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Economic and Environmental Benefits of Green Office Buildings

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List of Abbreviations

BREEAM	Building Research Establishment Environmental Assessment Method
CBECS	Commercial Building Energy Consumption Survey
EPA	U.S. Environmental Protection Agency
LEED	Leadership in Energy and Environmental Design
SF	Square Feet
UK	United Kingdom
U.S.	United States of America
USGBC	U.S. Green Building Council

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Abstract

The underlying study contributes empirical evidence for the economic benefits of certified green office buildings in form of rental premia. On top of that, the costs arising from green certifications, potential intangible value benefits and the environmental benefits of green office properties are examined. In the empirical part, property data from 1,608 certified green buildings and 4,643 non-certified comparables in the U.S. market are matched to investigate the economic impacts of green certifications. A hedonic regression model is conducted to point out the effects of green ratings by the LEED and Energy Star rating system on the weighted average rent of green office real estate. The results from the hedonic model suggest that labeled office buildings show up to 12 % higher average rents than conventional non-certified properties. Additionally, it is found that certified green buildings also provide a wide range of environmental benefits.

1 Introduction

1.1 Problem Definition and Objective

In times of worldwide climate change, increasing scarcity of natural resources, as well as huge CO₂-emissions need and demand for sustainability has reached nearly all fields of business. Especially in the real estate sector, the requirements for new and existing properties are rising significantly. Due to the fact, that buildings account for roughly about 40 % of energy and raw material consumption and approximately 30 % of greenhouse gas emissions, the real estate industry has already become aware of the outstanding necessity of incorporating sustainable issues into buildings (Royal Institute of Chartered Surveyors, RICS, 2005). Therefore, the performance of properties has become comprehensively measurable, and the benefits of “Green Buildings” have been recognized by developers and construction companies. Apart from that, several intelligent technologies and products, such as specific green building certification systems and several energy saving devices are offered on the property markets. Particularly with respect to the development of future real estate projects, the necessity of incorporating sustainable issues becomes apparent. A statement that underlines this need was given by Rick Fedrizzi, president, CEO, and founder of the U.S. Green Building Council, who said: “Over and over again, Americans are saying the same thing: The key to a prosperous future is sustainability, and the triple bottom line - environmental responsibility, economic prosperity and social equity – is imperative as we move forward” (Katz, 2009).

Besides the environmental necessity of “Green Buildings” and incorporating sustainable issues into properties, the cost factor also plays a very important role in the real estate business and it is gaining increasing interest within property markets. Since energy costs account for approximately 30 % of a building’s operational costs in an average office building (FY Power, 2010), the optimization potential becomes rather apparent. In order to maintain further sustainable development in the real estate industry, several rating systems have been established. The most common rating systems for “green” and “sustainable” buildings are LEED, Energy Star, and Green Globes for the United States, Green Star for Australia, and BREEAM (British Research Establishment Environmental Assessment Method) for the United Kingdom. The systems are also used and applied to the European countries, which are so far in a developing stage for own certification

systems. Besides the already established and widely used certification systems mentioned before, the individual European countries are constructing their own certification systems. On the basis of these rating systems the energy efficiency and the sustainability of properties can be determined. Yet, however there is no reliable data on European “green office buildings” publicly available. This is due to the fact, that currently the number of rated “green buildings” is limited but increasing, as governments and industries support the “green” development (BRE, 2008). Nevertheless, ecologically efficient measures are proven to be profitable respectively for strategic as well as investment decisions (Margolis and Walsh, 2003).

According to the information given, the question arises, what effects do green certifications particularly by LEED and Energy Star, have on office real estate? As a matter of fact, the following research questions for the underlying study evolve:

1. Do green certifications impact rental rates of office buildings?
 - a. If yes, to what extent are office rents affected by green certifications?
 - b. Which rating system has a greater impact, LEED or Energy Star?
 - c. What are the monetary effects for investors and owners?

2. What are the environmental benefits of green certified office buildings?
 - a. What are the potential intangible value benefits for owners, investors, and tenants?

