AN EXAMINATION OF THE POTENTIAL RELATIONSHIP BETWEEN GREEN STATUS AND PRICE: PERSPECTIVES FOR THE MULTIFAMILY SECTOR

by

COLIN GREGORY COUCH

(Under the Direction of Andrew T. Carswell)

ABSTRACT

This study investigates whether a relationship exists among sale price and green building status for multifamily properties located in Chicago, Illinois; New York, New York; Portland, Oregon; and Seattle, Washington. It is hypothesized that Leadership in Energy and Environmental Design (LEED) certification will have a positive relationship with sale price when compared to non-green multifamily properties, *ceteris paribus*. Data are analyzed from Chicago, New York, Portland, and Seattle, primarily because these cities contain the greatest number of green multifamily properties within the CoStar database. The sample for this project is drawn from a collection of 25 green multifamily properties and 111 non-green multifamily properties. Using analysis of variance (ANOVA) and multiple regression to examine the sample of 136 multifamily properties, results of the study indicate that there is not a significant positive relationship between LEED certification and sale price for multifamily properties in Chicago, New York, Portland, and Seattle.

INDEX WORDS: LEED Certification, Multifamily Properties, Green Building

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Dedication

I dedicate this thesis to the late Gregory Stevens Couch and Laurel Anne Hoover, two individuals who have greatly influenced my life.

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Chapter 1

Introduction

Sustainable development can be defined as "[…] development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland Report, 1987, p. 43). This study investigates whether a relationship exists among sale price and green building status for multifamily properties in Chicago, New York, Portland, and Seattle. Few studies have examined this potential relationship, and further research is necessary in order to develop an understanding of Leadership in Energy and Environmental Design (LEED) certification's possible relationship with sale price. It is important for sellers and buyers of green multifamily properties to be knowledgeable of any relationship that may exist among sale price and green status for multifamily properties. Within the study, implications for sellers and buyers are addressed.

Green building affects the environment as well as one's health and productivity. The purpose of green building is to produce healthier living and working atmospheres by reducing the environmental footprint of structures, which is a concern for select members of society (Pitts & Jackson, 2008). Sustainable buildings protect particular resources, i.e., water, land, and energy, more so than buildings built to standard code. This type of sustainable building can potentially add value to the structure.

This study is structured as follows: Chapter 2, the review of literature, will summarize existing research pertaining to green building among commercial developers. In Chapter 3, the methodology will be presented and explained. Chapter 4 will cover the results of the study. Finally, Chapter 5 will present the discussion and implications of the research.

Problem Statement

If sellers and buyers from the multifamily property sector do not gain an understanding of the potential relationship between LEED certification and sale price, an inefficient market has the potential to exist. It is important for sellers of green multifamily properties to have a thorough understanding of LEED certification's potential relationship with sale price. If data indicate that LEED certification raises sale price, sellers may have reason to increase listing prices for LEED certified multifamily properties. If sellers of green multifamily buildings overestimate the pricing of green multifamily properties relative to non-green multifamily properties, it is likely these properties will have a longer marketing time. Conversely, if sellers of green multifamily buildings underestimate pricing, it is likely these properties will have a shorter marketing time and a depreciated return on the investment. It is important to note that marketing time has implications on the opportunity cost of the investment; e.g., if a seller is unable to liquidate their asset, then he or she will be unable to invest that money in other methods.

It is imperative for buyers of green multifamily properties to understand the value LEED certification may or may not add to a property. If a relationship exists among sale price and LEED status for multifamily properties, buyers should gain knowledge of this association in order to make educated housing decisions. Buyers may one day become sellers, and it is critical that sellers understand their products in order to successfully sell. More specific research is necessary in order to better understand the potential relationship between LEED certification and sale price for multifamily properties.

Purpose of the Study

Green multifamily development is an escalating trend, possibly bearing incentives for sellers and buyers alike. Identifying a possible association between LEED certification and sale price is essential in order for sellers and buyers to make educated decisions based on green status. The purpose of this study is to determine if a relationship exists between green building status and sale price for multifamily properties located in Chicago, Illinois; New York, New York; Portland, Oregon; and Seattle, Washington. This study will inform whether there is a sale price premium for green multifamily developments.

Hypothesis

ANOVA and regression are utilized to address the following hypothesis:

H_0: LEED certification has no relationship with sale price when compared to non-green multifamily properties, *ceteris paribus.*

H_A: LEED certification has a positive relationship with sale price when compared to non-green multifamily properties, *ceteris paribus.*

Limitations of the Study

A limitation of the study is the data set utilized. The data were provided by CoStar Group and contained missing variables. Data were requested for all green multifamily properties within the CoStar database. For those areas which harbored the greatest number of LEED certified multifamily properties, a control group of non-LEED certified multifamily properties was requested for each. Of the 63 LEED certified multifamily properties located in Chicago, New York, Portland, and Seattle, sale price information was limited. Of the 200 non-LEED certified multifamily properties located in Chicago, New York, Portland, and Seattle, sale price information was limited. Because of the limited sale price information, it was necessary to utilize RealQuest Express, a product made available by CoreLogic. Sale price variables were collected through the utilization of CoreLogic RealQuest Express and merged with CoStar data.

Chapter 2

Review of Literature

Introduction. The purpose of this literature review is to identify common threads found in previous research pertaining to green commercial development versus non-green commercial development. This study builds upon existing research related to both green and non-green development. Multifamily development has continuously evolved over the years, recently progressing toward green building (Carswell & Smith, 2009). As stated above, the purpose of green building is to produce healthier living and working atmospheres by reducing the environmental footprint of structures (Pitts & Jackson, 2008). A motivating factor for this study is the lack of research related to green building status and the effect that status has on value for the multifamily sector.

Costs, Benefits, and Incentives. Miller, Spivey, and Florance (2008) performed one of the initial systematic studies focusing on questions of advantages relating to investing in environmental design and energy savings. Using the CoStar database, the researchers compared LEED certified and U.S.-based Energy Star office buildings as a sample of green office buildings to a sample of non-LEED/non-Energy Star buildings (Miller et al., 2008). The researchers determined that green does, in fact, pay off in ways not before recognized. Miller et al. (2008) found that even in cities reluctant to adopt green building practices, costs to develop green structures are exceeded by elevated occupancy rates and quicker absorption, both of which add to the value of the property. According to the authors, overall costs to build green are reasonable if early planning occurs. Several cities require LEED certification for buildings of a particular size, while others offer incentives for green development, such as, quicker permit reviews, density bonuses, tax incentives, and lower permitting fees. Miller et al. (2008) discussed a lack of data, resulting in the inability to distinguish between the levels of LEED certification. Data of this degree may provide a more descriptive analysis of the benefits for the different levels of LEED certification: Certified, Silver, Gold, or Platinum (Miller et al., 2008).

According to Kats (2003), there is a burgeoning view that green construction costs are greater than conventional construction costs, which is the most difficult barrier for green development. The researcher examined whether green development is reasonable from a cost benefit standpoint. Kats (2003) discussed the price difference of green buildings vs. non-green buildings by contacting several architects and builders to determine the cost of 33 green properties within the U.S. compared to those with non-green designs. Kats (2003) found the premium for green construction to be approximately 2% over traditional construction, which is much lower than perceived and is decreasing with the growth of green development. Furthermore, the premium is in part a result of the time required to integrate sustainable practices into design (Kats, 2003).

Kats (2003) compared energy use for both green and non-green buildings. Savings accrued by an energy-efficient building add to the value of the structure and increase profitability. In addition, Kats (2003) presented a summary of the monetary benefits of green development, which are illustrated in Table 1. This table is relevant because multifamily property values are dependent upon the profitability of the building, and these savings drive up the price of the multifamily property. According to the author, information for this table was provided by Capital E Analysis.

Table 1

Monetary Benefits of Sustainable Buildings (per ft^2)

Category	20-year Net Present Value
Energy Savings	$5.80
Emissions Savings	$1.20
Water Savings	$0.50
Operations and Maintenance Savings	$8.50
Productivity and Health Benefits	$36.90 to $55.30
Subtotal	$52.90 to $71.30
Average Extra Cost of Building Green	(-3.00 to -$5.00)
Total 20-year Net Benefit	$50 to $65

Source: Kats, G.H. (2003). Green building costs and financial benefits. *Massachusetts Technology Collaborative,* 1-8.

As illustrated in Table 1, Kats (2003) suggested that the financial profits resulting from green buildings are over 10 times the average initial cost for constructing a green development. According to the author, the cost of green development is much lower when planned in the early stages of construction. The data indicate that it is cost effective to build green. The findings provide incentive for commercial developers to build green (Kats, 2003).

Kats' (2006) report analyzed the costs and benefits of America's green schools. Data were derived from 30 green schools constructed across 10 states from 2001 - 2006. Architects of green and conventional schools supplied data on savings and costs for comparison. Findings show green construction costs to be only 2% greater than conventional construction costs for schools. The monetary benefits of green school development are over 20 times greater than the cost of green building. Savings accrued by individual schools add to the value of the structure. In conclusion, green building (for schools) is highly effective from a cost standpoint (Kats, 2006).

