUES OF SIX COMMUNITIES IN CINCINNATI, OHIO

DISSERTATION

Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of The Ohio State University

By

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ABSTRACT

The value of the urban forest as a component of the urban environment is significant. Environmental benefits of the urban forest include improved air quality, energy conservation through reduction of heating and cooling costs, climate moderation, flood control, reduction in noise levels and wildlife habitat. The urban forest also provides many social benefits. Studies have shown that trees reduce stress and improve the physical health of urbanites. Financial support for urban forestry in many cities is on the decline. The objective of this research was to evaluate the impact trees have on property values of six communities (Bond Hill, Carthage, Clifton, Hyde Park, Kennedy Heights and North Avondale) of varying socio-economic levels in Cincinnati, Ohio. Tax assessor records were obtained from property sales between the years 2000 and 2005. One hundred sites were randomly selected from each of the six communities. Data were collected from each site during the winter as well as the summer months. Dominant genus, caliper of dominant genus, estimate of tree cover, and overall property maintenance were recorded. Using the hedonic method of cost benefit analysis it was determined that each percentage increase in tree cover added $783.98 to the property value. The average value of tree canopy across the 600 sites is $20,226 or 10.7% of the sale price of the home. The findings from this research will be useful to Urban Forestry
Departments in their requests for funding.
Dedicated to my husband, Tom and my children,

Erika and Taylor for their love and encouragement as I pursued a dream.
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CHAPTER 1

INTRODUCTION

The value of the urban forest as a component of the urban environment is significant. Environmental benefits of the urban forest include improved air quality, energy conservation through reduction of heating and cooling costs, climate moderation, flood control, reduction of noise levels and improved wild life habitat (Dwyer et al., 1992). The urban forest also provides many social benefits to society. Trees help to reduce stress and improve the physical health of urbanites. Research among hospital patients found that patients with a view of trees improved significantly faster than those without a tree view (Ulrich, 1984). The presence of trees and well maintained turf grass reduces crime and provides stronger social ties among neighbors (Kuo, 2003). Despite the many benefits of the urban forest, financial support for urban forestry programs is on the decline (Dwyer et al., 1992). Educational awareness and financial support are needed to plant and maintain urban trees so that we may continue to reap the benefits trees provide to humans, the environment and wildlife.

Previous research in the United States and Europe has shown varying impact trees have on property values. Environmental, economic and social factors affect willingness
to pay for trees and therefore impact varies from country to country and even region to region within the United States. Providing research data to support the link between trees and an increase in property values may encourage homeowners as well as municipalities to invest in tree planting and maintenance and to support local forestry projects. Communities will benefit from a decrease in spending for such items as erosion control and storm water management as well as an increase in tax revenue due to the increase in tax base from higher property values.

This research focuses on the city of Cincinnati, Ohio. The Urban Forestry Program of the Cincinnati Park Board’s Natural Resources is responsible for planting and maintaining over 80,000 street trees on over 1,000 miles of public right-of-way. This program employs five Urban Foresters and two technicians with an annual budget of 1.6 million dollars (Hunt, 2008). The program has been in operation since 1981 and is funded through an annual urban forestry assessment which appears on the property owner’s tax bill each January. In hopes of increasing the budget of the Cincinnati Urban Forestry Program, Dr. T. Davis Sydnor, Professor of Urban Forestry, School of Environment and Natural Resources at The Ohio State University was approached by the Cincinnati Urban Forestry Department for help with this research. It was thought that if research found trees to have a positive effect on property values there might be an increase in financial support for the forestry program in Cincinnati.

The objective of this research was to evaluate the impact trees have on property values of six distinct communities of varying socio-economic levels in the city of Cincinnati, Ohio. The communities included Bond Hill, Carthage, Clifton, Hyde Park, Kennedy
Heights and North Avondale. It was hypothesized that tree cover would have a positive effect on the sale price of homes.

The Hedonic Method of cost benefit analysis was utilized to estimate the monetary value of the environmental asset (tree cover). This method assumes that differences in property prices are due to differences in housing characteristics. Property prices should reflect the extra money people are willing to pay for an environmental asset such as trees (Tyrväinen, 1997). This method relates the market price of a good, typically housing, to the set of characteristics that define it. The monetary value of each characteristic can be calculated by observing the differences in the market price of commodities sharing the same attributes (Morancho, 2003). The price paid for a good is considered to be the sum of the price paid for each characteristic (Morancho, 2003).

A hedonic model can be computed from data about prices and property attributes. Implicit prices for different housing characteristics are estimated by multiple regression analysis (Tyrväinen, 1997). In regression analysis attributes such as square footage and the number of bedrooms are held constant while evaluating the effect of a variable such as tree canopy. Problems with collinearity in the hedonic price model suggest restricting the model to a small number of variables (Tyrväinen, 1997). The variables chosen for this research model include sales date, living square footage, lot size, number of bedrooms, year built, number of bathrooms and canopy cover.
Benefits and costs of the urban forest have been the subject of significant study (Norwak 1993; McPherson et al. 1999). Research has been conducted in environmental areas such as air quality (Scott et al. 1998; Beckett et al. 2000), energy conservation (McPherson and Roundtree 1993; Laverne and Lewis 1996; Simpson and McPherson 1996; Simpson 1998), carbon sequestration (Ip, 1996; McPherson 1998; McPherson and Simpson 1999) and storm water management (Xiao et al. 1998). Studies have found trees have an impact on the reduction of domestic violence (Sullivan and Kuo, 1996), reduction in crime (Kuo, 2003) and improvement in health among hospital patients (Ulrich, 1984).

Placing a monetary value on trees has been approached in a number of ways. The International Society of Arboriculture (ISA) has developed a formula to estimate the value of individual trees. Development of this formula began in 1947 when the National Shade Tree Conference (now ISA) appointed a committee tasked with developing a method for estimating the value of shade trees (Chadwick, 1980; Cullen 2005). Responsibility for this method is now vested in The Council of Tree and Landscape Appraisers (CTLA) which is a group of seven green industry associations. The current
guidelines were published in 2000. This formula looks at the basic value or replacement cost of a tree along with the species, condition and location to estimate an individual tree value (International Society of Arboriculture, 1979). These four factors are then multiplied together to determine the tree value (Kielbaso, 1979).

The Helliwell System developed in the United Kingdom in 1967 is commonly used to settle legal disputes involving trees in the UK (Helliwell 1967; Coombes 1994). This value is determined by multiplying seven attribute scores together: size of tree, useful life expectancy, importance of position in the landscape, presence of other trees, relationship to setting, form and special factors (Helliwell 1967; Price 2003). Each attribute is scored on a scale of one to four. This number is then multiplied by a “unit value” (£14) which is occasionally updated in accordance with inflation (Price, 2003).

The Danish Tree Care Association which is the Denmark Chapter of the ISA developed a valuation model specific to Danish climate and culture. Drawing on inspiration from the American Council of Tree and Landscape Appraisers (CTLA) a committee of representatives from the green-industry was organized to develop the model referred to as VAT03 (Randrup, 2005). The four primary factors in this model consist of a basic value, health condition of the tree, location of the tree, and age of the tree (Randrup, 2005).

In 1988 the Burnley Method was developed at the Victorian College of Agriculture and Horticulture Limited in Burnley, Australia (McGarry and Moore, 1988). This method which is similar to the CTLA method was revised in 1991 (Moore, 1991). The appraised value is found by multiplying tree volume, base value, life expectancy, form and vigor, and location (Watson, 2002).
The Standard Tree Evaluation Method (STEM) was developed in New Zealand in 1996 (Flook, 1996). This method evaluates condition, amenity and notable (special merit) qualities on a scale of 3 to 27 for each of the three categories (Watson, 2002). The total point value is then multiplied by the wholesale cost of a five year old tree. Planting and maintenance costs are then added to the total (Watson, 2002). The final number is then converted to retail price (Watson, 2002).

Developed in Spain in 1990 and later revised in 1999, the Norma Granada method uses a series of tables to estimate tree value (Asociacion Española de Parques y Jardines Publicos, 1999). Tree species (growth rate and longevity) and size estimate tree value (Watson, 2002). The value is multiplied by the whole sale cost of a nursery tree and prices can adjust based on condition and location (Watson, 2002).

A study of five formula methods: Council of Tree & Landscape Appraisers (United States), Standard Tree Evaluation Method (New Zealand), Helliwell (Great Britain), Norma Granada (Spain) and Brunley (Australia) was conducted to compare the different values reached by each of the methods (Watson, 2002). Six trees were evaluated by nine individuals each using all five methods. The CTLA and Helliwell methods were found to produce the lowest values while the Norma Granada produced the highest (Watson, 2002).

Estimating tree value has also been approached from other angles. The presence of trees on the property (Morales, 1980; Morales, et al. 1983) or the view of trees from the lot (Garrod & Willis 1992; Luttik 2000; Tyrväinen & Miettinen 2000) have had positive effects on property values. Still other approaches have sought to find a relationship
between the distance of trees from the house (Powe et al. 1997; Tyrväinen 1997) or age and species (Willis & Garrod, 1992) and the comparative sale price of houses.

**Cost Benefit Analysis.** As early as 1808 cost benefit analysis (CBA) was used by the United States Army Corps of Engineers to evaluate the cost and benefits of water related projects (Hanley and Spash 1993). By 1936 the U.S. Corps of Engineers was required to evaluate the cost and benefits of all water projects (Hanley and Spash 1993). Although early methods were unsophisticated they opened the way for further economic study into the use of cost benefit analysis in evaluating environmental projects.

Three Cost Benefit Analysis methods commonly used when studying the environment are the Contingent Valuation Method, the Travel Cost Method and the Hedonics Pricing Method. The first two methods rely on hypothetical data while Hedonics uses actual market sales data to estimate environmental resources.

Contingent Valuation Method allows economic values to be estimated on goods not actually traded on the open market (Hanley and Spash, 1993). This is the most commonly used method for placing value on environmental assets (Tyrräinen, 1996). To obtain these estimates interviews or mail surveys are utilized. A carefully constructed hypothetical market is set up and sample consumers are asked their willingness to pay (WTP) or their willingness to accept (WTA) a change in the level of environmental service flows (Hanley and Spash, 1993). This method asks individuals explicitly to place a monetary value on environmental goods or services (Turner et al., 1994). For example, this method may be used to estimate a town’s willingness to pay for a new sewer system that would improve water quality in the local streams and river by preventing sewer runoff. The consumer may be asked questions such as how important clean water is to...
them, how often do they use the local river or streams for recreation, and how much are they willing to pay to improve water quality. Contingent Valuation Method has been used to value the urban forest (Dwyer et al. 1989; Tyrväinen and Väänänen 1998; Lorenzo et al. 2000; Tyrväinen 2001; Schroeder et al. 2003).