1.2 Course of the Investigation

With reference to the steadily rising market for “green” and sustainable products, environmental and economic issues gain more and more of the focus of attention. A broad number of special certification systems for “green buildings” has established within the real estate markets. These real estate certification systems, like for instance LEED and Energy Star, try to quantify and qualify environmental costs in order to optimize and reduce them.

Sustainable construction of buildings strives for a minimization of energy and resource consumption and a very low contamination of the environment in all sections of the property life-cycle (SABD, 2005). In line with these friendly developments in the real estate industry, several value determining factors are affected. On the one hand, the environmental issues of “green office buildings” affect intangible assets like corporate reputation and trust. On the other hand, the economic issues of “green office buildings” result in greater productivity of buildings in terms of lower operational costs due to higher energy efficiency. Apart from that, it is important to investigate the exact impacts of “green office buildings” on rental rates and therefore property values, which are suggested to be respectively higher. Therefore, owners, investors and tenants could probably receive premia from “green office buildings” regarding costs savings, returns, and risk.

Consequently, this study attempts to quantify the economic and environmental benefits from certified “green office buildings” on rental rates. In order to determine the precise impact of green certifications on office properties, an empirical analysis is conducted on a data sample of certified and non-certified office buildings in the United States. Further, the costs of green certifications in connection with potential intangible value benefits are examined by reporting and comparing the results of several studies providing research about these issues. In addition to that, the benefits of “green office buildings” towards the natural environment will be analyzed with respect to studies and articles regarding the natural issues. Here, the benefits of “sustainable office properties” are related to environmental problems, like pollution in terms of CO₂-emissions, the climate change, and the scarcity of natural resources, in order to give future prospects. Respectively, the connection between sustainable development and green certification of office buildings are discussed.

The underlying study on economic and environmental benefits of green office buildings is organized by the following structure.

In Section 2, the relation between sustainable development and green office buildings will be described. In coherence to that, the evolution of incorporating sustainable elements within office properties will be examined. This includes a depiction of demand and necessity for sustainable development in office real estate. Furthermore, the main

European and U.S. certification systems like BREEAM, LEED, and Energy Star are explained as well as the marketability of green office properties will be described.

Section 3 serves as an introduction to the underlying empirical analysis by giving information about the data set used. Thereby, the source of data and precise numbers summarizing the complete data set and the analysis sample will be illustrated.

Section 4 will explain the specifics of the constructed hedonic regression model, and the results of the conducted regression are going to be presented. The empirical analysis of the underlying study investigates potential economic benefits of the certified “green properties” in comparison to comparable non-certified buildings. The properties in the analyzed sample are related to each other by a hedonic regression model in order to investigate differences between values and rental rates of certified “green buildings” and non-certified properties.

Section 5 provides an analysis of the costs of green certifications and environmental issues related to green office buildings. Additionally, the link between sustainable development and green certification, with respect to environmental benefits are examined. Further, potential intangible value benefits arising through the certification of green office buildings are discussed.

Section 6 will summarize the findings of the underlying study and a conclusion is drawn. Finally, the future prospects and an outlook for this respective field of study are provided.

2 Sustainable Development and Green Office Buildings

“Green buildings are designed, constructed, and operated to boost environmental, economic, health, and productivity performance over that of conventional buildings” (USGBC, 2002). In accordance with this definition of the term “green building”, it is worth mentioning, that green building also stands for ”sustainable” and “high-performance” building (Baum, 2007).

In the following subsection, the current state of the art of sustainable development of new properties and the establishment of existing green buildings will be described and explained. This is structured by depicting demand and necessity for sustainable development, giving an overview over the current market conditions for green properties, and introducing the most influential European and U.S. certification systems.