Yudelson (2008) made the business case for building green commercial buildings by compiling a list of incentives. These incentives include lower insurance from selective companies, adding to the property's value, increase in public relations, sales/property tax abatements, and a variety of other incentives (Yudelson, 2008). Langdon (2007a) discussed benefits for green building owners, which creates desire for builders to use green building practices. He also discussed factors that drive green design strategies. Langdon (2007a) suggested that building costs go up roughly 3 - 5% for green designs. However, the author discussed elevated energy and water costs associated with non-green designs (Langdon, 2007b). N. King and B. King (2005) discussed the benefits of financial incentives pertaining to commercial renovation and construction, i.e., relaxed zoning restrictions and exemptions, streamlined permitting, financial grants, and tax credits.

Price and Rental Premiums of Green versus Non-Green. Miller's (2010) study found significant sales price premiums and rental premiums for LEED certified office buildings. Energy Star rental rates track closer to market rate. Furthermore, in particular instances and certain markets, rental rates were not always elevated as tenants were not willing to pay extra for LEED certified buildings. In other instances, Federal agencies that were required to lease LEED certified office space did so at a premium. An elevated vacancy rate exists in select markets for LEED certified office buildings; however, the rental premiums balance this disparity (Miller, 2010). Though the author discussed the green commercial market, he avoided discussion on the multifamily sector.

Using the CoStar database, Fuerst and McAllister (2008) examined the effects of LEED and Energy Star certification on rental rates and prices for commercial real estate. The authors compared LEED and Energy Star certified commercial properties to non-certified properties in the same metropolitan areas. It is worth noting that only metropolitan areas containing certified properties were analyzed within this study, and findings were consistent across the major market areas examined. The findings suggest that certified buildings demand a rental premium, and the higher the certification the greater the premium. In addition, the findings suggest that a price premium exists for both LEED and Energy Star certified properties (Fuerst & McAllister, 2008).

According to Miller, Pogue, Gough, and Davis (2009), the benefits associated with building healthy green environments far outweigh the costs. For example, healthier office environments increase productivity, reduce sick time, and encourage long term employment which adds to the value of the property. The results for this particular study were determined from a survey of 500 tenants who moved into either LEED or Energy Star rated office buildings. For tenants concerned with building quality, evidence shows that tenants will pay a premium for healthy buildings and demand discounts for unhealthy buildings (Miller et al., 2009). Though the authors discussed green building as it relates to the commercial market, they ignored the multifamily housing market.

Occupancy Status. Fuerst and McAllister (2009) examined the effects of LEED and Energy Star labeling (eco-labeling) on occupancy rates for commercial offices. The authors compared LEED and Energy Star certified commercial offices to non-certified offices. The results suggest that buildings with certification have higher occupancy rates compared to traditional buildings (Fuerst & McAllister, 2009). This translates to higher net operating income for this property sector, further justifying the decision to seek sustainable building certifications for commercial office spaces.

The objective of Jackson's (2009) study was to analyze the risks and returns associated with both LEED and Energy Star certified buildings. The results of the study illustrate that LEED and Energy Star certified properties have higher occupancy rates and steeper rental costs in comparison to traditional buildings. Also, the results confirm that premiums outweigh any added costs for green construction (Jackson, 2009). These findings may encourage multifamily developers to seek sustainable building certifications.

Market Value and Assessed Value. After looking into LEED certification's effect on market value and assessed value, Dermisi (2009) determined that certification level and rating often influence market value and assessed value. There were occasions when market value and assessed value were not affected; e.g., while controlling for Metropolitan Statistical Area only, the LEED Existing Building designation had no effect on market value and assessed value. In addition, the author discovered that Energy Star certification drastically increases market value as well as assessed value (Dermisi, 2009). Through case study research and anecdotal evidence, Pitts and Jackson (2008) suggested that market value is affected by green building, and in some cases property value increases.

Valuation. With the growth of green development, appraisers will be called to consider green building in their real estate valuations, and it is imperative that valuations be supported by market evidence (Pitts & Jackson, 2008). As stated by the authors, it is the responsibility of the appraiser to conclude whether a green building has greater value than a conventional building. Additionally, appraisers must be cognizant of green property features and be able to assess the impact of these features on the value of the building. According to Pitts and Jackson (2008), the income capitalization approach aids assessors in valuing green commercial properties. Green features may decrease energy costs, water costs, maintenance costs, insurance costs, as well as legal costs, and cost reductions increase the net operating income of a structure. Cost savings that accrue over time in a green building may outweigh the initial expense of green construction (Pitts & Jackson, 2008). Though the authors discussed green building as it relates to the commercial market and the single family residential market, it is important that research not overlook the multifamily sector.

Net Operating Income. Carswell and Smith (2009) discussed the relationship between energy costs and net operating income. An example of how energy savings affect net operating income is as stated: if a tenant's energy bill is rolled into his or her lease, the owner of a green multifamily property will directly benefit from energy savings, thus increasing net operating income. Because a positive relationship exists between net operating income and property value, energy savings translate to an increase in property value (Carswell & Smith, 2009). The authors presented a flow chart which illustrates the benefits for green multifamily property owners and/or operators as: the owner/operator implements energy efficient upgrades; the primary benefits of such upgrades are as stated: decrease in energy consumption, increase in tenant/employee satisfaction, less strain on infrastructure, and an increase in the life of sustainable building materials. Meanwhile, intermediate effects include fewer vacancies, elevated retention rates, fewer absences, and less employee/tenant turnover; expense and revenue items consist of reduced energy and utility bills, increase in revenue, decrease in marketing costs, reduced turnkey expenses, reduced training costs, reduced overtime expenses, reduced maintenance costs, and reduced capital expenditures. The primary outcome translates to an increase in net operating income, while the secondary outcome is an increase in the value of the property (Carswell & Smith, 2009).

Government Regulation. According to Persram, Lucuik, and Larsson (2007), 47% of America's corporate leaders anticipate that the government will make green building mandatory. Various development companies are adopting environmentally sound building practices voluntarily, whereas others are doing so as a result of government regulations (Parlow, 2008). "Lead by Example" is a form of public policy requiring LEED and/or Energy Star certification for all public buildings (R. Simons, E. Choi, & D. Simons, 2009). As stated by Carswell and Smith (2009), a transformation is underway requiring green building practices in existing building code.

Environmental Literacy. Brounen, Kok, and Quigley (2012) investigated the significance of behavior and awareness with regard to household energy consumption. After developing and distributing a survey to 1,721 households, the researchers measured the degree to which individuals were knowledgeable of their use of energy and if they had attempted to decrease their energy bill. The findings illustrate low energy literacy; e.g., only 56% of respondents were knowledgeable about their monthly energy charges and only 60% properly assessed financial decisions regarding energy efficient technologies (Brounen, Kok, & Quigley, 2012). If a relationship does exist among sale price and green building status for multifamily properties in Chicago, New York, Portland, and Seattle, it may be the result of high environmental literacy. In opposition, if a relationship does not exist, it may be the result of low environmental literacy.

Common Threads. A common theme illustrated in the studies above is that there is incentive for commercial developers to adopt green building practices (Kats, 2003; Langdon, 2007a; Miller et al., 2008; Yudelson, 2008). The literature suggests that green building costs are reasonable in comparison to conventional construction costs (Jackson, 2009; Kats, 2003; Kats, 2006; Langdon, 2007a; Miller et al., 2008; Pitts & Jackson, 2008). Specifically, previous research suggests that costs to build green are from 2% - 5% greater than conventional construction costs (Kats, 2003; Kats, 2006; Langdon, 2007a). Findings reveal significant sales price premiums and rental premiums for LEED certified properties (Fuerst & McAllister, 2008; Miller, 2010). According to the literature, LEED and Energy Star certified properties have higher occupancy rates in comparison to traditional buildings (Fuerst & McAllister, 2009; Jackson, 2009).

Green Building Rating Systems. Gowri (2004) recognized that the transformation of the building industry was a result of green rating systems. These voluntary rating systems are often used as checklists for design (Gowri, 2004). A few prevalent green rating systems include LEED, Energy Star, Earth Craft House, Green Globe, Green Seal, and NAHB Green. LEED was created in March of 2000 by the U.S. Green Building Council, and is a commonly used certification obtained by builders in order to classify developments as green (Kats, 2003; U.S. Green Building Council, 2011). "LEED provides building owners and operators with a framework for identifying and implementing practical and measurable green building design, construction, operations and maintenance solutions" (U.S. Green Building Council, 2011). LEED is applicable to both commercial and residential properties. LEED points are based on a 100 point system; a project must earn a minimum number of points and complete all necessary prerequisites in order to be eligible for certification (U.S. Green Building Council, 2011). The LEED point system is illustrated in Table 2.

Table 2

Levels of LEED Certification

Certification Level	Points
Certified	40 - 49
Silver	50 - 59
Gold	60 - 79
Platinum	80 +

Source: U.S. Green Building Council. (2011). About LEED. Retrieved December 17, 2011, from http://www.usgbc.org/Default.aspx

Incorporating an integrated approach to green development can result in synergies among credits (U.S. Green Building Council, 2011). Synergies can be described as strategies that yield multiple benefits, whereas trade-offs on the other hand, are considerations where there are multiple outcomes to weigh against one another in order to arrive at the most beneficial result.