The Travel Cost Method was originally developed for use by the United States Park Service in 1947 (Hanley and Spash, 1993). The most common use for this method is outdoor recreation modeling such as fishing, hunting, boating and forest visits (Hanley and Spash, 1993). Travel Cost Method assists in placing monetary value on a non-market environmental good such as a visit to a National Park. The money an individual is willing to pay for a park visit is not just the admission fee. There are other associated costs for such a visit including such travel expenses as gasoline, food and lodging. The purchase of sporting equipment needed for the visit is also included in the price a person is willing to pay for the park visit. Collecting visitor zip code information aids in calculating willingness to pay. The zip codes help determine the distance traveled and the cost associated with such distances. These calculations may be skewed if the park visit was not the only activity on the visitor’s agenda. A business trip or family visit will decrease the amount a person is willing to pay for the park visit. The Travel Cost Method has also been a tool in the evaluation of the urban forest (Dwyer et al., 1983).

The third environmental cost benefit analysis method is the Hedonic Pricing Method. This method is typically used to estimate the monetary value an environmental attribute has on property value. It has been used to measure the impact factors such as noise level, water pollution and air particulates have on the value of a property. Hedonics relies on the assumption that many factors such as square footage, lot size, number of bathrooms
and environmental quality influence house price (Tyrväinen, 1996). The selling price of a home is assumed to be the sum of its characteristics. The value of a property is a function of the values of all the characteristics of that property (Garrod and Willis, 1992). Variation in the selling price can be explained by differences in housing characteristics (Tyrväinen, 2000). Multiple regression analysis is used to place a value on individual housing characteristics which may be either negative or positive. Selling price of a house is the dependent variable. It reflects the market price of that property. Independent variables are the attributes of the property. When developing a hedonic price equation it is important to use a minimum number of variables as these variables may be closely correlated causing a problem with multi-collinearity. For example, if a house is located close to a busy highway as the noise levels increase due to increased traffic so do the levels of exhaust fumes. This multi-collinearity may cause problems such as imprecise coefficient estimates and wrong signs on variables even though the R² may be high (Hanley and Spash, 1993). Bias when choosing variables is another problem to face when using hedonics.

Of the three Cost Benefit Analysis methods described above, Hedonics is the only method that relies on actual market price to estimate the value of environmental attributes. When using the Contingent Valuation Method a hypothetical market is developed to estimate commodities prices. The Travel Cost Method seeks to estimate a value on non-market environmental goods. The cost of consuming an environmental service such as a visit to a National Park is used as a proxy for price (Hanley and Spash, 1993). Although factors such as multi-collineratity and bias when choosing variables may be a problem with hedonics, the use of actual price data is a benefit.
**Previous Research.** Various studies have been conducted within the United States and Europe to evaluate the monetary effect trees have on property values. These studies have been conducted in several U. S. cities including Manchester, Connecticut, Athens, Georgia and Austin, Texas as well as European cities in Finland and Spain. An early study conducted by the U. S. Forest Service in Amherst, Massachusetts found that on an average lot trees contributed seven percent to the property value and on some lots trees contributed as much as 15 percent to property values (Payne, 1973).

**Manchester, Connecticut.** In 1980 a study in Manchester, Connecticut was conducted to determine whether or not trees contributed to residential property values and if so to what extent. Sixty houses were selected with the help of local real estate agents and construction firms familiar with the area. All properties selected were four to five years old at the time of sale. The properties were given a rating of either good or poor tree cover. Good tree cover was represented as lots with mature trees containing fifty to sixty percent tree cover. Lots with no tree cover were given a poor tree cover rating. This study evaluated thirty properties from each of these two tree cover ratings for a total of sixty properties.

Tax assessor records were obtained to collect data regarding each property. The following information was recorded on each property: sale price, square footage, number of rooms, number of bedrooms, number of baths, lot size, city or on-site utilities, number of fireplaces, number of garages, age of house, sale date and loan to value ratio. Sale price is the dependent variable. Using multiple regression analysis the independent variables with the largest influence on sale price were sale date, number of bathrooms, square footage, number of garages, and number of fireplaces, tree cover and
neighborhood. These independent variables are listed in rank order. This study determined that good tree cover added $2,686 or six percent to the value of a property in Manchester, Connecticut (Morales, 1980).

**Athens, Georgia.** A study conducted by the United States Department of Agriculture, Southeastern Forest Experiment Station in Athens, Georgia found that an average sales price increase of $1700 to $2100 or three to five percent was associated with treed lots (Anderson and Cordell, 1985). Over 800 single-family home sales completed between 1978 and 1980 were studied to determine these findings. Data on these property transactions were obtained from the local Board of Realtors Multiple Listing Service (MLS) publication series. This publication contains the written description, sale price, length of time on the market, financing arrangements and a photograph of each completed transaction. All data used in this study was obtained through the MLS publication and no physical inspection of the properties was done.

Data such as sale price, square footage, lot size, age of the property, number of bedrooms, number of bathrooms, length of time on the market, and type of utilities was obtained for the 852 properties studied. Tree count was determined from the real estate photos. The photos were small but consistent as all were taken by professional photographers. Only the front yard was considered in the tree count. According to researchers challenges counting trees on lots with dense stands of small hardwoods may have occurred, but these lots were considered densely treed (Anderson and Cordell, 1985). Trees counted were divided into evergreen and deciduous and within each of these two groups the trees were classified by size (small, medium and large). Quality of the landscape or its maintenance was not recorded.
Correlation and regression analysis for this research was conducted using the Statistical Package for the Social Sciences (SPSS). The correlations indicated how closely different the property characteristics were associated (Anderson and Cordell, 1985). Regression analysis was used to examine the separate effects each of the housing characteristics had on the selling price (Anderson and Cordell, 1985).

Analysis of the data found the most important variables in determining the sale price included square footage, age of house, number of rooms, number of bedrooms, number of baths, car storage capacity, age of the house, and number of trees in the front yard. This study determined that treed lots were responsible for a three to five percent increase in sale price. Tree species and tree size did not contribute significantly to sale price.

**Austin, Texas.** A study utilizing two methods of tree valuation was conducted on 120 residential properties in Austin, Texas. The International Society of Arboriculture (ISA) formula method is commonly used by arborists to estimate the value of individual trees. This method is the most widely used method of determining monetary tree value (Tate, 1989). The CTLA method is used by arborists and nurserymen and accepted by the court system as the norm (Martin et al, 1989). *Valuation of landscape trees, shrubs and other plants* describes this method (Martin et al, 1989). This guide is published by the International Society of Arboriculture under the guidance of the Council of Tree & Landscape Appraisers. Seven national and international organizations support this Council including the American Nursery and Landscape Association, American Society of Consulting Arborists, Tree Care Industry of America, PLANET, American Society of Landscape Architects, Society of American Foresters and the International Society of Arboriculture. The second method used in this study was the predictive modeling
method. Regression analysis is utilized to predict the residential property value (dependent variable) with independent variables that represent the lot and house characteristics (Martin et al, 1989).

This study was conducted to estimate tree value due to a serious problem caused by Ceratocystis fagacearum, the oak wilt fungus. At the time of the study oak wilt was a serious problem in 35 counties in this area of Texas. The researchers were interested in obtaining an estimate of the financial impact of this serious disease. A cost benefit analysis was needed to assess the cost of disease control options.

Four neighborhoods were chosen for the study. Each of the neighborhoods was at least 20 years old and the properties were valued from $30,000 to $600,000. House values were obtained from the Travis County Appraisal District because each of these neighborhoods was stable. As a result sale prices were either out of date or unavailable for some of the homes. Thirty properties were chosen from each of the neighborhoods.

To obtain the tree value using the ISA method each tree on all 120 properties was evaluated. The following ISA formula was utilized:

\[
\text{TREE VALUE} = \text{BASIC VALUE} \times \text{SPP} \times \text{CNP} \times \text{LCP}
\]

\[
\text{BASIC VALUE} = \begin{cases} 
\text{a) replacement cost for trees up to 8 inches (20 cm) in diameter, or} \\
\text{b) Diameter}^2 \times 0.7854 \times 22
\end{cases}
\]

\[
\text{SPP} = \text{species percentage}
\]

\[
\text{CNP} = \text{condition percentage}
\]

\[
\text{LCP} = \text{location percentage}
\]
These percentages represent the relative favorability of specific tree characteristics.

The species, condition and location percentages were obtained from a fact sheet on the evaluation of shade trees in Texas developed by Dewers and Dreesen (Martin et al, 1989). Replacement cost was obtained from local nurserymen.

*Quercus fusiformis* (Live oak) and *Ulmus crassifolia* (Cedar elm) comprised approximately 50 percent of the trees in these four neighborhoods. Most of the trees in the study were found to be small due to the poor rocky soil and high tree density.

Evaluation of the lots was repeated utilizing the predictive modeling method. Regression analysis was used to estimate the tax appraised value of each residential property which is the dependent variable in this model. The independent variables are the property characteristics and included square footage of the house, lot size, age of the house, if the property included a pool or not, number of bathrooms, fireplace, air conditioning, type of garage or carport, storage areas, number of driveways, fencing, number of porches and tree data collected.

The ISA method of tree evaluation estimated the value trees have on property price in the four Austin neighborhoods to be 13 percent of the appraised value. The predictive modeling method found the tree value to be 19 percent of the appraised value. Researcher for this project found the predictive modeling method more reflective of what people are willing to pay for trees (Martin, et al 1989). In the past the ISA formula was the only method available to account for differences in tree value on different lots (Martin, et al 1989).

Greece, New York. A research study was conducted in Greece, New York a suburb of Rochester in the western part of the state. Eastman Kodak is a large employer in the
area and residents of Greece have access to amenities such as recreation and commerce (Morales et al, 1983). Researchers felt that although other studies had already been conducted to estimate the value trees add to property, changes in the real estate market warranted more research (Morales et al, 1983). These researchers were also interested in comparing more than one method of tree valuation. The International Society of Arboriculture (ISA) method and multiple regression analysis were used in this study. For this study regression analysis is referred to as the real estate approach.

Forty-four newly constructed homes in the same development sold over the same two year period were evaluated. The developer created the concept of unique and interesting homes and tried to break the “sameness” mold you find in many developments (Morales et al, 1983). Twenty-two homes sites had mature tree cover and twenty-two sites had no tree cover. Property tax records were obtained from the town office and the following data was collected for each home site: sale price, date of sale, number of rooms, lot square footage, number of fireplaces, age of house, number of garages and square footage of the house. Tree cover was also noted for each property as either, no tree cover or mature tree cover.

Multiple regression analysis found that houses with no tree cover and those with mature tree cover were comparable. These houses were similar in size, age, lot size, number of rooms and were sold within the same time frame. Analysis also showed that houses with good tree cover were somewhat larger than houses without cover but the lots with out tree cover tended to be bigger (Morales et al, 1983). Since all houses were located within the same neighborhood they had access to the same local goods and services.
Since treed and untreed lots were comparable the researchers compared sale prices. Lots with mature trees sold for $9500 more than lots without trees. The lots with no tree cover tended to be near the main road or in close proximity to land zoned for higher density development. Therefore, it was assumed that the tree cover did not account for the total $9500 differential in sale price (Morales et al., 1983).

The wooded home sites were evaluated using the *Guide for Establishing Value of Trees and Other Plants* developed by the International Society of Arboriculture. Indigenous species such as *Acer* (Maple), *Fagus* (Beech), *Carya* (Hickory) and *Quercus* (Oak) were found on these lots. On average the homeowners had also planted five trees. Introduced species such as *Malus* (Crabapple) and *Picea* (Spruce) were added to the landscape.