2.1 Demand and Necessity for Sustainable Development in Real Estate

As already mentioned in the introduction, within times of worldwide climate change, increasing scarcity of natural resources, as well as huge CO₂-emissions need and demand for sustainability has reached nearly all fields of business. Especially in the real estate sector, the requirements for new and also existing properties are rising significantly. It is proven that buildings account for 39 % of greenhouse gas emissions in the United States and about 50 % in the UK respectively (Climate Change Corporation, 2009). As a result, the real estate industry has already become aware of the outstanding necessity of incorporating sustainable issues into buildings (Royal Institute of Chartered Surveyors, RICS, 2005). Therefore, the performance of properties has become comprehensively measurable, and the benefits of green buildings have been recognized by developers and construction companies. Apart from that, several intelligent technologies and products are offered on the property markets, such as, different green building certification systems as BREEAM, LEED, and Energy Star. These are available in particular versions for the assessment of a range of property types. Further, a lot of energy saving technologies, like special heating systems, etc. have been developed in order to support green certifications.

According to the current demand situation in the real estate markets and the findings presented in the RREEF research report by Nelson, it can be observed that the global

warming has become an emerging mainstream concern that drives the actions of major companies (Nelson, 2007). Moreover, the report states that since real estate can be regarded as one of the biggest consumers of natural resources, efforts to reduce the “carbon footprint” of business-related activities are increasing. Furthermore, and especially as a result of government regulations, public pressures, and new business opportunities, companies “compete in being most green”. This new trend leads to a steadily growing demand for socially-conscious investment vehicles like green real estate properties, which is reflected by the fact that the spending for these socially-conscious investments was growing by ten times as much to nearly \$ 1.6 trillion within the last ten years (Nelson, 2007). The motivation for the increased investments can be attributed to possible competitive advantages and the potential of gaining outsized returns from entering this new field of business. Hence, that actually shows that organizations across the real estate sector recognize the necessity and importance of taking care of environmental challenges (Nelson, 2007). This observation is in line with a statement of the managing director of Jones Lang LaSalle Chicago, Elaine Melonides, who said: “A company like Ernst&Young hires thousands of employees each year out of college, and many of those young workers want to align with companies that are looking to improve the environment” (Barista, 2008). This statement can be seen as a rather good example of the current state of the general opinion within the economic sector towards the development of sustainable real estate. Moreover, the statement above and the rising number of short-term developers investing in LEED-certified properties can definitely be regarded as a rather positive development of “green’s coming of age in the financially driven commercial office world” (Barista, 2008). Additionally, another survey in this respective field of study pointed out, that three-quarters of the respondents are planning to incorporate sustainable issues into their future projects because of the rising energy costs (Mortgage Banking, 2009). The facts and statements quoted above clearly point out the importance of sustainable development in real estate. It becomes apparent that the necessity for sustainability and green issues within the real estate sector is not only based on economic benefits but, also on environmental issues. Thus, the demand for green and sustainable development in real estate is expected to rise continually which is also confirmed by the given statements of executives from real estate companies.

2.2 European and U.S. Certification Systems for Green Office Buildings

“During the last decade, the willingness to pay a premium for ecologically efficient buildings has risen, and consequently, the supply for sustainable buildings has risen to satisfy the demand” (Schuster, 2009). Together with this development, the landscape of certification systems for green buildings changed and gained more and more importance. The field of building environmental assessment has matured remarkably quickly since the introduction of BREEAM in 1990. In general, “the certification codes label and rank sustainable buildings in order to increase market transparency” (Schuster, 2009). The majority of these certification codes are country-based; however, there are three internationally accepted labels. The three main certification standards are known to be BREEAM, LEED, and Energy Star. According to the statistics provided on the websites of the respective rating systems, BREEAM has the highest amount of certified properties followed by Energy Star and LEED. BREEAM has around 100,000 buildings under certification (BRE, 2007), Energy Star has certified nearly 9,000 buildings (Energy Star, 2009-d), whereas LEED accounts for approximately 14,000 certified properties (USGBC, 2009-a). Although, the certification systems are growing internationally, they are still rather country based and therefore the comparability of the numbers is restricted. However, all these major certification systems are third-party systems, which quantify the environmental sustainability of both new and existing properties. So far the application of the certification systems was not mandatory. However, from now on it is mandatory in some U.S. states to build according to the LEED standards when publicly funded developments are realized. For example, in California all new state funded properties have to meet certain LEED standards, in Los Angeles all government buildings over 7,500 SF and in San Francisco all municipal buildings over 5,000 SF need to be built after LEED standards (Falk, 2007). Furthermore, in Boston and Washington DC, public and private commercial properties over 50,000 SF are required to be constructed according to LEED (Falk, 2007). Similar to the regulations in the U.S., a BREEAM certification is recommended for all new properties in the UK (Climate Change Corporation, 2009).