LEED recognizes performance in the following areas: Sustainable Sites, Water Efficiency, Energy & Atmosphere, Materials & Resources, Indoor Environmental Quality, Locations & Linkages, Awareness & Education, Innovation in Design, and Regional Priority. The Sustainable Sites category encourages further development on land which has been previously developed. The Water Efficiency category focuses on water reduction. The Energy & Atmosphere category promotes energy saving strategies. The Materials & Resources category supports the 3Rs (reduce, reuse, and recycle); source reduction is highly valued. The Indoor Environmental Quality category encourages healthy indoor air quality and acoustics; natural daylight is highly regarded. The Locations & Linkages category recognizes that the location of a home impacts the environment. This category values infill sites with existing infrastructure. The Awareness & Education category acknowledges that in order for a home to be green, the owner/operator must know how to utilize the property to its fullest potential. The Innovation & Design category is an extra credit category. Points are awarded for innovative strategies and technologies which are beyond and/or outside of LEED's requirements. Finally, the Regional Priority category recognizes that regions have local environmental concerns and rewards individuals for addressing such concerns (U.S. Green Building Council, 2011).

Specific rating systems within LEED include New Construction (NC), Existing Building: Operations and Maintenance (EB: O & M), Commercial Interiors (CI), Core & Shell (CS), Schools (SCH), Retail, Healthcare (HC), Homes, and Neighborhood Development (ND). A partnership exists among LEED and Energy Star for the purpose of collecting data. And, Energy Star Portfolio Manager is utilized for data collecting purposes (U.S. Green Building Council, 2011). “The fact that incremental costs of ENERGY STAR investments are about half of LEED investments makes ENERGY STAR an attractive option for developers who desire a more cautious approach to sustainable project development” (Jackson, 2009, p. 104).

Energy Star’s rating system, established in 1992, operates on a 100 point scale that indicates how efficiently a building operates (Energy Star, 2011; R. Simons, E. Choi, & D. Simons, 2009). The Earth Craft House program was developed in 1999 by the Greater Atlanta Home Builders Association and Southface. Earth Craft’s program is a point-based program. Homes certified to a particular level are required to meet Energy Star guidelines (Earth Craft, 2011). Green Globe is an international certification system which focuses on operations and management. An independent third-party auditor works with clients to insure Green Globe standards are met (Green Globe, 2011). Created in 1989, Green Seal provides sustainability standards for companies, products, and services through third-party certification (Green Seal, 2011). The National Association of Home Builders (NAHB) Green program promotes environmentally friendly construction. In addition, “[t]he suite of services was unveiled in February 2008 to provide a comprehensive set of educational resources, advocacy tools, a credible green standard, and referrals to a national green home certification system by the NAHB Research Center, a qualified and independent third party” (National Association of Home Builders, 2011).

Voluntary green building rating systems, though useful, can be used as checklists and do not always produce environmentally friendly structures. In certain cases, developers use voluntary rating systems as a means to obtaining a green label and may sacrifice integrated design techniques. Green building rating system critics suggest this fault produces buildings green by label, not by design (Choi, 2009).

Sustainable Cities

Chicago, Illinois

Chicago, Illinois's Green Tech University provides classes on sustainability and green building topics. The Industrial Rebuild Program aids top energy and waste demanding companies in becoming more energy efficient in their operations and creates a market for renewable energy. This rebate program estimates energy savings to be approximately ten to twenty-five percent (Regelson, 2005). The Green Permit Program streamlines the permitting process for LEED and Energy Star buildings, thus saving in building costs along the way. The city is attempting to eradicate code barriers that slow green building. The New Homes for Chicago Program is a multifamily building program which incorporates green design building techniques. This income qualified program is funded by various programs and grants (Regelson, 2005).

New York, New York

The New York City Department of Design and Construction (hereafter DDC) develops sustainable public works, which reduce New York's carbon footprint. DDC has been successful by incorporating the following sustainable categories into New York's projects: Sustainable Site, Water Efficiency, Energy Efficiency, Healthy Interiors, and Materials and Resources. In 2006, the Mayor presented New York with a sustainability plan focusing on the following environmental categories: air, energy, land, transportation, and water. The purpose of this plan is to reduce New York's contribution to climate change (Burney, 1996).

Portland, Oregon

Portland, Oregon implemented an energy policy that focuses on both renewable resources and energy efficiency. Portland's ReThink Green Building Training Certificate program offers builders and architects valuable information pertaining to energy efficiency. Additionally, this program explains how to utilize state tax credits and grants. The Energy Trust of Oregon offers rebates for the following: solar hot water, solar electric, biopower, wind, and so forth. Portland has extensive green building programs that offer technical assistance and incentives to builders. Portland LEED is utilized in Portland and is an extension of the U.S. Green Building Council's program (Regelson, 2005).

Seattle, Washington

Seattle, Washington's Office of Sustainability and Environment implements policies pertaining to sustainability. The city of Seattle uses a holistic approach to better the environment. Seattle produces hydropower which provides the community with clean energy at an affordable cost. City Light, Seattle's energy provider, has been carbon and greenhouse gas neutral since 2005. Seattle's Department of Planning and Development promotes sustainable development in an attempt to conserve the earth's resources, create healthy environments, reduce runoff, and extend the structure's life (Simmons, 2011). In summary, "[c]ities like Seattle and Portland are coming on strong as green leaders and even Chicago hosts over 100 buildings with green roofs as of 2008" (Miller et al., 2008, p. 13).

Chapter 3

Methodology

Introduction. This study examines whether a relationship exists among sale price and green building status for multifamily properties located in Chicago, IL; New York, NY; Portland, OR; and Seattle, WA. This study adds to previous literature by focusing only on multifamily properties located in Chicago, New York, Portland, and Seattle. The results of this study will help sellers and buyers make educated decisions pertaining to green multifamily housing and non-green multifamily housing. The potential relationship between green building status and sale price of multifamily properties is investigated using analysis of variance (ANOVA) and a multiple regression model with up to eight covariables.

Data

CoStar

For this research, the CoStar database was utilized because "CoStar conducts expansive, ongoing research to produce and maintain the largest and most comprehensive database of commercial real estate information" (CoStar, 2011). CoStar was founded in 1987 by Andrew Florance, and the database can be utilized to identify LEED certified and Energy Star rated commercial properties. Specifically, CoStar data include information relevant to LEED certified and Energy Star rated multifamily properties. LEED was created by the U.S. Green Building Council and is internationally recognized as a green building rating system. And, "ENERGY STAR is a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy helping us all save money and protect the environment through energy efficient products and practices" (Energy Star, 2011). Specifying whether or not a multifamily property is LEED certified and/or Energy Star rated is an important attribute of CoStar in order to better understand the implications of such certifications.

CoreLogic

In addition, data were derived from CoreLogic RealQuest Express because, "CoreLogic RealQuest® Express offers a simplified lineup of solutions that provides the data needed for initiating, reviewing, or verifying real estate property and ownership information" (CoreLogic, 2011). RealQuest Express makes it possible to search over 145 million properties for sale price information and more. RealQuest Express is a product made available by CoreLogic and is utilized as a research tool for this study; missing sale price variables were acquired using RealQuest Express.

U.S. Census Bureau

Lastly, demographic data were gathered using American FactFinder by the U.S. Census Bureau. The Census Bureau administers roughly one hundred censuses and surveys per year without disclosing personal identifiers. Data collected were made available through American FactFinder (U.S. Census Bureau, 2011).

Variables

Dependent Variable

The dependent variable within the model is 2011 sale price (salepr2011). The dependent variable is calculated using the consumer price index (CPI) formula. In order to calculate CPI, the original sale price must be multiplied by the 2011 conversion value for each city; next, divide by the conversion value listed for the year in which the property sold. For the purpose of this study, sale price values are adjusted by city as there is variation between the locations in question.

Log of sale price is conducted (logsalepr11) in order to correct heteroscedasticity. Heteroscedasticity can be described as a pattern in residuals and this pattern is often fan shaped. Had saleprice11 been the response variable, a fan pattern would have been observed. The log transformation corrected this (see Figure 2).

Independent Variables

Independent variables within the model include: the year the property was sold minus the year the building was built which equals the age of the property at sale (prage); the number of stories in the building (nstories); land area acreage (landar); rentable building area (rentar); median population age (medage); total population per zip code (totalpop); population per square mile (popsqmile); and LEED certification (leedcert) which is a binary variable coded 0 or 1. Specifically, the property is given a value of 0 if it is not LEED certified and a value of 1 if it is LEED certified. The binary variable, leedcert, is the key independent variable in the model. This variable makes it possible to investigate the potential relationship between sale price and LEED certification. It is important to note that the variable, prage, is squared in the model in order to determine if there is an accelerated effect of age on property value; however, the variable does not prove to be significant.

Demographic variables presented include: median population age (medage); total population per zip code (totalpop); and population per square mile (popsqmile). In order to calculate population per square mile, otherwise known as population density, land area in square meters must be divided by 2,589,988, which is the meter to mile conversion value; next, total population is divided by the calculated value. These data were provided by the U.S. Census Bureau and were collected using American FactFinder.

Table 3 presents the independent covariables included in the multiple regression model. Also presented in Table 3 is the expected relationship each independent variable will have on the dependent variable.