The trees were found to be typical for an urban woodlot in the northeast. Most of the trees were given a fair rating due to the fact that they had never been trimmed and many contained broken limbs and some rot. Some tree damage also occurred during construction and decline was noted due to change in grade, root cutting and soil compaction. An average increase of $6000 was calculated using the ISA method of valuation.

Regression analysis found a $9500 increase in sale price for lots with mature tree coverage whereas the ISA method of valuation calculated an increase of $6000. One explanation for this may be how the developer marketed and developed the lots (Morales et al., 1983). The developer was aware of the desirability of treed lots and may have inflated their value (Morales et al., 1983). The location of the treed lots in the secluded portion of the development may have also been a factor (Morales et al., 1983).
An ISA value of $6000 may have been lower than expected due to a tree health rating of fair (Morales et al, 1983). Many trees were suffering from various site disturbing ailments (Morales et al, 1983).

**Greenville, South Carolina.** A study of the quality of landscaping and its effect on the sale price of homes in Greenville, South Carolina concluded that a house with an excellent landscape rating would sell for four to five percent higher than a house with a good rating. Homes with a fair or poor rating sold for eight to ten percent below homes with a good rating.

Approximately 300 single family homes sold between 1991 and April 1993 were studied. Data used for the analysis was collected from the Greenville county tax collector’s office. An on-site inspection of each property to evaluate the landscape was done by professional landscape design specialists. Landscape quality of adjacent lots and the neighborhood as a whole was also evaluated.

Landscape quality was assessed in terms of type, size and condition of trees and plants. Subjective concepts such as balance, symmetry and unity were also evaluated for each site. Thirty percent of the properties were found to have good landscape, while 18% were rated excellent. Fair to average landscapes accounted for 29% of the sites and 23% were rated poor.

Using regression analysis it was determined that improved landscaping had a positive impact on housing prices (Henry, 1994). Landscape quality of adjacent lots was also a factor in determining sale price of the property in question (Henry, 1994). Dollar return from landscaping varies on the size of the lot and the price of the home (Henry, 1994).
Lake Tahoe Basin of California. A study of the Lake Tahoe Basin of California was conducted between 1990 and 1994 to predict the value contribution of forest conditions on small urban-wildland interface properties. Stand Density Index (SDI) and a tree health measurement were added to the traditional property characteristics such as house size, lot size, and number of rooms to develop a model to predict the impact tree care has on property values.

Often property owners are unaware of the value a healthy, attractive forest can add to the total value of a property (Thompson et al, 1999). The purpose of the research was to identify and quantify forest characteristics and their value to residential properties in the Lake Tahoe Basin.

The Lake Tahoe Basin lies on the border of Nevada and California. The Nevada side contains primarily *Pinus jeffreyi* (Jeffery pine) while the California side is a mixed conifer type of forest containing such species as *Abies concolor* (White fir), *Pinus ponderosa* (Ponderosa pine) and *Pseudotsuga menziesii* (Douglas-fir). The Lake Tahoe Basin forest is unhealthy due to human-caused overstocking which has resulted in insect epidemics and disease (Thompson et al, 1999). A ten year drought has also added stress particularly to the White fir. An abnormally dense forest due to fire exclusion along with these other factors has lead to high tree mortality (Thompson et al, 1999).

Fire is a natural thinning mechanism but over the last century due to urbanization this corrective process has been suppressed which has allowed diseased trees to survive and tree stands to become very dense (Thompson et al, 1999). The aesthetics of the forest has been dramatically affected by the dead and dying trees and may be linked to a decline in property values (Thompson et al, 1999).
Researchers developed a method of evaluating the tree stands using the Stand Density Index developed by Reineke and a measurement for degree of infection. The observed error term is $\varepsilon$. The model developed for this study is as follows:

$$\text{PRICE} = H_1 (\text{SQFT}) + H_2 (\text{ACRES}) + H_3 (\text{VIEW}^2) + H_4 (\text{INFECT}) + H_5 (\text{SDI}) + \varepsilon$$

One hundred properties were randomly selected from over 300 small parcels (.3 to 5 acre) transactions that occurred between 1989 and 1994 on the California side of the basin. Property characteristics were collected during the summer of 1994. Sample size was reduced to 76 sites because price or property characteristics were unable to be verified on some of the selected transactions (Thompson et al, 1999).

Results of the study found that by thinning an excessively dense stand of trees value can be added to the property. Thinning trees increases the aesthetics of the property and promotes vigorous growth of the remaining trees (Thompson et al, 1999). Tree thinning also reduced the threat of fire which is a serious concern in this part of the country (Thompson et al, 1999). This research estimated the contribution a healthy forest can add to property values in this high end real estate market is between 5% and 20% of market price.

**North Carelia, Finland.** The urban forest provides many non-consumptive benefits to the population including such items as clean air, peace and quiet, screening and recreational activities (Tyrväinen, 1997). A study was conducted to determine whether and how the urban forest benefits in North Carelia, Finland were capitalized in property prices (Tyrväinen, 1997). The hedonic pricing method was used to evaluate external costs and benefits of the urban forest as they relate to housing (Tyrväinen, 1997).
The forests of Scandinavia differ from those in other parts of Europe. Many towns in Scandinavia are surrounded by forest unlike central Europe with its many man-made parks and tree lines (Tyrväinen, 1997). New housing construction in Finland usually occurs among the forested areas and because of this factor large forest preserves are often found on the fringe of cities (Tyrväinen, 1997).

The study was conducted in the town of Joensuu in North Carelia, Finland home to 48,000 inhabitants in the eastern part of the country. The terrain of the town is flat with a river running through the center and a lake bordering it. Most of the housing in the area is either single family or row homes. A typical forest consisting of 69% *Pinus sylvestris* (Scotch pine) and 17% *Betula* (Birch) surrounds this area.

Row house apartments were chosen for this study because there would be less variation than in single family homes. Sale price and property characteristics were collected from the local tax authorities on 1006 properties from 14 different housing areas. The row house apartments chosen had a maximum of five rooms. The data was collected from transactions that occurred from 1984-1986 which was a reasonably stable period in the housing market in Finland.

Location of schools, shops and other public services along with urban forest areas were marked on a town map. The minimum size necessary for consideration as a wooded green space was 0.3 ha. Measurements were calculated from each row home to the local amenities and forested areas.

A general hedonic price function was calculated to explain the apartment sales prices:

\[ P = f(A_i, L_i, E_i) \]
where \( A_i \) is a vector of apartment characteristics such as age and size, \( L_i \) is a vector of local attributes such as schools and shops and \( E_i \) is a vector describing environmental characteristics such as accessibility to recreation and green space.

Age and distance to the center of town had the strongest effect on apartment sale price. The study also showed a decrease in sale price the farther an apartment was from water or other recreation areas. Sale price of apartments with nearby forested land were negatively impacted by the proximity of the trees. The forests in this area of Finland are mainly coniferous with 69% being Scotch pine. Most of the forests in this area are 50-60 years old and tend to be located close to row houses (Tyrväinen, 1997). With only six hours of daylight during the winter months light is an important feature of an apartment and may explain the negative value (Tyrväinen, 1997). The effect of trees on housing prices depends on there distance, size and quality therefore proper urban forest maintenance is important for capitalization of property values (Tyrväinen, 1997).

**Salo, Finland.** Another study conducted in Finland sought to value non-priced urban forest amenities by comparing dwelling prices and the amenities associated with the properties. Researchers studied 590 terraced house sales in the city of Salo, Finland a town of 23,000 inhabitants in the northwest part of the country. It is located 110 kilometers northwest of Helsinki.

Salo is an old commercial center with the largest employer in the area being Nokia Phone Company. Housing and industry is concentrated along the Salo River which runs through the center of town. The landscape is made up of open fields and forested glacial ridges called eskers.
Data was collected from sale between 1984 and 1986 since this was a reasonably stable financial period in Finland (Tyrväinen and Miettinen, 2000). Terraced homes were chosen because they tend to be similar in characteristics. Homes had a maximum of five rooms.

The four variables chosen to measure forest amenities were distance to the nearest wooded recreational area, direct distance to the nearest forested area, the relative amount of forested areas in the housing district and the view from the dwelling windows. For this study wooded greenspace had to be a minimum of 0.3 hectares.

Results of the study found that an increase of one kilometer to the nearest forested area deceased on average the value of the dwelling by 5.9 percent. Homes with a view of the forested area sold for 4.9 percent more than homes without the view.

**Castellón, Spain.** The purpose of this research was to evaluate the relationship between housing prices and green areas in the city of Castellón, Spain using the hedonic method of cost benefit analysis. Along with the traditional variables used to evaluate the housing market environmental variables were added to the model. The three environmental variables studied were the existence of views of a park or public garden, the distance from the property to the nearest green area and the size of that open space.

Results of this study of 810 properties found that the size of the living area had the greatest effect on the price of the home. Number of bathrooms, size of the balcony, age of the building, existence of an elevator and existence of a storage room were also found to be statistically significant.

Distance from a green area was the only environmental variable found to be significant. Size of that green space was not an important attribute for home owners.
Research estimated that for every 100 meters from a green space the value of the property dropped 1800 euro (Morancho, 2003). Numerous small green spaces scattered throughout the city were found to be more appropriate than a few large parks (Morancho, 2003).

**Portland, Oregon.** A study was conducted in Portland, Oregon to investigate the impact of open spaces such as public parks, natural areas and golf course on home values (Bolitzer and Netusil, 2000). Data from home sales, home characteristics and neighborhood characteristics were obtained from Metro Source, a company that collects such data from town assessors’ offices. Distance of each house from open space and the central business district was also obtained from Metro Source. A total of 16,402 single family homes selling between 1990 and 1992 were studied.

Typical home characteristics such as age of the house, number of bathrooms and lot acreage along with an open space variable were included in the hedonics model. A home was considered to be near open space if the property was within 457 meters (1500 ft) of that space. Distinction between the different types of open space was also included in the model. Research found properties located within 457 meters (1500 ft) of any open space sold for $2105 more than properties located more than 457 meters (1500 ft) away. Homes located within 457 meters (1500 ft) from a 20 acre open space sold for $2670 more than properties that did not fall with this radius. Proximity to public parks and golf courses increased property values while proximity to private parks and cemeteries should no significant effect on home values.
**Cleveland, Ohio.** In 2001 research was conducted in Cleveland, Ohio to determine the impact trees and landscaping had on office rental rates. A total of 85 office building with 270 individual leases were chosen for this study.

Structural data such as total building square footage, age of the building, number of floors and parking were collected from a commercial real estate brokerage firm along with lease information. Landscape evaluations were conducted by Davey Resource Group which looked at such items as landscape maturity, percentage of ground cover, visual screening, shade and aesthetics.

Results of this study found landscaping with good aesthetic value added 7% to average rental rate of an office building. A building with good shade also had a positive impact on rental rates with an added value of 7%. Visual screening negatively impacted the rental rates by 7.5%. Researchers concluded that tenants valued visibility over the privacy a screen would provide (Laverne and Winson-Geideman, 2003).