One can find certain differences within these conducts and a particular divergence in geographic magnitude. Most of these voluntary certification and rating systems for green buildings have grown in scope. The following section will give an overview of these certification systems as well as their meaning.

2.2.1 BREEAM

The British Building Research Establishment Environmental Assessment Method, short BREEAM, is the oldest and first certificate for sustainable assessment on the market. BREEAM was founded in 1990 and became with 100,000 certified properties alone in the United Kingdom, and about approximately 700,000 properties currently registered for assessment, the most widely used certification standard in the world (BRE, 2007).

Within the BREEAM environmental building assessment method several different versions are offered in order to assess different property types. Next to the most important versions like office, housing, and industrial properties, also specialized versions as for instance BREEAM: prisons or BREEAM: healthcare, are available. All these versions of the BREEAM certification systems are updated and extended on a regular basis in order to maintain accuracy in the assessments. Separately, it is worth mentioning that this certification standard can be applied to both existing properties as well as to properties under development.

Properties that are assessed receive credits within nine categories, which altogether reflect the overall performance of a building and lead to the final category scores of the property under assessment. Hence, the weighted average of the single category scores results in an overall score on a scale of Pass, Good, Very Good, Excellent, and Outstanding (Climate Change Corporation, 2009). The Following illustration depicts the single steps and input for the BREEAM rating process:



Figure 1: BREEAM certification process (Source: BRE, 2007).

Through a set of environmental weightings the sum of the category scores forms a percentage basis that is connected to the BREEAM overall rating (BRE, 2007). The certain scores are awarded at the following overall percentages:

- Unclassified < 30 %
- Pass > 30 %
- Good > 45 %
- Very Good > 55 %
- Excellent > 70 %
- Outstanding > 85 %

2.2.2 LEED

The LEED certification system was developed by the U.S. Green Building Council and stands for the term “Leadership in Energy and Environmental Design”. The USGBC is a non-profit organization, which consists of more than 11,000 companies in the U.S. property market. Objective of the USGBC is the promotion of sustainability in real estate properties. The most important and well-known development of the council is the LEED certification system. After the outcome of the first version of LEED in the year 1998, a significantly renewed version came on the market in 2000. Today, the latest

version of LEED is version v3, which is the product of a constant adaptation to changing market conditions (USGBC, 2009-a).

Generally, LEED can be described as an internationally recognized green building certification system. It measures, through third-party verification, to what extent a building reflects sustainability issues that improve the property's performance, such as, energy savings, water efficiency, CO₂ emissions reduction, improved indoor environmental quality, and stewardship of resources and sensitivity to their impacts (USGBC, 2009-b). The assessment process framework is quite similar to that of the BREEAM certification system. Accordingly, the LEED rating method is applied and evaluated on the six categories mentioned above. Within the rating system, different versions for different property types are available. More precisely, a building is evaluated by an application process, ranging from 5 to 17 points. In this application process, the properties receive the points for incorporating a particular green design feature as mentioned above or by achieving various benchmarks (Nelson, 2007). In the end, the building under assessment is granted one of the four certification statuses: Certified (lowest), Silver, Gold, and Platinum (highest) (The Nature Conservancy, 2009). The four possible rating stages are:

- Certified (26-32 points)
- Silver (33-38 points)
- Gold (39-51 points)
- Premium (52-69 points)

The specific distribution of the weighted points is depicted in the following figure. It is striking that the environmental issues assessed by LEED are quite close to those assessed by the BREEAM certification system.