Table 3

Description and Expected Relationship of the Independent Variables

Independent Variables	Description	Expected Relationship
	Property Characteristics	
prage	Property age: the year property sold minus the year the building was built.	+ or -
nstories	Number of stories: the number of stories in the building.	+ or -
landar	Land area AC: the land area in acres.	+
rentar	Rentable building area: the rentable building area per square foot.	+
leedcert	LEED certification: a dummy variable coded 0 or 1.	+
	Population Characteristics	
medage	Median population age: the median age for both male and females living in each metropolitan area.	+
totalpop	Total population: the total population per zip code.	+ or -
popsqmile	Population per square mile: The population per square mile otherwise referred to as population density.	+ or -

As illustrated in Table 3, the independent variables assigned a + symbol are expected to have a positive relationship with the dependent variable sale price. Conversely, the independent variables assigned a - symbol are expected to have a negative relationship with the dependent variable sale price.

Property age could have a positive or negative relationship with the dependent variable, sale price, when taking historical value into consideration. Although an older property could be expected to sell at a discounted value, historical properties may sell at a premium. According to Laurice and Bhattacharya (2005), age can positively affect sale price as sale price can rise with age after approximately twenty years, all other things held constant. Number of stories could have a positive or negative relationship with sale price; e.g., when purchasing a multifamily property targeted at the elderly, the future owner and/or operator may be willing to pay a premium for a one story building. Consistent with single-family residential literature, B. Bloom, M.C. Nobe, and M.D. Nobe (2011) reported "*[n]umber of stories* does not have a predictable coefficient as the decision to buy a ranch or two-story house is presumably a decision of preference, not superiority" (p.118). As land area increases, sale price is expected to rise. As rentable building area increases, it is likely sale price will increase as more rentable space is an asset. LEED certification is expected to raise sale price as LEED certification may increase desirability, which would raise the valuation of the property because consumers may desire it and be willing to pay more for it. When considering median population age, it is reasonable to assume that some communities in which the properties are located have generational differences. This may translate to different levels of consumer tastes as to the types of properties sought; for example, a city with a low median population age may have a greater demand for LEED certified multifamily properties. Therefore, it is expected that a positive relationship will exist between median population age and sale price. As total population increases, it is possible sale price will increase as a result of an increase in demand; however, it is feasible that developers will build LEED certified multifamily properties in underpopulated regions and charge a premium for the third-party certification. Similarly, as population per square mile increases, sale price can be expected to increase based on demand; however, it is possible that as population per square mile increases, sale price will decrease (Geoghegan, 2002).

Similar to related studies that utilize regression, independent variables within the model are appropriate. B. Bloom, M.C. Nobe, and M.D. Nobe (2011) incorporated the following independent variables in their regression model: age, total square footage, lot size, number of stories, and Energy Star qualified (a dummy variable coded 0 or 1). Using these and other independent variables, the researchers conducted a hedonic regression analysis and discovered a sale price premium of $8.66 per square foot for Energy Star qualified residential homes (B. Bloom, M.C. Nobe, & M.D. Nobe, 2011). Miller et al. (2008) conducted numerous hedonic price models in order to measure the impact of age, sale date, and location on the dependent variable, sale price per square foot. Fuerst and McAllister (2008) ran a hedonic model in order to measure "[…] price differences between certified buildings and randomly selected non-certified buildings in the same metropolitan area controlling for differences in age, height, quality, metropolitan, etc." (p. 4). In order to investigate the effect of LEED and Energy Star labeling on occupancy rates of office properties, Fuerst and McAllister (2009) included the following control variables in their ordinary least squares (OLS) and quantile regression model: age, height, quality, and building class. The independent variable age is a common control found in related studies that utilize regression (B. Bloom, M.C. Nobe, & M.D. Nobe 2011; Fuerst & McAllister, 2008; Fuerst & McAllister, 2009; Geoghegan, 2002; Laurice & Bhattacharya, 2005;

Miller et al., 2008). Other common controls include height/number of stories and quality (B. Bloom, M.C. Nobe, & M.D. Nobe 2011; Fuerst & McAllister, 2008; Fuerst & McAllister, 2009; Geoghegan, 2002).

Hypothesis

According to B. Bloom, M.C. Nobe, and M.D. Nobe (2011), third-party certifications are valued by consumers; however, the researchers investigated this relationship as it pertains to single-family residential housing. Further research is necessary to verify if a similar relationship exists in the multifamily sector. Therefore, the hypothesis for this study is as stated:

H_0: LEED certification has no relationship with sale price when compared to non-green multifamily properties, *ceteris paribus.*

H_A: LEED certification has a positive relationship with sale price when compared to non-green multifamily properties, *ceteris paribus.*

Statistical Analysis

Descriptive statistics are conducted in order to illustrate the means, standard deviations, minima, and maxima for the variables within the model. Also, the descriptive statistics provide correlations among variables. The Box-Cox transformation suggests whether or not a log transformation is necessary. The ANOVA results indicate that the model is significant, and at least one of the variables is significant at alpha = .05. After further research, the ANOVA indicates that three variables are significant in the model. A multiple regression for the full model is performed to determine if there is a relationship between LEED certification and sale price when compared to non-green properties. All eight variables are included in order to have an initial model and to check for positive/negative coefficients. The stepwise regression exemplifies the order in which variables are removed from the model, e.g., LEED certification, number of stories, total population, square age, and median age. And, the stepwise regression confirms that three variables are significant in the model. The residual plot determines whether or not residuals have constant variance over the range of predicted values. The histogram of residuals is examined in order to demonstrate the distribution of residuals. The multiple regression model utilized in this study is as displayed.

2011Sale Price = $\beta_0 + \beta_1$**Age of Property at Sale* + β_2**Number of Stories* + β_3**Land Area AC* + β_4**Rentable Building Area* + β_5**Median Population Age* + β_6**Total Population Per Zip Code* + β_7**Population Per Square Mile* + β_8**LEED Status (Coded 0 or 1)* + ε

Chapter 4

Results

This research study seeks to fill a gap in the literature related to the potential relationship between LEED certification and sale price in the multifamily property sector. In this chapter, the potential relationship between the independent variables (age of building at sale, number of stories, land area, rentable building area, median population age, total population per zip code, population per square mile, LEED status) and the dependent variable (sale price) is analyzed.

Data and Sample Descriptions

A modest number of LEED certified multifamily properties is compared to a larger number of non-LEED certified multifamily properties in the same metropolitan areas. The sample for this project is drawn from a collection of 136 multifamily properties located in Chicago, New York, Portland and Seattle. Of the sample, 25 of the multifamily properties are LEED certified, whereas the control group is made up of 111 non-certified multifamily properties; the sample is illustrated in Table 4. The time span in which multifamily properties were built in Chicago, New York, Portland, and Seattle is from 1863 to 2010. The rationale behind this particular study is to determine if a relationship exists between sale price and green building status for multifamily properties in these designated areas.

Table 4

LEED Certification by City

City	LEED-certified (Green) Multifamily Properties	Non-certified (Non-Green) Multifamily Properties	Frequency
Chicago	4	26	30
New York	4	16	20
Portland	9	28	37
Seattle	8	41	49
Total	**25**	**111**	**136**

Given the literature, it is expected that LEED certification will impact sale price and the adoption of green building practices. Chicago, New York, Portland, and Seattle are ideal locations to obtain a sample. The basis for a sample size of 25 LEED certified multifamily properties is derived from an understanding of those cities in the United States which harbor the greatest population of green multifamily properties. The basis for a sample size of 111 non-LEED certified multifamily properties is a result of data set availability. Table 5 presents the number of properties per level of LEED certification by market area.

Table 5

Number and Level of LEED Certification per Metropolitan Area

City	Certified	Silver	Gold	Platinum	Total
Chicago	2	1	1	0	4
New York	0	1	2	1	4
Portland	0	2	7	0	9
Seattle	3	5	0	0	8
Total	**5**	**9**	**9**	**1**	**25**

For the purpose of this study, the specific level of LEED certification is not differentiated. LEED certification is a binary variable in the model and properties are assigned a 0 if they are not LEED certified and a 1 if they are any level of LEED certified.

Descriptive Statistics

Table 6

Descriptive Statistics

	Mean	Std. Deviation	Min	Max	N
		Property Characteristics			
logsalepr11	14.483	1.670	10.81	19.56	136
prage	46.120	35.691	0	140	136
squagepr	3391.993	3846.374	0	19600	136
nstories	7.040	10.385	1	58	136
rentar	91328.130	155328.620	2704	750000	136
landar	0.771	2.083	0.031	17.46	136
		Community Characteristics			
medage	35.496	3.710	23.1	47.5	136
totalpop	33259.780	20827.447	2308	113900	136
popsqmile	19920.791	22864.538	1444	101800	136

Table 6 is an illustration of the descriptive statistics for the study. Descriptive statistics are conducted in order to illustrate the means, standard deviations, minima, and maxima for the variables within the model. The dummy variable leedcert does not appear in the descriptive statistics, as it is a categorical variable. Overall, there were 128 missing variables removed from the model.