**Attitudes and Preferences.** Much research has been conducted to assess attitudes and preferences towards trees. College students from six continents, Africa, Asia, Australia, Europe and North and South America were studied to determine their tree shape preferences. Preference for spreading and globular shaped trees was found across nationalities (Sommer and Summit 1996; Sommer 1997). Columnar and conical shaped trees were the least desirable shapes. Researchers found that although both early experiences and formal characteristics play a role in the perceived attractiveness of a tree, formal characteristics had the greater influence.

A study of North American immigrants found that differences in cultural background played an important role in perception of the urban forest (Fraser and Kenney, 2000).
This study found that immigrants from Britain responded most favorably towards shade tree while immigrants from China were least likely to plant trees. Italian and Portuguese immigrants preferred planting fruit trees and vegetable gardens. These findings are consistent with the traditional use of trees in the native homeland of each immigrant population.

A study of five Midwestern towns found residents preferred large trees over small trees (Kalmbach and Kielbaso, 1979). Large trees were defined as those reaching more than 25 ft tall at maturity. This preference was independent of a person’s education, age or sex. Other U. S. studies noted similar findings on tree size preference (Schroeder and Cannon 1983; Sommer et al 1989; Schroeder and Ruffolo 1996; Schroeder et al. 2006).

A survey was conducted in Toledo, Ohio to assess the attitudes of residents towards street trees before removal of Ash trees (Fraxinus spp.) due infestation of Emerald Ash Borer (Agrilus planipennis) (Heimlich et al. 2008). This study found large trees with a variety of summer and fall foliar characteristics was highly valued by the residents. Researchers concluded that planting a number of different species would satisfy the respondents, preventing a monoculture of same species street trees which may create similar disease and pest issues in the future.

Research conducted in Scotland concluded that residents prefer smaller trees and fewer plantings (Hitchmough and Bonugli, 1997). A study conducted in southwest England in 2003 found a preference towards smaller trees with a slower growth rate as well (Schroeder et al., 2006). Researchers concluded that in cooler, less sunny climates shade is not appreciated as much as it would be in a warmer, sunnier area (Schroeder et al., 2006).
Trees play an important role in improving the aesthetic quality of a community (Sommer et al. 1989; Schroeder and Ruffolo, 1996; Todorova et al. 2004). The benefits trees provide outweigh annoyances such as falling leaves and debris, suckers, insects and reduction in visibility (Sommer and Sommer 1989; Schroeder and Ruffolo 1996). Flowers do not seem to play an important role when choosing a tree (Schroeder and Ruffolo 1996; Heimlich 2008) although underplantings of bright flowers were important to residents of Sapporo, Japan (Todorova et al. 2004).
This study was conducted within six communities in Cincinnati, Ohio. These six communities are of varying socioeconomic backgrounds and include Bond Hill, Carthage, Clifton, Hyde Park, Kennedy Heights and North Avondale. Most of the properties in this area are 60-80 year old single family homes on small urban lots. More affluent areas such as Clifton and Hyde Park have some properties with larger lots. These communities also included some apartment buildings, duplexes and condominiums. For this study apartment buildings were excluded. Tax assessor records were obtained from home sales between the years 2000 and 2005. One hundred property sales were randomly selected from each of the six communities. The initial data was collected during the winter when the deciduous foliage was not present. Dominant genus, caliper range of dominant genus, estimate of tree cover, and overall property maintenance was recorded. Caliper of dominant genus was recorded as less than 25 cm (10 inches) or more than 25 cm (10 inches). Also noted was whether the dominant genus was evergreen or deciduous. The data collection was repeated during the summer months when trees were in full canopy.
For data collection a physical inspection and assessment of each of the 600 properties was done. Dominant genus was determined and noted as to deciduous or evergreen. For simplified analysis deciduous genera were recorded as zero and evergreen genera recorded as one. Caliper of the dominant genus was then determined as less than or greater than 25 cm (10 inches). Less than 25 cm (10 inches) was recorded as zero and more than 25 cm (10 inches) was recorded as one. Number of trees on the property was recorded. Canopy cover was then estimated. If the canopy of a tree on an adjacent property overhung the property being inspected this tree canopy was included in the estimate of cover but not included in the tree count. Only trees planted on the property or street trees that bordered the property were included in the tree count. Property maintenance was recorded on a scale of 1-5 with 5 being the best. This included both home and property maintenance. Finally impact of the landscape was assessed on a scale of 1-5 with 5 being the best.

The Hedonic Method of cost benefit analysis was utilized to estimate the value of each of the property attributes including tree cover. A hedonic model can be computed from data about property prices and attributes. Implicit prices for different housing characteristics are estimated by multiple regression analysis. Attributes such as square footage and lot size are held constant while evaluating the effect of another variable such as tree cover. Restricting the model to a small number of variables helps to eliminate problems with collinearity.

The Hedonic Pricing Method relates the market price of a good, typically housing, to the set of characteristics that define it. The monetary value of each characteristic can be calculated by observing the difference in the market price of commodities sharing the
same attributes (Morancho, 2003). It is theorized that goods are defined by the set of characteristics that form them and the price paid for that good is the sum of the price paid for each characteristic of that good (Morancho, 2003). This is written as follows:

\[ P = f(x_1, x_2, x_3, x_n, z) \]

where \( P \) is the market price of the property and \( x_1, x_2, x_3, \ldots x_n \) represent the property characteristics such as square footage and number of bathrooms. Tree cover, the environmental attribute is expressed as \( z \). The environmental variable without a market price is referred to as the hedonic variable (Morancho, 2003).

Linear models have been utilized in previous hedonic research (Tyrväinen 1997; Morancho 2003). Linear models are in use due to the ease of interpretation although there are many reasons to believe price and the environmental variable may be non-linear (Morancho, 2003). A linear model assumes that the marginal willingness to pay for an additional unit of an attribute, for example an extra percentage of tree cover, remains constant. In developing the model for this analysis, a quadratic model tested tree cover and age of the properties and they were not found to be significant. This will be discussed later.

The basic regression analysis formula is as follows:

\[ P_i = b_1x_{1i} + b_2x_{2i} + b_3x_{3i} + \ldots + b_nx_{ni} + b_2z_i + \epsilon_i \]

where \( x_{1i}, x_{2i}, \ldots, x_{ni}, z_i \) are the housing variables, parameters \( b_1, b_2, \ldots, b_n, b_z \) are the marginal willingness to pay for each of the property attributes and \( \epsilon_i \) is the error term for the equation.

Data were analyzed using the Proc REG procedure of SAS statistical software (Cary, North Carolina) ordinary least squares regressions. Most of the models tested assumed a
linear relationship between home prices (dependent variable) and the independent variables. This assumes the willingness to pay for an additional unit of a given variable is constant. Linear models tend to be used due to the ease of interpretation (Morancho, 2003). Testing for quadratic effects of cover and age of the property was done but was not found to be significant (P<0.05).
CHAPTER 4
RESULTS AND DISCUSSION

Demographics. The city of Cincinnati, located in the southwestern part of the state is the fourth largest city in Ohio. The greater metropolitan area which includes counties in Kentucky and Indiana is home to 1,900,000 people. The city encompasses 77.2 square miles and is divided into 48 distinct communities. Cincinnati is home to a number of large companies including Procter and Gamble, The Kroger Company and Chiquita Brands International. Based on the 2000 census the median household income of the city of Cincinnati was $29,493.

Six communities were chosen for this research with the help of the city urban foresters. The six communities include Bond Hill, Carthage, Clifton, Hyde Park, Kennedy Heights and North Avondale. The following will be a brief discussion of each community using data collected from the 2000 U. S. census.

Bond Hill has a population of 9,682 (Table 1) with a total of 4,166 households of which 2,521 are family households (Table 3). Over half of the family households are headed by females (Table 3). The unemployment rate for residents over the age of 16 is 6.7% or a total of 301 persons in a work force of 4,477 (Table 4). The median household income was $28,543 in 2000 (Table 6) with 1999 persons falling below the poverty line.
Thirty-seven percent of the population over the age of 25 is high school graduates while 28% have less than a high school education (Table 8). Only 9.4% of the population over the age of 25 has a Bachelor’s Degree or higher (Table 8). The racial mix in this community as of the 2000 census was 4% white, 93% black with the remainder listed as other (Table 9).

The population of Carthage in 2000 was 2,412 (Table 1) with a total of 1,066 households of which 594 were families (Table 3). Thirty percent of the families were headed by females (Table 3). The unemployment rate for residents over the age of 16 was 6% in a work force of 1,129 persons (Table 4). The median household income for this community in 2000 was $27,364 (Table 6) with 378 persons or 16% of Carthage residents falling below the poverty line (Table 7). Thirty-three percent of residents over the age 25 had a high school education while only 9% had a four year college degree or higher (Table 8). Thirty-six percent of the adult population had less than a high school diploma (Table 8). In 2000 this community was 89% white, 9% black and 2% other (Table 9).

In 2000 the population of Clifton totaled 8,546 persons (Table 1) including 4,552 households of which 1,692 were family households (Table 3). Seventeen percent of the family households were headed by women (Table 3). The Clifton workforce of persons over 16 had an unemployment rate of just over 3% (Table 4) with a median household income of $32,548 (Table 6). Sixteen percent of the population fell below the poverty line (Table 7). Clifton is located near the University of Cincinnati which may explain the high level of education in this community compared to other communities studied. A large student population may also skew the percentage of persons below the poverty line
upwards. Sixty-one percent of its residents over the age of 25 have a Bachelor’s Degree or higher while 12.5% have a high school education (Table 8). Nine percent of the adult population has less than a high school diploma (Table 8). The racial mix of Clifton in 2000 was 75% white, 15% black and 10% other (Table 9).

The population of Hyde Park was 13,640 at the time of the 2000 census (Table 1). Households with families totaled 2,919 with 10% of these households headed by women (Table 3). The total number of households in the community was 7,139 (Table 3). The unemployment rate for residents over the age of 16 was 1.7% (Table 4) with 5% of persons falling below the poverty line (Table 7). The median household income for Hyde Park in 2000 was $59,541 (Table 6). The residents of this community are also highly educated with 69.5% of the population over the age of 25 obtaining a Bachelor’s Degree or higher (Table 8). Only four percent of the adult population has less than a high school education (Table 8). Ninety-three percent of the population of Hyde Park is white, three percent black and the remainder listed as other (Table 9).

Kennedy Heights had a population of 5,689 in 2000 (Table 1) with a total of 2,551 households in this community (Table 3). Sixty percent of the households were family households of which 34% were headed by females (Table 3). Kennedy Heights had an unemployment rate of 5.6% for residents over the age of 16 during the 2000 census (Table 4). The median household income was $32,882 (Table 6) with two percent of the population falling below the poverty line (Table 7). Twenty-three percent of the population over the age of 25 had obtained a four year college degree or higher while 15% had less than a high school diploma (Table 8). Thirty-two percent of adult residents
had graduated from high school (Table 8). Racial mix for this community included 21% white, 76% black and three percent other (Table 9).

The population of North Avondale was listed as 6,326 in the 2000 census data (Table 1) which included 2,285 households of which 1,231 were families (Table 3). Thirty-one percent of the families were headed by females (Table 3). The unemployment rate for residents over the age of 16 was five percent (Table 4) while 10% of its residents fell below the poverty line (Table 7). The median household income for North Avondale during the 2000 census was $39,297 (Table 6). Thirty-seven percent of the residents over the age of 25 have a Bachelor’s Degree or higher while 19% have a high school diploma (Table 8). Fifteen percent of the adult population has not completed high school (Table 8). The racial composition of North Avondale during the 2000 census was 45% white, 52% black with the remainder of the population listed as other (Table 9).