Category	Points Available	% of total Points	Example
Sustainable Sites	14	20%	Land use & transportation Issues
Water Efficiency	5	7%	Water usage & reduction
Energy & Atmosphere	17	25%	Energy consumption
Materials & Resources	13	19%	Material & resource management
Indoor Environmental Quality	15	22%	Health & well-being issues, incl. Smoke protection
Innovation & Design Process	5	7%	Rewards for specific designs
Points Total Σ	69	100%	

Table 1: LEED Certification Point System (Adapted from: USGBC, 2008).

By having a closer look at Figures 1 and Table 1, the differences between the emphases of the BREEAM and the LEED rating systems become apparent. While the BREEAM certification system focuses on nearly all particular rating categories with the same emphasis, LEED makes specific distinctions within the weighting of the different categories. Table 2 illustrates the categories “Indoor Environmental Quality” and “Innovation and Design Process”, of which innovation and design are not included in the BREEAM certification process. Additionally, the category “Management” from the BREEAM assessment credits is omitted by LEED. This indicates that the LEED labelling process lays special emphasis on the property’s indoor environmental quality. A possible reason might be the specific characteristics of the most important market for each system. Since the LEED label is mostly adopted and used in the U.S. market, which consists of in most cases badly isolated properties, it might be an explanation for the special focus on the indoor quality by LEED.

2.2.3 Energy Star

Next to BREEAM and LEED, Energy Star is the third major building environmental assessment method. The Energy Star label can be characterized as a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy. It was invented in 1992 by the U.S. Environmental Protection Agency (EPA) with the target to

reduce costs and protect the environment. Energy Star is developed to identify and promote energy-efficient products to reduce greenhouse gas emissions (Energy Star, 2009-a). The first labelled products were computers and monitors. In the present, the EPA has extended the Energy Star Label with the assessment of new homes as well as commercial and industrial buildings. Compared to BREEAM and LEED, the Energy Star certification system appears to be more popular for existing buildings (Fuerst & Mc Allister, 2008).

The Energy Star scheme evaluates buildings according to the assessment of the particular energy performance of the property. Thereby, buildings can receive a score on a scale of 100 points in total. First, the building under assessment is compared to a peer group of similar buildings that are selected by the Commercial Building Energy Consumption Survey (CBECS). The CBECS is accomplished by the Department of Energy and has determined the following peer groups: banks and financial institutions, courthouses, hospitals, hotels, K-12 schools, medical offices, municipal wastewater treatment plants, offices, residence halls/dormitories, retail stores, supermarkets, and warehouses (Energy Star, 2009-b). In the end, a minimum of 50 % of the assessed building's gross floor area must be assigned to one of the peer groups determined by the CBECS (Schuster, 2009). If the property under assessment receives 75 or more of the total 100 points, the building obtains an Energy Star certification.

2.3 The Marketability of Sustainable and Green Office Properties

As already mentioned before, green certificates awarded for office real estate rely on several aspects of sustainable construction. Therefore, investors and landlords of these buildings apprehend that certifications increase the marketability of office properties by the provision of benefits to potential buyers or tenants. From the buyer's perspective these benefits are especially: lower operating costs, better employee productivity, and improved image advantages in comparison to non-certified properties (Fuerst & Mc Allister, 2008). Accordingly, the listed benefits of green certifications should result in a rising and more profitable marketability of certified green office buildings. However, there are also some studies on the market that did not find evidence for the expectation that the benefits of certifications lead to higher base rents, since tenants require a proof for the enhanced productivity within certified green properties (Miller, Spivey, &

Florance, 2008-a). As a result, not all retrieved benefits of certified office buildings have increased the property's marketability for investors in the past years. However, the benefits mentioned above have gained increasing popularity and appreciation by people and especially tenants (Miller, Spivey, & Florance, 2008-a).