The log sale price mean indicates that after a transformation has been conducted, in order to correct the pattern which would have existed among residuals, the new log sale price mean is 14.5. A property age mean of 46.1 indicates a mature stock of multifamily buildings analyzed within this study. There are valuation differences between newly built properties and older built properties. For example, older properties (those around 50 years of age) are likely deteriorating and dropping in value whereas newer properties are going to require less maintenance. However, some older properties may have greater value if they are protected by historical preservation codes. After transforming the independent variable property age, the mean rises to 3,392. Consistent with previous research, property age is squared in order to determine if there is an accelerated rate of depreciation (Laurice & Bhattacharya, 2005). It is important to note that neither property age nor square property age is significant in the model. The mean number of stories (7.0) is expected for multifamily properties. The mean rentable building area of 91,328.1 square feet is high, indicating a significant amount of rentable square footage in the data. The mean land area of 0.8 acres is low, indicating the properties in the study sit on a relatively small acreage of land. This number is not surprising for the LEED properties, as LEED awards points for a limited land area. Also, this number is not surprising for non-certified properties, as there is a limited land area available within the cities observed. A mean median population age of 35.5 is low, indicating a relatively young population in the zip codes examined. This could have implications on the adoption of third-party rating systems such as LEED. A mean total population of 33,259.8 is high, indicating a large number of individuals living within the zip codes examined. And this high total population could be an indication of high demand. Finally, the mean population per square mile (population density) is 19,920.8. An elevated population density could be an indicator of increased demand for properties, which would have an upward effect on building value.

Noteworthy minima and maxima values include the following: a minimum property age and/or square property age of 0 signifies a property with the same year built and year sold. Few properties in the data were built and sold in the same year; specifically, five properties were built and sold in the same year. The minimum median population age of 23.1 is extremely low, which may be the result of the particular zip code and its proximity to The University of Washington in Seattle. The minimum total population value of 2,308 indicates that there may not be many competing properties in the particular zip code, and as a result: (a) there may be a sense of exclusivity among residents, (b) there could be a countervailing sense of isolation that is a negative driver toward value, and (c) perhaps the building is located in an area that has a lot of mixed use development. Conversely, a maximum total population value of 113,900 indicates that there may be elevated competition for properties in the particular zip code. A wide variation exists among the minimum and maximum number of stories. There are implications between low- and high-rise buildings, and their valuation; however, number of stories could have a positive or negative relationship with sale price (B. Bloom, M.C. Nobe, & M.D. Nobe, 2011).

Table 7

Descriptive Statistics for LEED certified Properties

	Mean	Std. Deviation	Min	Max	N
		Property Characteristics			
logsalepr11	16.099	1.858	12.949	19.565	25
prage	9.040	23.467	0	104	25
squagepr	610.400	2268.744	0	10816	25
nstories	19.800	14.883	3	58	25
rentar	303398.900	177599.700	27969	750000	25
landar	0.887	0.848	0.110	4	25
		Community Characteristics			
medage	36.400	3.000	31.2	42.1	25
totalpop	19704.320	15482.380	2308	59283	25
popsqmile	19644.710	18507.490	1443.983	69106.18	25

Table 8

Descriptive Statistics for non-LEED certified Properties

	Mean	Std. Deviation	Min	Max	N
		Property Characteristics			
logsalepr11	14.119	1.394	10.814	18.657	111
prage	54.477	32.561	3	140	111
squagepr	4018.477	3857.389	9	19600	111
nstories	4.162	6.218	1	50	111
rentar	43564.430	101020.200	2704	722000	111
landar	0.744	2.272	0	17	111
		Community Characteristics			
medage	35.292	3.834	23	48	111
totalpop	36312.810	20709.980	7688	113916	111
popsqmile	19982.970	23808.570	2865	101814	111

After filtering LEED certified multifamily properties and non-LEED certified multifamily properties, noteworthy observations are as described. Tables 7 and 8 illustrate that LEED certified properties are newer on average than non-LEED certified properties. Also, the five properties built and sold in the same year are all LEED certified. The mean number of stories proves to be consistent with LEED standards; e.g., the LEED rating system awards points for properties built up rather than out, minimizing the footprint of the structure. Consistent with LEED, the mean number of stories in LEED certified properties is 19.8, and the mean number of stories in non-LEED certified properties is 4.2. The LEED certified properties, on average, have a significantly greater rentable building area, which is thought to positively affect sale price. The mean land area is greater for the sample of LEED certified properties, which is not consistent with LEED standards as the U.S. Green Building Council (USGBC) awards points for a limited land area. In summary, the USGBC awards points for restoring/protecting the habitat and maximizing a site's open space. It is possible that certain LEED properties in the study were retrofitted, in which case, the land area of the property would be unchangeable. It was predicted that the median population age would be lower in those zip codes harboring the LEED certified properties; however, the mean median population age in those areas that contain the LEED certified multifamily properties is 36.4, while the mean median population age in those areas that contain the non-LEED certified properties is 35.3. With a mean total population of 19,704.3 for green properties and a mean total population of 36,312.8 for non-green properties, it is illuminating that the zip codes harboring non-certified properties have a greater mean total population. Similarly, Tables 7 and 8 illustrate that LEED certified multifamily properties are located in areas with a slightly lower population density. This could be the result of depreciated land prices in areas with fewer residents.

Table 9

LEED certified Properties versus the rest of the city

	Mean	Min	Max	Chicago	New York	Portland	Seattle
medage	36.400	31.2	42.1	32.9	35.5	35.8	36.1
totalpop	19704.320	2308	59283	2695598	8175133	583776	608660
popsqmile	19644.710	1443.983	69106.18	11841.772	27012.441	4375.260	7250.907

Table 9 is a comparison of LEED certified population characteristics and city population characteristics. The mean median population age in those areas containing LEED certified properties is slightly greater than the median ages in Chicago, New York, Portland, and Seattle, which indicate that it is not a younger population investing in green properties. And this could be the result of elevated income levels for slightly older individuals. Because the median population ages for Chicago, New York, Portland, and Seattle are similar (below 40) and the mean median population age for LEED certified properties is 36.4, marketing for certified properties should be aimed at this particular generation.

Table 10

Pearson Correlation

	logsalepr11	squagepr	rentar	landar	medage	totalpop	nstories	popsqmile
logsalepr11	1.000	-.296	.684	.306	.085	-.284	.597	.144
squagepr	-.296	1.000	-.372	-.223	-.191	.366	-.258	0.377
rentar	.684	-.372	1.000	.195	.005	-.365	.869	0.022
landar	.306	-.223	.195	1.000	-.003	-.080	-.022	-.178
medage	.085	-.191	.005	-.003	1.000	-.250	-.012	-.046
totalpop	-.284	.366	-.365	-.080	-.250	1.000	-.286	.219
nstories	.597	-.258	.869	-.022	-.012	-.286	1.000	.174
popsqmile	0.144	0.377	0.022	-.178	-.046	.219	.174	1.000

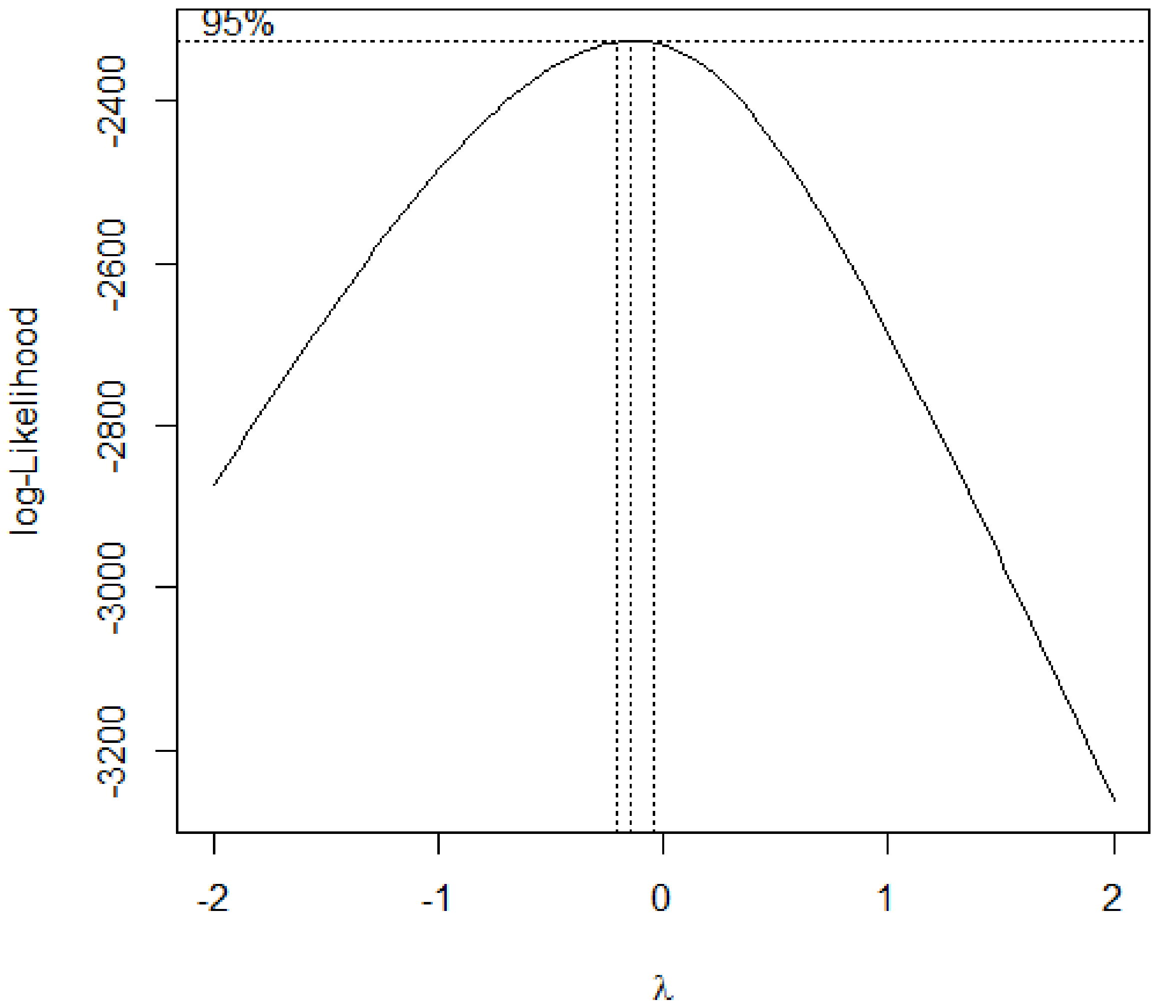
Note: The dependent variable saleprice11 should not be used as a log transformation is needed.