<table>
<thead>
<tr>
<th>Neighborhood</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bond Hill</td>
<td>4,233</td>
<td>5,449</td>
<td>9,682</td>
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<tr>
<td>Carthage</td>
<td>1,176</td>
<td>1,236</td>
<td>2,412</td>
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<tr>
<td>Clifton</td>
<td>4,206</td>
<td>4,340</td>
<td>8,546</td>
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<td>Hyde Park</td>
<td>6,262</td>
<td>7,378</td>
<td>13,640</td>
</tr>
<tr>
<td>Kennedy Heights</td>
<td>2,580</td>
<td>3,109</td>
<td>5,689</td>
</tr>
<tr>
<td>North Avondale</td>
<td>2,871</td>
<td>3,455</td>
<td>6,326</td>
</tr>
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</table>

Table 1: Population of six Cincinnati, Ohio neighborhoods. Information obtained from 2000 U.S. census data.
<table>
<thead>
<tr>
<th>Neighborhood</th>
<th>Less than 19 yrs.</th>
<th>20-24 yrs.</th>
<th>25-64 yrs.</th>
<th>Older than 65 yrs.</th>
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<tr>
<td>Bond Hill</td>
<td>2,916</td>
<td>635</td>
<td>4,792</td>
<td>1,339</td>
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<tr>
<td>Carthage</td>
<td>620</td>
<td>154</td>
<td>1,301</td>
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<td>Clifton</td>
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<td>1,069</td>
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<td>2,284</td>
<td>1,178</td>
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<td>Kennedy Heights</td>
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<tr>
<td>North Avondale</td>
<td>2,127</td>
<td>790</td>
<td>2,674</td>
<td>735</td>
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</tbody>
</table>

Table 2: Age Distribution of six communities in Cincinnati, Ohio. Information obtained from 2000 U.S. census data.
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<thead>
<tr>
<th></th>
<th>Bond Hill</th>
<th>Carthage</th>
<th>Clifton</th>
<th>Hyde Park</th>
<th>Kennedy Heights</th>
<th>North Avondale</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Family Households</strong></td>
<td>2,521</td>
<td>594</td>
<td>1,692</td>
<td>2,919</td>
<td>1,522</td>
<td>1,231</td>
</tr>
<tr>
<td>Married w/ Children</td>
<td>355</td>
<td>145</td>
<td>492</td>
<td>955</td>
<td>285</td>
<td>300</td>
</tr>
<tr>
<td>Married w/o Children</td>
<td>644</td>
<td>223</td>
<td>818</td>
<td>1,539</td>
<td>622</td>
<td>474</td>
</tr>
<tr>
<td>Female HH w/ children</td>
<td>753</td>
<td>91</td>
<td>148</td>
<td>151</td>
<td>292</td>
<td>217</td>
</tr>
<tr>
<td>Female HH w/o children</td>
<td>553</td>
<td>87</td>
<td>137</td>
<td>159</td>
<td>231</td>
<td>168</td>
</tr>
<tr>
<td><strong>Non-Family Households</strong></td>
<td>1,645</td>
<td>472</td>
<td>2,860</td>
<td>4,220</td>
<td>1,029</td>
<td>1,054</td>
</tr>
<tr>
<td>Single Person</td>
<td>1,442</td>
<td>400</td>
<td>2,299</td>
<td>3,418</td>
<td>938</td>
<td>870</td>
</tr>
<tr>
<td><strong>Total Households</strong></td>
<td>4,166</td>
<td>1,066</td>
<td>4,552</td>
<td>7,139</td>
<td>2,551</td>
<td>2,285</td>
</tr>
</tbody>
</table>

Table 3: Household types of six communities in Cincinnati, Ohio. Information obtained from 2000 U.S. census data.
<table>
<thead>
<tr>
<th>Residents Employed</th>
<th>Residents Unemployed</th>
<th>Total Labor Force</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bond Hill</td>
<td>4,176</td>
<td>301</td>
</tr>
<tr>
<td>Carthage</td>
<td>1,061</td>
<td>68</td>
</tr>
<tr>
<td>Clifton</td>
<td>4,967</td>
<td>166</td>
</tr>
<tr>
<td>Hyde Park</td>
<td>8,377</td>
<td>142</td>
</tr>
<tr>
<td>Kennedy Heights</td>
<td>2,737</td>
<td>163</td>
</tr>
<tr>
<td>N. Avondale</td>
<td>3,030</td>
<td>162</td>
</tr>
</tbody>
</table>

Table 4: Resident employment of those over 16 years old in six Cincinnati, Ohio communities. Information obtained from 2000 U.S. census data.

<table>
<thead>
<tr>
<th>Less than $10,000</th>
<th>10-$24,999</th>
<th>25-$35,999</th>
<th>35-$49,999</th>
<th>Greater than $50,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bond Hill</td>
<td>725</td>
<td>1,159</td>
<td>634</td>
<td>628</td>
</tr>
<tr>
<td>Carthage</td>
<td>154</td>
<td>324</td>
<td>191</td>
<td>173</td>
</tr>
<tr>
<td>Clifton</td>
<td>707</td>
<td>1,078</td>
<td>615</td>
<td>605</td>
</tr>
<tr>
<td>Hyde Park</td>
<td>340</td>
<td>885</td>
<td>753</td>
<td>1,254</td>
</tr>
<tr>
<td>Kennedy Hgts.</td>
<td>242</td>
<td>708</td>
<td>382</td>
<td>332</td>
</tr>
<tr>
<td>N. Avondale</td>
<td>235</td>
<td>519</td>
<td>284</td>
<td>316</td>
</tr>
</tbody>
</table>

Table 5: Income levels for six Cincinnati, Ohio communities. Information obtained from 2000 U.S. census data.

<table>
<thead>
<tr>
<th>Median Household Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cincinnati</td>
</tr>
<tr>
<td>Bond Hill</td>
</tr>
<tr>
<td>Carthage</td>
</tr>
<tr>
<td>Clifton</td>
</tr>
<tr>
<td>Hyde Park</td>
</tr>
<tr>
<td>Kennedy Heights</td>
</tr>
<tr>
<td>N. Avondale</td>
</tr>
</tbody>
</table>

Table 6: Median household income for six Cincinnati, Ohio communities. Information obtained from 2000 U.S. census data.
### Table 7: Number of people and families in six Cincinnati, Ohio communities who fell below the poverty level in 2000. Information obtained from 2000 U.S. census data.

<table>
<thead>
<tr>
<th>Community</th>
<th>Persons below Poverty Level</th>
<th>Family below Poverty Level</th>
<th>% All Persons</th>
<th>% of Families</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bond Hill</td>
<td>1999</td>
<td>495</td>
<td>21%</td>
<td>20%</td>
</tr>
<tr>
<td>Carthage</td>
<td>378</td>
<td>72</td>
<td>16%</td>
<td>12%</td>
</tr>
<tr>
<td>Clifton</td>
<td>1378</td>
<td>122</td>
<td>16%</td>
<td>7%</td>
</tr>
<tr>
<td>Hyde Park</td>
<td>631</td>
<td>52</td>
<td>5%</td>
<td>2%</td>
</tr>
<tr>
<td>Kennedy Hghts</td>
<td>456</td>
<td>102</td>
<td>2%</td>
<td>7%</td>
</tr>
<tr>
<td>N. Avondale</td>
<td>608</td>
<td>102</td>
<td>10%</td>
<td>8%</td>
</tr>
</tbody>
</table>

### Table 8: Educational levels of Residents over the age of 25 in six Cincinnati, Ohio communities. Information obtained from 2000 U.S. census data.

<table>
<thead>
<tr>
<th>Community</th>
<th>&lt;H.S.</th>
<th>H.S. Grad</th>
<th>Some College</th>
<th>Bachelor Degree or Higher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bond Hill</td>
<td>1,866</td>
<td>2,479</td>
<td>1,707</td>
<td>630</td>
</tr>
<tr>
<td>Carthage</td>
<td>572</td>
<td>526</td>
<td>359</td>
<td>150</td>
</tr>
<tr>
<td>Clifton</td>
<td>556</td>
<td>764</td>
<td>1,058</td>
<td>3,720</td>
</tr>
<tr>
<td>Hyde Park</td>
<td>414</td>
<td>827</td>
<td>1,874</td>
<td>7,097</td>
</tr>
<tr>
<td>Kennedy Heights</td>
<td>599</td>
<td>1,276</td>
<td>1,159</td>
<td>915</td>
</tr>
<tr>
<td>N. Avondale</td>
<td>500</td>
<td>654</td>
<td>1,029</td>
<td>1,258</td>
</tr>
</tbody>
</table>

### Table 9: Race distribution in six Cincinnati, Ohio communities. Information obtained from 2000 U.S. census data.

<table>
<thead>
<tr>
<th>Community</th>
<th>White</th>
<th>Black</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bond Hill</td>
<td>4%</td>
<td>93%</td>
<td>3%</td>
</tr>
<tr>
<td>Carthage</td>
<td>89%</td>
<td>9%</td>
<td>2%</td>
</tr>
<tr>
<td>Clifton</td>
<td>75%</td>
<td>15%</td>
<td>10%</td>
</tr>
<tr>
<td>Hyde Park</td>
<td>93%</td>
<td>3%</td>
<td>4%</td>
</tr>
<tr>
<td>Kennedy Heights</td>
<td>21%</td>
<td>76%</td>
<td>3%</td>
</tr>
<tr>
<td>N. Avondale</td>
<td>45%</td>
<td>52%</td>
<td>3%</td>
</tr>
</tbody>
</table>
Figure 1: Typical Bond Hill property. Winter picture #1 February 25, 2006.
Figure 2: Typical Bond Hill property. Summer picture #1 September, 20 2006.
Figure 3: Typical Bond Hill property. Winter picture #2 February 25, 2006.
Figure 4: Typical Bond Hill property. Summer picture #2 September 19, 2006.
Figure 5: Typical Carthage property. Winter picture #1 March 5, 2006.
Figure 6: Typical Carthage property. Summer picture #1 September 14, 2006.
Figure 7: Typical Carthage property. Winter picture #2 March 5, 2006.
Figure 8: Typical Carthage property. Summer picture #2 September 14, 2006.
Figure 9: Typical Clifton property. Winter picture #1 March 26, 2006.
Figure 10: Typical Clifton property. Summer picture #1 September 18, 2006.
Figure 11: Typical Clifton property. Winter picture #2 March 26, 2006.
Figure 12: Typical Clifton property. Summer picture #2 September 18, 2006.
Figure 13: Typical Hyde Park property. Winter picture #1 March 26, 2006.
Figure 14: Typical Hyde Park property. Summer picture #1 September 10, 2006.
Figure 15: Typical Hyde Park property. Winter picture #2 March 17, 2006.
Figure 16: Typical Hyde Park property. Summer picture #2 September 10, 2006.
Figure 17: Typical Kennedy Heights property. Winter picture #1 March 17, 2006.
Figure 18: Typical Kennedy Heights property. Summer picture #1 September 20, 2006.
Figure 19: Typical Kennedy Heights property. Winter picture #2 March 17, 2006.
Figure 20: Typical Kennedy Heights property. Summer picture #2 September 20, 2006.
Figure 21: Typical North Avondale property. Winter picture #1 March 25, 2006.
Figure 22: Typical North Avondale property. Summer picture #1 September 20, 2006.
Figure 23: Typical North Avondale property. Winter picture #2 March 25, 2006.
Figure 24: Typical North Avondale property. Summer picture #2 September 24, 2006.
**Winter Results.** The six hundred properties, 100 from each of the six communities, were first evaluated in the winter of 2005-2006. Data obtained from the Hamilton County tax assessor records on the real estate transactions and property characteristics of each transaction as well as the data collected from the on site inspection were analyzed using regression analysis. The following property characteristics were selected as the explanatory variables:

- Sale date: closing sale date in days
- Square footage: size of living space in square feet
- Number of acres: lot size in acres
- Number of bedrooms
- Style height: one story or two story
- Year built: house age in years
- Baths: assigned 1 point for a whole bath and .5 point for a half bath
- Cover: estimated percentage of tree cover
- Hyde Park
- Kennedy Heights
- Clifton
- Carthage
- North Avondale

The community of Bond Hill was held constant while the other five communities, Hyde Park, Kennedy Heights, Clifton, Carthage and North Avondale were variables in the model. (Table 10) This allowed a comparison of the differences in the communities as compared to Bond Hill.
In developing the model it was found that tree cover and the impact rating were closely correlated. When using both variables in the same model tree cover lost its significance. The model was run using both tree cover and the impact rating separately and each was found to be significant if used by itself. Both models had the same $R^2$ value and since the impact rating is a subjective variable, tree cover was chosen for the model.

The set of explanatory variables accounts for 68% ($R^2 = 0.681$) of the variation in housing price ($P \leq 0.05$) (Table 10). The $t$-values indicate that the Hyde Park variable had the greatest explanatory power with the Clifton variable following second in explanatory power (Table 10). Number of acres, living square footage, total number of baths, sales date, tree cover and year built had the remainder of the explanatory power, listed in rank order. All coefficient signs are positive which is as expected. From analysis of the data it was found that:

- If a house was located in Hyde Park, sale price would be significantly more than a comparable house in Bond Hill.
- If a house was located in Clifton, sale price would be significantly more than a comparable house in Bond Hill.
- As the size of the lot increased so did the sale price.
- As the square footage of the house increase so did the sale price.
- As the number of baths increased so did the sale price.
- Sale date had an effect on sale price. Houses that sold more recently sold for a higher price than properties that sold earlier.
- Tree cover had a positive effect on sale price.
• The year the house was built had an effect on sale price. Newer houses sold for a higher price than older houses.

The number of bedrooms and the style height variable were not significant in influencing the sales price. If the number of bedrooms had a significant positive effect it would have been interpreted as an increase in the number of bedrooms increased the sales price of the home. One possible reason for this may be by increasing the number of bedrooms while the square footage remained the same, the size of the bedrooms would become smaller. If the style height variable was found to be negatively significant then houses with two stories would be worth less than single story houses given they had the same square footage. The other three neighborhoods, Kennedy Heights, Carthage and North Avondale, were not significantly different from the constant, Bond Hill.

According to the coefficients obtained from this model the following can be said about the monetary effect of each variable:

• Each additional square foot of living space increases the price by $37.
• Each additional acre of land increases the price by $170,457.
• Each additional bathroom increases the price by $30,328.
• For every later day of sale the price increases by $12.
• Each additional percentage of tree cover increases the sale price by $561.
• For every later year a house was built the price increases by $481.
• Houses in Hyde Park are worth $161,315 more than Bond Hill.
• Houses in Clifton are worth $95,447 more than Bond Hill.
Results of this research indicate that living in Hyde Park or Clifton has the largest impact on the price of a home. Analysis also shows an increase of $170,457 for each additional acre, but since most of the properties studied are on small urban lots the value of the land, although still an important factor influencing price, is typically only a fraction of that amount. Results also indicate that tree cover has a significant positive effect on home values in the six communities studied. The average effect of tree canopy across all communities indicates an increase of $561 per one percent increase in tree cover. The mean property value for the 600 sites studied was $166,357 while the mean percentage of tree cover was 24.8. This indicates that the average value of tree canopy is $13,913 or 8.4% of the sale price of the home. These results are in line with previous findings. Morales found that good tree cover in Manchester, Connecticut increased property values by six percent (Morales, 1980) while tree cover in Austin, Texas increased property values as much as 19% (Martin et al, 1989).
Variable | Coefficient | t-ratio | P-Value
--- | --- | --- | ---
Sale Date | 12.35 | 3.20 | 0.0015
Square Footage | 37.11 | 6.28 | <.0001
# Acres | 170457.00 | 7.35 | <.0001
# Bedrooms | 4298.29 | 1.07 | 0.2860
Style Height | -10708.00 | -1.22 | 0.2244
Year Built | 481.47 | 2.75 | 0.0062
Total Baths | 30328.00 | 5.52 | <.0001
Cover | 561.20 | 2.91 | 0.0037
Hyde Park | 161315.00 | 13.89 | <.0001
Kennedy Heights | -1561.78 | -0.14 | 0.8918
Clifton | 95447.00 | 7.78 | <.0001
Carthage | 308.01 | 0.03 | 0.9793
North Avondale | 6789.17 | 0.54 | 0.5880

$R^2 = 0.681$, adjusted $R^2 = 0.674$, $F$-value = 96.29, n = 600

Table 10: Results of the analysis of the winter data. Data collected winter 2005-06 in the Cincinnati, Ohio communities of Bond Hill, Carthage, Clifton, Hyde Park, Kennedy Heights and North Avondale.
**Summer Results.** A repeat evaluation of the six hundred properties was conducted in the late spring and summer of 2006 when the tree canopy was in full cover. Again trees were counted, estimates of canopy cover and evaluation of dominant genus was noted. Properties were rated for landscape impact and maintenance and given a score of 1-5 with 5 being the best for each of these evaluations. Caliper size of the dominant genus was also obtained. The following property characteristics were selected as the explanatory variables for the summer analysis:

- Sale date: closing sale date in days
- Square footage: size of living space in square feet
- Number of acres: lot size in acres
- Style height: one story or two story
- Total rooms: number of rooms including bedrooms and other indoor living space
- Year built: house age in years
- Baths: assigned 1 point for a whole bath and .5 point for a half bath
- Cover: estimate percentage of tree cover

- Hyde Park
- Kennedy Heights
- Clifton
- Carthage
- North Avondale

The community of Bond Hill was held constant while the other five communities, Hyde Park, Kennedy Heights, Clifton, Carthage, and North Avondale were variables in the model (Table 11).
The set of explanatory variables accounts for 68% (R² = 0.681) of the variation in housing price (P ≤ 0.05) (Table 11). The t-values from the summer data also indicate that the Hyde Park variable had the greatest explanatory power. The Clifton variable had the second highest explanatory variable followed by living square footage, number of acres, total number of baths, sale date, tree cover and year built in that order. The coefficient signs of all significant variables were positive, as expected. From the analysis of the summer data it was found that:

- If a house was located in Hyde Park, sale price would be significantly more than a comparable house in Bond Hill.
- If a house was located in Clifton, sale price would be significantly more than a comparable house in Bond Hill.
- As the square footage of the house increased so did the sale price.
- As the size of the lot increased so did the sale price.
- As the number of baths increased so did the sale price.
- Sale date had an effect on sale price. Houses that sold more recently sold for a higher price than properties that sold earlier.
- Tree cover had a positive effect on sale price. As the percentage of canopy increased so did the sale price.
- The year the house was built had an effect on sale price. Newer houses sold for a higher price than older houses.

The total number of rooms and the style height were not significant in influencing property values. Kennedy Height, Carthage and North Avondale were not significantly different than the neighborhood held constant, Bond Hill.
According to the coefficients from the summer data analysis the following can be said about the monetary effect of each variable:

- Each additional square foot of living space increases the price by $45.
- Each additional acre of land increases the price by $159,457.
- Each additional bathroom increases the price by $34,512.
- For every later date of sale the price increases by $12.
- Each additional percentage of tree cover increases the sale price by $581.
- For every later year a house was built the price increases $450.
- Houses in Hyde Park are worth $162,410 more than Bond Hill.
- Houses in Clifton are worth $99,023 more than Bond Hill.

Summer results were very similar to the winter results with location of the property being the most important factor in determining sales price. Living in Hyde Park or Clifton has a large impact in determining the sales price of a home. The living square footage and the size of the lot also have a significant effect on price. The summer results indicated that the price per foot was seven dollars lower than winter results and the cost per acre was $11,000 higher than winter data. Winter analysis found the number of bedrooms was the best fit while summer analysis used the total number of rooms as the best fit. This may account for the differences in these results.

As with the winter results, summer results indicate that tree canopy is important to home buyers in these communities. The average effect of tree canopy across all communities indicates that for each percentage increase of tree cover, sales price increased by $580.92. The mean property value for the 600 sites analyzed was $166,357, while the mean percentage of tree cover was 27.1%. This indicates that the average value
of tree canopy across the 600 properties was $15,743 or 9.5% of the sale price of the home.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>t-ratio</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sale Date</td>
<td>12.11</td>
<td>3.13</td>
<td>0.0018</td>
</tr>
<tr>
<td>Square Footage</td>
<td>44.67</td>
<td>6.75</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td># Acres</td>
<td>159457.00</td>
<td>6.60</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Style Height</td>
<td>-6655.40</td>
<td>-0.76</td>
<td>0.4495</td>
</tr>
<tr>
<td>Total Rooms</td>
<td>-4261.16</td>
<td>-1.72</td>
<td>0.0851</td>
</tr>
<tr>
<td>Year Built</td>
<td>450.33</td>
<td>2.56</td>
<td>0.0106</td>
</tr>
<tr>
<td>Total Baths</td>
<td>34512.00</td>
<td>6.17</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Cover</td>
<td>580.92</td>
<td>2.60</td>
<td>0.0096</td>
</tr>
<tr>
<td>Hyde Park</td>
<td>162410.00</td>
<td>13.93</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Kennedy Heights</td>
<td>3900.08</td>
<td>0.34</td>
<td>0.7333</td>
</tr>
<tr>
<td>Clifton</td>
<td>99023.00</td>
<td>8.05</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Carthage</td>
<td>-2038.77</td>
<td>-0.17</td>
<td>0.8636</td>
</tr>
<tr>
<td>North Avondale</td>
<td>12360.00</td>
<td>0.98</td>
<td>0.3265</td>
</tr>
</tbody>
</table>

$R^2 = 0.681$, adjusted $R^2 = 0.674$, $F$-value = 96.40, $n = 600$

Table 11: Results of the analysis of summer data. Data collected in summer 2006 in the Cincinnati, Ohio communities of Bond Hill, Carthage, Clifton, Hyde Park, Kennedy Heights and North Avondale.