Table 10 checks for multicollinearity before any models are fit; multicollinearity occurs when two potential explanatory variables are highly correlated. If two variables have a correlation close to 1 or -1, then there is a strong linear association; therefore there is no need to fit both together in the model. The only variables with a high correlation are rentar and nstories with a correlation of .9.

Box-Cox Transformation

Figure 1

Box-Cox Transformation



Note: This is a Box-Cox transformation of Sale Price.

Figure 1 can be described as a Box-Cox transformation of the dependent variable sale price. Because the 95% confidence bands are close to 0, the plot suggests a log transformation. If the bands were close to 1, no transformation would have been needed. In summary, the left and right vertical lines are confidence bands, and the center vertical line is the point estimate suggesting a negative .1 exponent transformation. However, a log transformation is easier to interpret.

ANOVA

The purpose of ANOVA is to illustrate whether any variables are significant in the model. If the test reveals that at least one of the variables is significant, then further investigation will be needed.

Table 11

ANOVA for the Full Model

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
age	1	56.544	56.544	42.0005	0.000 *
rentar	1	120.990	120.990	89.8701	0.000 *
landar	1	10.641	10.641	7.9044	0.005715 *
medage	1	2.235	2.235	1.6604	0.199887
totalpop	1	0.043	0.043	0.0322	0.857902
leedcert	1	0.318	0.318	0.2364	0.627654
nstories	1	2.810	2.810	2.0875	0.150972
popsqmile	1	11.964	11.964	8.8866	0.003444 *
Residuals	127	170.977	1.346		

After conducting the full ANOVA (see Table 11), at least some variables are significant in the model. Further investigation is necessary to determine specifically which variables are significant at $\alpha = .05$.

Table 12

Analysis of Variance Table

Response: logsalepr11	*df*	*Sum Sq*	*Mean Sq*	*F value*	*Pr(>F)*
rentar	1	176.081	176.081	130.1136	0.000 *
landar	1	11.635	11.635	8.5975	0.004 *
popsqmile	1	10.176	10.176	7.5193	0.007 *
Residuals	132	178.634	1.353		

Note: The ANOVA results indicate that the model is significant, and at least one of the three variables is significant at $\alpha = .05$.

After the analysis (see Table 12), rentable building area, land area, and population per square mile are all significant. These results do not support the following hypothesis: LEED certification has a positive relationship with sale price when compared to non-green multifamily properties, *ceteris paribus.*

Regression

A multiple regression for the full model is conducted in order to determine whether there is a significant relationship between LEED certification and sale price, when compared to non-green multifamily properties. All eight parameters are included in order to have an initial model and also to check for positive or negative trends for specific variables, in particular for leedcert.

Table 13

Multiple Regression for the Full Model

Coefficients	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	12.836	1.111	11.556	0.000 *
age	-0.005	0.004	-1.275	0.205
rentar	5.07e-06	1.61e-07	3.157	0.002 *
landar	0.180	0.054	3.318	0.001 *
medage	0.028	0.028	0.976	0.331
totalpop	-4.20e-06	5.56e-06	-0.755	0.451
leedcert	0.090	0.360	0.249	0.804
nstories	0.015	0.022	0.682	0.496
popsqmile	1.51e-05	5.05e-06	2.981	0.003 *

Table 13 presents the multiple regression for the full model. Even if a specific variable is not significant, it is still of interest to know whether its effect on the log sale price is positive or negative. Holding all other variables constant, a property that is LEED certified has a log sale price that is, on average, 0.090 higher than a property that is not LEED certified. However, the variable leedcert does not contribute significantly to the final model.

The estimates for property age and total population are negative. This means that, holding all other variables constant, an increase in property age tends to result in a decrease in log sale price, as does total population. The other insignificant variables, median population age and number of stories, have positive estimates. This means that, holding all other variables constant, an increase in median population age tends to result in an increase in log sale price, and similarly for number of stories. However, none of these four variables contributes significantly to the final model.

Stepwise Regression

Using data from CoStar, CoreLogic, and the U.S. Census Bureau, a stepwise regression is conducted in order to determine whether there is a significant relationship between LEED certification and sale price, when compared to non-green multifamily properties. This study investigates this potential relationship using the following regression model:

2011Sale Price = $\beta_0 + \beta_1$**Age of Property at Sale* + β_2**Number of Stories* + β_3**Land Area AC* + β_4**Rentable Building Area* + β_5**Median Population Age* + β_6**Total Population Per Zip Code* + β_7**Population Per Square Mile* + β_8**LEED Status (Coded 0 or 1)* + ε.

Table 14

Logsaleprice

Coefficients	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	13.48	.1505	89.608	0.000*
rentar	6.869e-06	6.584e-07	10.433	0.000 *
landar	0.1692	.04989	3.392	0.001*
popsqmile	1.222e-05	4.458e-06	2.742	0.007 *

Note: R-Square = 52.56%; Adjusted R-Square = 51.48%; Std. Error of the Estimate = 1.163

After conducting a stepwise regression (see Table 14), variables were removed from the model in the following order: LEED certification, number of stories, total population, square age, and median age. Order is important because once the least significant variable is dropped, other variables might become significant. The model must be refit after each deletion until all remaining variables are significant. These results do not support the null hypothesis that LEED certification has a positive relationship with sale price when compared to non-green multifamily properties, *ceteris paribus.*

R-Square value can be described as the goodness of fit. The variation in log sale price is 52.56% affected by the significant variables. In other words, 52.56% of the variability in the log sale price is accounted for by rentar, landar, and popsqmile. The R^2 value of the model is […] "consistent with the range of R^2 values for similar models, which ranged from a low of 0.41 to a high of 0.86" (B. Bloom, M.C. Nobe, & M.D. Nobe, 2011, p. 119).

The following variables are not significant predictors of log sale price: property age/square property age, number of stories, median population age, total population, and LEED status. The only significant variables in predicting the log sale price are rentable building area, land area acreage, and population per square mile. The null hypothesis regarding LEED status cannot be rejected.

Interpretation:

1. Holding land area acreage and population per square mile constant, log sale price is expected to increase by 0.006869 for every additional thousand square footage of rentable building area.
2. Holding rentable building area and population per square mile constant, log sale price is expected to increase by 0.1692 for every additional acre of land area.
3. Holding rentable building area and land area acreage constant, log sale price is expected to increase by .00001222 for every additional unit of population per square mile.

Residual Plot

Figure 2

Residual Plot

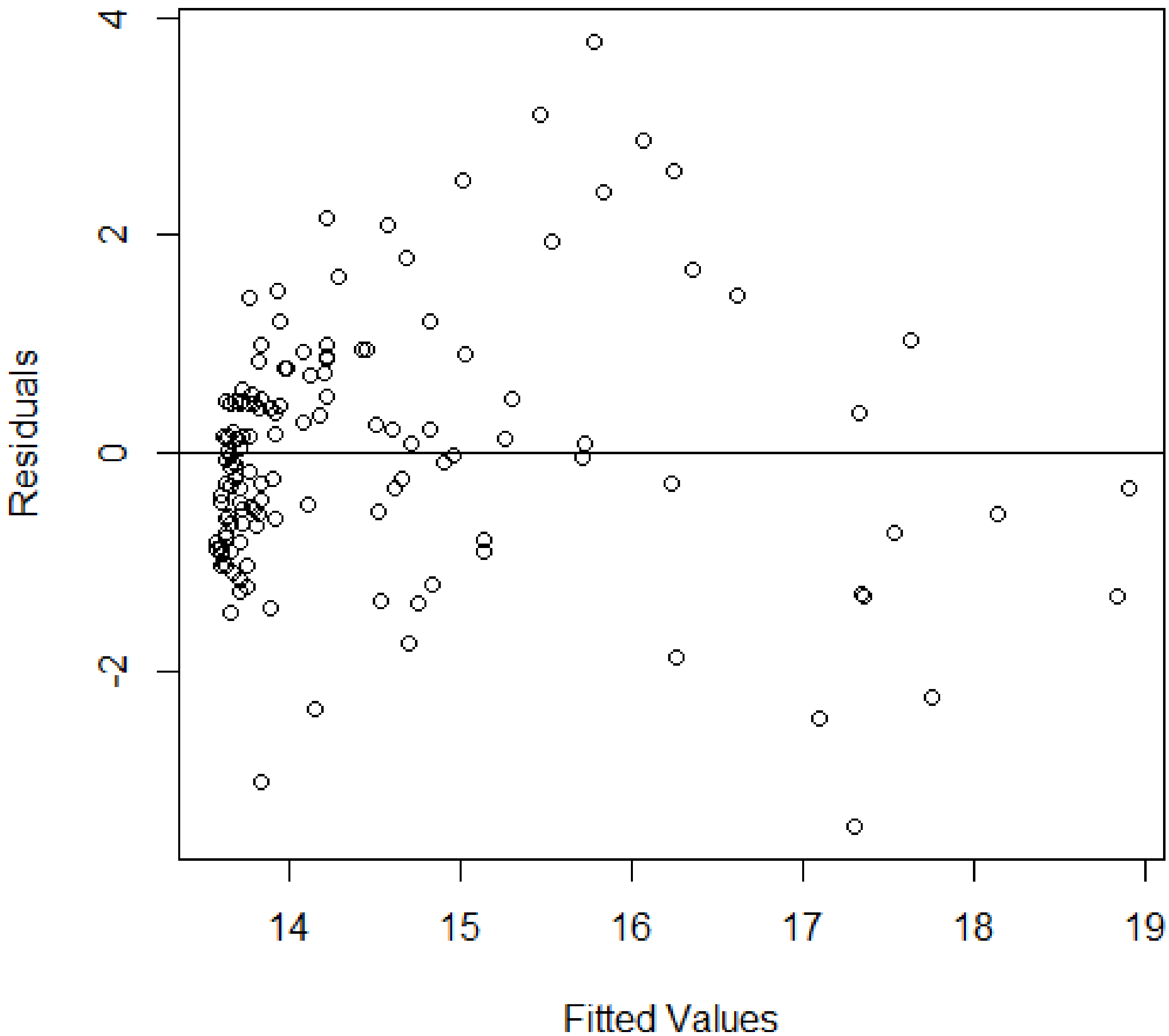
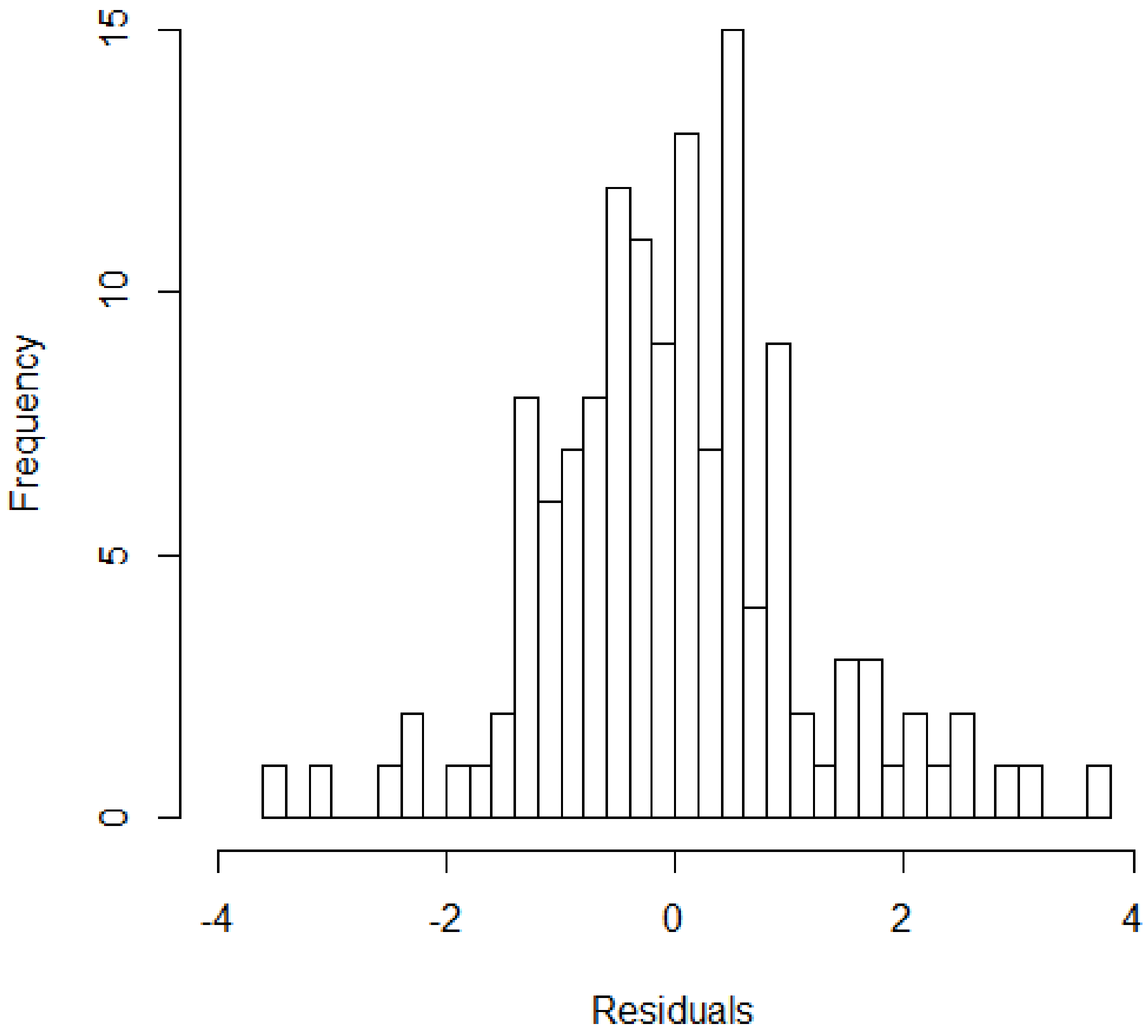


Figure 2, the residual plot presents fitted (predicted) response values versus residuals. A residual plot can be thought of as a diagnostic check for the model. It appears there is not a pattern; therefore, residuals appear to be constant. The residual plot tests for constant variance (homoscedasticity). Heteroscedasticity can be described as a pattern in residuals which appears as fitted values increase, and this pattern is often fan shaped. Had saleprice11 been the response variable, a fan pattern would have been observed. The log transformation corrected this.

Histogram of Residuals

Figure 3

Histogram of Residuals



A histogram of residuals, as seen in Figure 3, can also be thought of as a diagnostic check for the model. The residuals have a normal distribution with a mean of approximately 0. Regression models require the residuals to be normally distributed, and this histogram supports that assumption.

Chapter 5

Discussion

Findings. Neither property age nor square property age are significant predictors of log sale price; number of stories, median population age, and total population are not significant predictors of log sale price, either. Finally, LEED status is not a significant predictor of log sale price. The only significant variables in predicting the log sale price are rentable building area, land area acreage, and population per square mile. Based on the results from the multiple regression and ANOVA testing, the null hypothesis cannot be rejected.

Study Limitations. One of the limitations of the study is the four cities in question. These four cities are located in the Northern, Eastern, and Western part of the country, excluding the Southern region. More city data would have been helpful to expand generalizability of the study. Another limitation of the study is the absence of property income data. The U.S. Census Bureau does not make property income data available by zip code, and it is possible these data may have been significant. A threat to external validity is that the sample, restricted to 25 green and 111 non-green multifamily properties in Chicago, New York, Portland, and Seattle, cannot be generalized for the entire population of green and non-green multifamily buildings in the United States. One threat to internal validity is the omitted variable bias. Due to a shortage of data, it is possible that one of the necessary regressors was excluded from the model. This leads to a correlation of one or more regressors in the error term (Stock & Watson, 2007). A future study could include more explanatory variables.

Future Research. As discussed, the multifamily property sector has been overlooked in research, which warrants further analysis. Future studies related to the multifamily sector should incorporate cities in the Southern part of the country. As data collection in the green multifamily housing sector becomes more prevalent, future research should address whether a relationship exists among green status and market time. Further research is necessary in order to develop an understanding of LEED certification's potential relationship with market time. Also, further research is necessary in order to understand whether sellers of green multifamily buildings overestimate or underestimate the pricing of green multifamily properties relative to non-green multifamily properties.

Furthermore, it is imperative that future researchers understand the differences between conventionally built multifamily properties and multifamily properties built to LEED standards. LEED values particular property characteristics that conventional builders often overlook. For example, LEED awards points for buildings built up rather than out. As mentioned in the descriptive statistics, this study finds the mean number of stories for LEED certified properties to be 19.8, and the mean number of stories for non-LEED certified properties to be only 4.2. Also, LEED awards points for buildings that sit on a limited land area. In other words, LEED awards points for restoring and/or protecting the habitat as well as maximizing open space. This study finds the mean land area to be greater for the sample of LEED certified properties, which is inconsistent with the LEED rating system as LEED awards points for a limited land area. However, it is possible that the particular LEED properties analyzed were retrofits, in which case, the land area of the properties would be unalterable. LEED also awards points for multiple bedrooms designed to fit in a smaller square footage (SF) because a smaller SF is valued by LEED. Until less space becomes a commodity for consumers, LEED certified multifamily buildings will not sell for a premium. A paradigm shift is necessary in order for society to change its perspective on what amenities add value to a structure.