**Home Price Index.** The property transactions selected for this research occurred over a five year period, between 2000 and 2005. Since this was a relatively short period of time it was felt that adjustments for inflation would probably not significantly affect the findings. To test this hypothesis, sale prices were adjusted to the terms of the Home Price Index for the Cincinnati Metropolitan Statistical Area (MSA). All home sale prices were adjusted to third quarter 2007 terms. The remainder of the paper will be analyzed using 2007 prices.
**Combined evaluations.** The decision to purchase a property is often decided a number of weeks ahead of the actual closing date. It takes time to secure financing, have property inspections and possibly sell another house. The average length of time between contract signing and the actual closing date is approximately 45-60 days (Abele, 2008). In order to determine if this had an influence on the significance of tree cover both the winter data and the summer data were combined and 60 days was subtracted from the actual closing date. If this date fell between November 1st and April 30th the contract date was considered winter. If the date fell between May 1st and October 31st it was considered a summer contract. Since two sets of data were collected for each property the set of data that did not fall into the actual contract signing time was dropped from the analysis so the total number of observations remained 600 properties. The explanatory variables chosen for the analysis of the combined evaluations included:

- Sale date: sale date minus 60 days
- Square footage: size of living space in square feet
- Number of acres: lot size in acres
- Number of bedrooms
- Style height: one story or two story
- Year built: house age in years
- Baths: assigned 1 point for a whole bath and .5 point for a half bath
- Cover: estimated percentage of tree cover in summer
- Cover-winter: estimated percentage of tree cover in winter
- Hyde Park
- Kennedy Heights
• Clifton
• Carthage
• North Avondale

The cover variable represents the summer sold houses. The winter sold houses are represented by the cover-winter variable plus the cover variable. The cover-winter variable is an adjustment to the baseline which is summer cover. The community of Bond Hill was held constant while the remainder of the communities were used as variables in the model.

The set of explanatory variables accounts for 69% ($R^2 = 0.686$) of the variation in sale price of the properties ($P \leq 0.05$) (Table 12). The $t$-values indicate that the Hyde Park variable had the greatest explanatory power followed by the Clifton variable. The remainder of the significant variables in rank order included number of acres, living square footage, total number of baths, summer tree cover and year built. The coefficient sign for all significant variables was positive. From analysis of the combination summer/winter evaluation it was found that:

• If a house was located in Hyde Park, sale price would be significantly more than a comparable house in Bond Hill.
• If a house was located in Clifton, sale price would be significantly more than a comparable house in Bond Hill.
• As the size of the lot increased so did the sale price.
• As the living square footage increased so did the sale price.
• As the number of baths increased so did the sale price.
• Tree canopy had a positive effect on sale price. As the percentage of canopy increased so did the sale price.

• The year the house was built had an effect on sale price. Newer prices sold for more than older ones.

Sale date, number of bedrooms, style height, Kennedy Heights, Carthage, North Avondale and the cover winter adjustment were not significant. Analysis found that the effect of tree cover for summer sales was an increase in sale price of $783.98 per one percent of tree cover. The winter sales adjustment was -$111.27 per one percent of tree cover. This adjustment would be interpreted as one percent of tree cover adds $672.71 ($783.98 - $111.27 = $672.71) to the winter sale price but the cover winter variable was not significant.

According to the coefficients of the combination data the following can be said about the monetary effect of each variable:

• Each additional square foot of living space increases the price by $41.

• Each additional acre of land increases the price by $190,977.

• For every later year a house was built the price increases by $583.

• Each additional bath increases the price by $33,210.

• Each additional percentage of tree cover increases sale price by $784.

• Houses in Hyde Park are worth $183,574 more than Bond Hill.

• Houses in Clifton are worth $109,657 more than Bond hill.

Analysis of the combination of summer and winter data yielded similar results as the two sets of data analyzed separately. Homes located in Hyde Park and Clifton had the greatest influence on sale price. Number of baths, size of the lot, number of square feet,
the year the house was built and tree cover all have a positive influence on sale price. The effects of winter and summer cover were not significantly different from one another. There may be a slight tendency for tree cover to add less value during the winter months but it is a weak effect at best. This analysis used the estimated contract signing instead of the actual closing date to assess any differences in summer verses winter sales. The contract signing is the actual time when a decision is made to purchase a property.

The average effect of tree canopy across all six communities was an increase of $783.98 per one percent increase in tree cover. The mean sale price across the 600 sites was $188,730 with the mean canopy cover of 25.8%. This indicates the average value of tree canopy is $20,226 or 10.7% of the sale price of the home. All monetary values in this model are reflected in 2007 prices. Again this value is consistent with previous findings.
Table 12: Results of the analysis of the combination of summer and winter data. Data collected in 2005-2006 in the Cincinnati, Ohio communities of Bond Hill, Carthage, Clifton, Hyde Park, Kennedy Heights and North Avondale.
**Testing for quadratic effects.** A model was developed to determine if there was significant concavity to the effect of tree cover on sale price. If the model indicated a quadratic relationship the optimal percentage of tree cover could be determined. The following variables were included in this model:

- Sale date: closing sale date in days
- Square footage: size of living space in square feet
- Number of acres: lot size in acres
- Number of bedrooms
- Style height: one story or two story
- Year built: house age in years
- Year built squared: test for quadratic effect of house age
- Baths: assigned 1 point for a whole bath and .5 point for a half bath
- Cover: estimated percentage of tree cover
- Tree cover squared: test for quadratic effect of tree cover
- Hyde Park
- Kennedy Heights
- Clifton
- Carthage
- North Avondale

This model indicates that there does not seem to be significant concavity to the effects of tree cover (Table 13.). The explanatory variables account for 69% ($R^2 = 0.686$) of the variation in this model ($P \leq 0.05$) (Table 13). Living square footage, number of acres, total number of baths along with the two communities, Hyde Park and Clifton were found
to be significant in determining sales price. The year built was also insignificant for concave effects. The relationship between tree cover and sales price appears to be approximately linear. There does not seem to be an optimal percentage of tree cover.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>t-ratio</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sale Date</td>
<td>1.36</td>
<td>0.32</td>
<td>0.7481</td>
</tr>
<tr>
<td>Square Footage</td>
<td>41.40</td>
<td>6.38</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td># Acres</td>
<td>191349.00</td>
<td>7.44</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td># Bedrooms</td>
<td>4640.82</td>
<td>1.05</td>
<td>0.2939</td>
</tr>
<tr>
<td>Style Height</td>
<td>-9453.68</td>
<td>-0.98</td>
<td>0.3283</td>
</tr>
<tr>
<td>Year Built</td>
<td>14618.00</td>
<td>0.76</td>
<td>0.4468</td>
</tr>
<tr>
<td>Year Built 2</td>
<td>-3.62</td>
<td>-0.73</td>
<td>0.4650</td>
</tr>
<tr>
<td>Total Baths</td>
<td>33800.00</td>
<td>5.59</td>
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</tr>
<tr>
<td>Cover</td>
<td>634.77</td>
<td>0.90</td>
<td>0.3700</td>
</tr>
<tr>
<td>Cover 2</td>
<td>1.03</td>
<td>0.10</td>
<td>0.9180</td>
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<tr>
<td>Hyde Park</td>
<td>184551.00</td>
<td>14.40</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Kennedy Heights</td>
<td>402.29</td>
<td>0.03</td>
<td>0.9745</td>
</tr>
<tr>
<td>Clifton</td>
<td>111461.00</td>
<td>8.18</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Carthage</td>
<td>1131.09</td>
<td>0.08</td>
<td>0.9360</td>
</tr>
<tr>
<td>North Avondale</td>
<td>10511.00</td>
<td>0.76</td>
<td>0.4452</td>
</tr>
</tbody>
</table>

$R^2 = 0.686$, adjusted $R^2 = 0.678$, $F$-value = 85.07, $n = 600$

Table 13: Results of the analysis of quadratic effects
Evergreen versus deciduous. Previous research has indicated that homeowners do not seem to have a preference for evergreen species over deciduous species of trees (Anderson and Cordell, 1985). In order to determine if this was the case in the six communities studied, a model was developed to test for these preferences. Dominant genus information was collected during the on site property inspections. For use in the analysis, dominant deciduous trees were indicated with the number zero while dominant evergreen trees were indicated by the number one. The explanatory variables utilized in this model were as follows:

- Sale date: closing sale date in days
- Square footage: size of living space in square feet
- Number of acres: lot size in acres
- Number of bedrooms
- Style height: one story or two story
- Year built: house age in years
- Baths: assigned 1 point for a whole bath and .5 point for a half bath
- Cover: estimated percentage of tree cover
- Deciduous versus evergreen: assigned 0 for deciduous dominant genus and 1 for evergreen dominant genus
- Hyde Park
- Kennedy Heights
- Clifton
- Carthage
- North Avondale
Analysis of the research does not indicate a preference for either deciduous or evergreen trees over the other group. The set of explanatory variables accounted for 69% ($R^2 = 0.685$) of the variation in this model (Table 14). Consistent with the previous models, living in Hyde Park and Clifton have the greatest influence on sale price. The deciduous versus evergreen variable was found to be insignificant. These findings are consistent with previous research. Tree cover has been found to be important to the residents of the six Cincinnati communities but research indicates that they are not particular to the type of tree providing that cover.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>t-ratio</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sale Date</td>
<td>1.68</td>
<td>0.38</td>
<td>0.7038</td>
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<tr>
<td>Square Footage</td>
<td>40.02</td>
<td>6.04</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td># Acres</td>
<td>190337.00</td>
<td>7.34</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td># Bedrooms</td>
<td>4878.77</td>
<td>1.08</td>
<td>0.2805</td>
</tr>
<tr>
<td>Style Height</td>
<td>-9165.72</td>
<td>-0.93</td>
<td>0.3551</td>
</tr>
<tr>
<td>Year Built</td>
<td>558.50</td>
<td>2.81</td>
<td>0.0052</td>
</tr>
<tr>
<td>Total Baths</td>
<td>33506.00</td>
<td>5.44</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Cover</td>
<td>746.31</td>
<td>3.10</td>
<td>0.0021</td>
</tr>
<tr>
<td>Deciduous/Evergreen</td>
<td>-840.86</td>
<td>-0.09</td>
<td>0.9283</td>
</tr>
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<td>Hyde Park</td>
<td>186087.00</td>
<td>14.21</td>
<td>&lt;.0001</td>
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<tr>
<td>Kennedy Heights</td>
<td>886.95</td>
<td>0.07</td>
<td>0.9449</td>
</tr>
<tr>
<td>Clifton</td>
<td>115042.00</td>
<td>8.27</td>
<td>&lt;.0001</td>
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<tr>
<td>Carthage</td>
<td>-3027.30</td>
<td>-0.22</td>
<td>0.8232</td>
</tr>
<tr>
<td>North Avondale</td>
<td>12556.00</td>
<td>0.90</td>
<td>0.3709</td>
</tr>
</tbody>
</table>

$R^2 = 0.686$, adjusted $R^2 = 0.678$, $F$-value = 88.45, $n = 600$

Table 14: Results of the analysis of evergreen vs. deciduous trees on property values of the Cincinnati, Ohio communities of Bond Hill, Carthage, Clifton, Hyde Park and North Avondale.
**Genus.** Research has determined that people have preferences for tree size (Kalmbach and Kielbaso, 1979; Hitchmough and Bonugli, 1997; Heimlich 2008) and tree shape (Sommer and Summit 1996; Sommer 1997). Italian and Portuguese immigrants to North America were found to have preferences for fruit tree species (Fraser and Kenney, 2000). In the interest of determining if citizens of the six Cincinnati communities had a preference for tree genera, a model was developed to assess their preferences.