Though there are many differences between LEED and non-LEED properties, future studies should be conducted with an understanding of these differences in order to better understand the potential increase in value that third-party rating systems may add to multifamily properties. Data will forever evolve as developers adopt green building practices, and this is why it is critical that similar studies are carried out. Green building is innovative; there are limited data sets available for researchers. Data collection in this field would provide future researchers with access to information otherwise potentially unavailable. As data become readily available, a substantial amount of research will be necessary to understand a potential future correlation between LEED certification and sale price for multifamily properties. It is up to consumers and appraisers to determine the value of LEED, and it is up to researchers to report these findings.

Conclusions. This study investigates whether a relationship exists among sale price and green building status for multifamily properties in Chicago, New York, Portland, and Seattle. Few studies address this potential relationship between sale price and green status for multifamily properties, and further research was necessary in order to develop an understanding of LEED certification's possible relationship with sale price. Within the study, implications for multifamily sellers and buyers are addressed.

This study hypothesizes the following: LEED certification has a positive relationship with sale price when compared to non-green multifamily properties, *ceteris paribus*. After conducting ANOVA and multiple regression, it is concluded that the null hypothesis cannot be rejected. In other words, a relationship does not exist among sale price and green building status for multifamily properties located in Chicago, New York, Portland, and Seattle. It is possible that this finding may be the result of low environmental literacy among residents. For the purpose of this study, environmental literacy can be described as an individual's understanding of the LEED rating system. Therefore, low environmental literacy can be described as an individual's lack of knowledge related to the LEED rating system. Without an understanding of the LEED rating system, an individual may not be willing to pay a premium for such a certification. This is problematic as third-party rating systems, such as LEED, reduce the environmental footprint of a structure. In addition, it is possible that a relationship does not exist between sale price and green building status for multifamily properties located in the metropolitan areas analyzed because there is a lack of data. Access to a larger sample of LEED and non-LEED certified multifamily properties would most likely have provided more definitive results.

The findings from this study are not consistent with previous research; the literature reported a sale price premium for LEED certified properties (Fuerst & McAllister, 2008; Miller, 2010). In addition, previous research related to the single-family residential sector concluded a sale price premium for Energy Star qualified single-family homes located in Fort Collins, CO (B. Bloom, M.C. Nobe, & M.D. Nobe, 2011). After analyzing multifamily data from Chicago, New York, Portland, and Seattle, no such relationship was found between LEED certification and sale price. It is worth noting that even if a specific variable is not significant, such as leedcert, it is still important to know its effect on the log sale price. This study finds that when all other variables are held constant, a property that is LEED certified has a log sale price that is, on average, 0.090 higher than a property that is not LEED certified. However, leedcert does not contribute significantly to the final model.

References

Bloom, B., Nobe, M.C., & Nobe, M.D. (2011). Valuing green home designs: A study of ENERGY STAR® homes. *Journal of Sustainable Real Estate, 3*(1), 109-126.

Brounen, D., Kok, N., & Quigley, J. M. (2012). *Residential energy literacy and capitalization.* Maastricht, MD: The European Centre for Corporate Engagement.

Brundtland, T. (1987). Brundtland report. In: *(WCED) World Commission on Environment and Development, Our Common Future.* Oxford University Press, Oxford, UK.

Carswell, A.T., & Smith, S.W. (2009). The greening of the multifamily residential sector. *Journal of Engineering, Design & Technology, 7*(1), 65-80.

Choi, C. (2009). Removing market barriers to green development: Principles and action projects to promote widespread adoption of green development practices. *Journal of Sustainable Real Estate*, *1*(1), 107-138.

CoreLogic. (2011). *Simplified Solutions.* Retrieved January 24, 2012, from http://express.realquest.com/

CoStar. (2011). *About Costar.* Retrieved January 24, 2012, from http://www.costar.com/about/

Dermisi, S.V. (2009). Effect of LEED ratings and levels on office property assessed and market values. *The Journal of Sustainable Real Estate, 1*(1), 1-26.

Energy Star. (2011). *About Energy Star.* Retrieved July 21, 2011, from http://www.energystar.gov/index.cfm?c=about.ab_index

Fuerst, F., & McAllister, P. (2008). Green noise or green value? Measuring the effects of environmental certification on office property values. Retrieved July 3, 2011, from http://dx.doi.org/10.2139/ssrn.1140409

Fuerst, F., & McAllister, P. (2009). An investigation of the effect of eco-labeling on office occupancy rates. *The Journal of Sustainable Real Estate, 1*(1), 1-16.

Geoghegan, J. (2002). The value of open spaces in residential land use. *Land Use Policy*, *19*(1), 91-98.

Gowri, K. (2004). Green building rating systems: An overview. *ASHRAE Journal, 46*(11), 56-59.

Green Globe. (2011). *Certification introduction.* Retrieved December 31, 2011, from http://www.greenglobe.com/introduction

Green Seal. (2011). *About Green Seal.* Retrieved January 3, 2012, from http://www.greenseal.org/

Jackson, J. (2009). How risky are sustainable real estate projects? An evaluation of LEED and ENERGY STAR development options. *The Journal of Sustainable Real Estate. 1*(1), 91-106.

Kats, G.H. (2003). Green building costs and financial benefits. *Massachusetts Technology Collaborative*, 1-8.

Kats, G. (2006). *Greening America's schools costs and benefits.* Retrieved August 24, 2011, from http://www.usgbc.org/ShowFile.aspx?DocumentID=2908

Kats, G., Alevantis, L., Berman, A., Mills, E., & Perlman, J. (2003). *The costs and financial benefits of green buildings: A report to California's sustainable building task force.* Retrieved August 5, 2011, from http://www.usgbc.org/Docs/News/News477.pdf

King, N.J., & King, B.J. (2005). Creating incentives for sustainable buildings: A comparative law approach featuring the United States and the European nation. *Virginia Environmental Law Journal*, *23*(397), 397-459.

Langdon, D. (2007a). *Cost of green revisited: Reexamining the feasibility and cost impact of sustainable design in the light of increased market adoption.* Retrieved October 19, 2011, from http://www.greenbiz.com/research/report/2007/10/17/cost-green-revisited-reexamining-feasibility-and-cost-impact-sustainable-

Langdon, D. (2007b). *The cost and benefit of achieving green building*. Retrieved May 30, 2011, from http://www.davislangdon.com/upload/StaticFiles/AUSNZ%20Publications/Info%20Data/InfoData_Green_Buildings.pdf

Laurice, J., & Bhattacharya, R. (2005). Prediction performance of a hedonic pricing model for housing. *Appraisal Journal*, *73*(2), 198-209.

Miller, N. (2010). Does green still pay off? *The Journal of Sustainable Real Estate,* 1-8.

Miller, N., Pogue, D., Gough, Q., & Davis, S. (2009). Green buildings and productivity. *The Journal of Sustainable Real Estate,1*(1), 65-89.

Miller, N., Spivey, J., & Florance, A. (2008). Does green pay off? *Journal of Real Estate Portfolio Management, 14* (4), 1-21.

NAHBGreen. (2011). *About NAHBGreen.* Retrieved December 17, 2011, from http://www.nahbgreen.org/AboutNAHBGreen/default.aspx

Parlow, M.J. (2008). Greenwashed?: Developers, environmental consciousness, and the case of playa vista. *Marquette University Law School Legal Studies Research Paper Series, 35*(08-05), 513-532.

Persram, S., Lucuik, M., & Larsson, N. (2007). Marketing Green buildings to Tenants of Leased Properties. *Canada Green Building Council*.

Pitts, J., & Jackson, T.O. (2008). Green buildings: Valuation issues and perspectives. *The Appraisal Journal, 76*(2), 115-118.

Regelson, K. (2005). *Sustainable cities*. Retrieved June 26, 2011, from http://rmc.sierraclub.org/energy/library/sustainablecities.pdf

Simons, R., Choi, E., & Simons, D., (2009). The effect of state and city green policies on the market penetration of green commercial buildings. *Journal of Sustainable Real Estate, 1*(1) 139-166.

Simmons, J. (2011). *Office of Sustainability and Environment.* Retrieved March 21, 2011, from http://www.seattle.gov/environment/

Stock, J., & Watson, M. (2007). *Introduction to econometrics.* Boston, MA: Addison Wesley.

U.S. Census Bureau. (2011). *What We Provide.* Retrieved January 24, 2012, from http://factfinder2.census.gov/faces/nav/jsf/pages/what_we_provide.xhtml

U.S. Green Building Council. (2011). *About LEED.* Retrieved December 17, 2011, from http://www.usgbc.org/Default.aspx

Yudelson, J. (2008). *The green building revolution*. Washington, DC: Island Press.