During the on site inspection dominant genus was noted for each of the 600 properties. Over 40 different genera of trees were found to be dominant on the 600 properties. Although there were many genera some were very common while others were only noted on a few properties. The six top genera were chosen as they represented the majority of trees in the communities and it was thought that using genera with only a few properties represented would not be a valid assessment of preferences. The following were the top six genera and the quantities noted:
**Table 15**: Six most common dominant genera for the combination summer/winter analysis with quantities noted.

Analysis indicated that the tree genus was not important to property owners in the communities studied (Table 16). The model captured 69% ($R^2 = 0.688$) of the variation in sales price ($P \leq 0.05$) (Table 16). All six genera were not found to be significant. Residents of these six communities are willing to pay for trees on the property but do not seem to have a preference for a specific type of tree. Most home owners are probably not knowledgeable of the specific qualities of the various trees so to them a tree is a tree whether it is a large shade tree or a small flowering tree.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>t-ratio</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sale Date</td>
<td>0.56</td>
<td>0.13</td>
<td>0.8959</td>
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<tr>
<td>Square Footage</td>
<td>40.60</td>
<td>6.21</td>
<td>&lt;.0001</td>
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<tr>
<td># Acres</td>
<td>194558.00</td>
<td>7.57</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td># Bedrooms</td>
<td>3747.56</td>
<td>0.84</td>
<td>0.4009</td>
</tr>
<tr>
<td>Style Height</td>
<td>-9825.98</td>
<td>-1.01</td>
<td>0.3122</td>
</tr>
<tr>
<td>Year Built</td>
<td>515.52</td>
<td>2.63</td>
<td>0.0087</td>
</tr>
<tr>
<td>Total Baths</td>
<td>33653.00</td>
<td>5.60</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Cover</td>
<td>750.33</td>
<td>3.13</td>
<td>0.0018</td>
</tr>
<tr>
<td>Maple</td>
<td>-6470.45</td>
<td>-0.64</td>
<td>0.5221</td>
</tr>
<tr>
<td>Oak</td>
<td>9334.83</td>
<td>0.86</td>
<td>0.3916</td>
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<tr>
<td>Spruce</td>
<td>-8943.75</td>
<td>-0.69</td>
<td>0.4900</td>
</tr>
<tr>
<td>Pine</td>
<td>768.06</td>
<td>0.04</td>
<td>0.9641</td>
</tr>
<tr>
<td>Crabapple</td>
<td>28081.00</td>
<td>1.53</td>
<td>0.1260</td>
</tr>
<tr>
<td>Pear</td>
<td>3484.95</td>
<td>0.21</td>
<td>0.8354</td>
</tr>
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<td>Hyde Park</td>
<td>181083.00</td>
<td>14.10</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Kennedy Heights</td>
<td>-700.57</td>
<td>-0.06</td>
<td>0.9556</td>
</tr>
<tr>
<td>Clifton</td>
<td>107132.00</td>
<td>7.86</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Carthage</td>
<td>-5735.84</td>
<td>-0.43</td>
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</tr>
<tr>
<td>North Avondale</td>
<td>10700.00</td>
<td>0.77</td>
<td>0.4408</td>
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</tbody>
</table>

$R^2 = 0.689$, adjusted $R^2 = 0.678$, $F$-value = 67.49, $n = 600$

Table 16: Results of the analysis of tree genus on property values of the Cincinnati, Ohio communities of Bond Hill, Carthage, Clifton, Hyde Park and North Avondale.
**Neighborhoods.** The six neighborhoods, Bond Hill, Carthage, Clifton, Hyde Park, Kennedy Heights and North Avondale vary from one another demographically. Hyde Park is the most affluent with a median household income of $59,541 while Carthage has the lowest median household income with $27,364 (Table 6). Hyde Park also ranks number one in college education with 69.5% of its residents having a Bachelor’s Degree or higher (Table 8). Carthage ranks lowest in college education with only nine percent of its residents receiving a four year degree (Table 8). With differences in education, income and household family status there is likely to be differences in attitudes about trees. A model was developed to determine if these six neighborhoods varied significantly in their willingness to pay for trees (Table 17).

As in previous models, living in Hyde Park and Clifton are important in determining the sale price of a property (Table 17). The explanatory variables in this model explained 70% of the variation in price ($R^2 = 0.697$) ($P \leq 0.05$) (Table 17). Lot size, living square footage, number of baths and the year the home was built were also found to be significant.

Tree cover seems to be valued more in Hyde Park and North Avondale where it had a significant effect on property values (Table 17). The $P$ value for cover in Clifton was 0.118 which may indicate that cover has a weak effect in determining sale price in this community. The cover effect in Bond Hill, which was the constant, Carthage and Kennedy Heights is very close to zero and may have a slightly negative effect on sale price.

The two top median income communities in this study are Hyde Park and North Avondale (Table 6). Hyde Park and Clifton are the two best educated communities in the
study (Table 8). As we examine the effects of tree cover on sale price, income and educational levels may play a part in a person’s willingness to pay for trees. A person who can afford the costs associated with tree planting and maintenance may be more likely to look at trees as an asset. This person may be willing to pay extra for a property with trees. As I was conducting my research I spoke with a couple of people in Bond Hill and Carthage. One woman, who happened to have three very beautiful mature oaks on her property, told me I could cut them down if I needed them for my research. She was tired of raking and cleaning up the acorns. A gentleman in Carthage asked me if I could cut down his tree because he did not want to pick up tree litter anymore. These people probably could not afford to have a maintenance crew care for their trees and looked at them more as a burden than an asset.
<table>
<thead>
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<th>Variable</th>
<th>Coefficient</th>
<th>t-ratio</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
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<td>Sale Date</td>
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<td>0.7557</td>
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<td>Square Footage</td>
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<td>6.60</td>
<td>&lt;.0001</td>
</tr>
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<td># Acres</td>
<td>176772.00</td>
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<td># Bedrooms</td>
<td>5062.71</td>
<td>1.17</td>
<td>0.2444</td>
</tr>
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<td>Style Height</td>
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<td>-0.68</td>
<td>0.4955</td>
</tr>
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<td>Year Built</td>
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<td>2.90</td>
<td>0.0038</td>
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<tr>
<td>Total Baths</td>
<td>31722.00</td>
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<td>&lt;.0001</td>
</tr>
<tr>
<td>Cover</td>
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<td>Hyde Park Cover</td>
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<td>Kennedy Heights Cover</td>
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<td>Carthage Cover</td>
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<td>North Avondale Cover</td>
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<td>Hyde Park</td>
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<td>6.06</td>
<td>&lt;.0001</td>
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<td>Kennedy Heights</td>
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<td>Clifton</td>
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<td>3.45</td>
<td>0.0006</td>
</tr>
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<td>Carthage</td>
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<tr>
<td>North Avondale</td>
<td>-56953.00</td>
<td>-2.45</td>
<td>0.0147</td>
</tr>
</tbody>
</table>

\( R^2 = 0.698, \text{ adjusted } R^2 = 0.689, F\text{-value} = 74.58, n = 600 \)

Table 17: Results of the analysis of the effect of neighborhood tree cover on the property values of the Cincinnati, Ohio communities of Bond Hill, Carthage, Clifton, Hyde Park, Kennedy Heights and North Avondale
CHAPTER 5

SUMMARY

Results of this research indicate that tree cover has a positive monetary effect on the sale price of homes in the six Cincinnati, Ohio communities studied. From the coefficients derived from the analysis it was estimated that the average value of tree canopy is $20,226 or 10.7% of the total sale price of the homes observed.

Location of the home in either Hyde Park or Clifton had the most significant effects in determining sale price. Square footage, lot size, number of baths and year built are also important factors in determining sale price.

Analysis of summer and winter data as well as the combination summer/winter data determined that time of year was not an important factor influencing a buyers’ willingness to pay for trees. Tree cover is important to property owners whether they are purchasing a home in the summer or the winter season. Analysis of the combination summer/winter data utilized the approximate date the contract to purchase the property was signed and not the actual closing date of the sale. This was determined by counting back sixty days from closing as determined by the Multiple Listing Service of Cincinnati, Ohio. This method allowed an analysis of the time the actual decision was made to purchase the property and not the closing date.
A model was developed to determine if there was an optimum amount of tree cover. Analysis indicated that the quadratic effect of tree cover was not significant and that the relationship between tree cover and sale price is approximately linear. There does not appear to be an optimal percentage of tree cover.

Previous research has indicated that homeowners do not seem to have a preference for evergreen species over deciduous species of visa versa (Anderson and Cordell, 1985). Analysis of the six Cincinnati communities found similar findings. Homeowners in these communities do not seem to have a preference for either evergreen or deciduous species.

Some studies have indicated that property owners may have a preference for one species of tree over another. Research conducted in Scotland concluded that residence preferred smaller trees (Hitchmough and Bonugli, 1997). A study conducted in southwest England found a preference towards smaller trees with a slower growth rate (Schroeder et al., 2006). Analysis of the six Cincinnati communities studied determined that residents do not seem to have a preference for one species of tree over another.

The six communities studied, Bond Hill, Carthage, Clifton, Hyde Park, Kennedy Heights and North Avondale vary from one another demographically. Hyde Park is the most affluent with a median household income of $59,541 while Carthage has the lowest household median income with $27,364 (Table 6). Differences also exist in other demographic areas such as household family status, education, age and unemployment. Demographic differences may affect a person’s attitude towards trees. A study of North
American immigrants found that differences in cultural background played an important role in perception of the urban forest (Fraser and Kenney, 2000).

Results of this study found differences among the communities with respect to the value placed on trees. Tree cover seems to be valued more in Hyde Park and North Avondale where it had a significant effect on property values. These two communities also had the highest household median income, $59,541 and $39,297 respectively. Results of the analysis may also indicate that tree cover has a weak effect on property values in Clifton. Although the median household income of Clifton is $32,548 this number may be skewed downward due to the fact that the University of Cincinnati is located in Clifton. Clifton is home to many students which may affect median income values.

Tree cover was not significant in the communities of Bond Hill, Carthage and Kennedy Heights. The income level of these three communities was lower than that of Hyde Park and North Avondale. Homes in these communities are smaller while many of the homes in Hyde Park and Clifton are larger with beautiful architecture. Financial factors may play a role in determining a willingness to pay for treed property.

Trees have a positive effect on property values in the Cincinnati communities studied. This is particularly true for the communities of Hyde Park, North Avondale and Clifton. These findings may provide useful information to urban forestry departments in the Cincinnati area as well as other regions of the country in their requests for funding to support new tree plantings and maintain existing trees. The results may also encourage home owners to plant trees on their property and provide financial support as well as volunteer hours to community forestry projects. As homeowners are made aware of the
positive impact of trees on the environment and property values we may find that they will become more involved in forestry projects throughout their community.
APPENDIX A

MAP

Map of Cincinnati Communities Studied
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