In the upcoming part the potential benefits obtained from certified green office buildings are further specified, and the green properties' marketability is addressed by explaining the different value-affecting advantages. First of all, the study of Eichholtz, Kok and Quigley (2009-a) stresses that eco-efficient investment in certified real estate raises the property's economic productivity in four different ways. According to the authors, these productivity improvements respond to resource savings, lower operating costs, decreasing gas emissions, and hedging against rising energy prices (Eichholtz, Kok, & Quigley, 2009-a). A good example for the mentioned value-affecting advantages of green buildings is the lower energy consumption. Studies report energy savings of approximately 28 % on average in LEED certified green buildings (Kats, 2003). These findings can be underlined by the results of another study investigating energy consumption of green buildings in the Canadian market. The authors of the article analyzed LEED-certified buildings and found out that these consume 18-39 % less energy per floor area than conventional properties (Newsham, Mancini, & Birt, 2009). Besides the energy consumption, the degree of environmental quality in green office buildings also affects their marketability. A higher degree of environmental quality in green offices bears the possible effect of increased employee productivity through an improved working environment (Porter & Van der Linde, 1995). As a matter of fact, it can be concluded that health and productivity costs are higher in office buildings that have a badly maintained environmental quality. Even though these effects are rather hard to quantify, potential tenants are willing to pay more for better indoor environmental quality (Eichholtz, Kok, & Quigley, 2009-a). In addition to the facts stated above, another survey regarding green building facts led to similar outcomes. In the survey 754 commercial real estate executives were interviewed, and the results suggest that 84 % of the respondents reported lower energy costs in green buildings. Moreover, 68 % experienced overall cost savings in green properties, and 72 % said that green certifications create higher building values (Turner, 2008). Particularly these answers and statements by the executives of companies being active in the real estate sector, stress the growing importance of green buildings for property markets. On the

one hand, green properties are recognized to save money through lower energy consumption and on the other side green certificates are supposed to increase property values. As a result, it can be expected that certified green buildings gain increasing attention by investors. Since the financing of real estate is a crucial part of realizing projects it is important that potential investors or lenders realize and value the potential benefits of green certificates. With the purpose of providing a clear overview about the specifics of financing green buildings, the Green Building Finance Consortium was founded. In an interview for a journal, the founder and executive director of this consortium, Scott Muldavin, stated that the characteristics of sustainable construction can have positive effects towards lenders (Fulton, 2007). Further, Muldavin said that the problem is still that green buildings do not have special risk and valuation assessment approaches that serve lenders and investors as fiduciary responsibility. However, some banks have started offering discounts and greater loan-to-value ratios for the financing of green building projects (Fulton, 2007).

In accordance with these statements and the range of potential benefits from certified green buildings, it becomes rather apparent that sustainable properties show a high potential marketability. The more the benefits of certified green buildings are realized and assessed, the bigger the opportunities for special financing and investments for labeled properties will be. In the end, most people in the commercial real estate and construction industry “believe that demand for green building is going to grow rapidly over the next five to ten years, as more dimensions supporting the benefits of environmental design become available” (Cardin, 2009).

2.4 Advantages and Disadvantages of Green Certification Systems and Green Buildings

In order to give an overview of the benefits and deficiencies of the main certification systems, mentioned before in this section, the most important facts and specifications are summarized once more. Additionally, the general advantages and disadvantages of green buildings are outlined.

By comparing the three certification systems BREEAM, LEED, and Energy Star it becomes apparent that the BREEAM and the LEED systems are quite similar in the evaluation of the properties. Both rating systems are updated on a regular basis and

provide different versions for particular property types. Furthermore, the systems can be applied for existing properties as well as for buildings under development. Although, both BREEAM and LEED rely on very similar rating categories, the LEED certification system provides a special category for “Innovation and Design Process” which is not included within the BREEAM system. In addition, the category “Management” is omitted from LEED categories. Hence, the emphases of the two certification systems become apparent. Whereas LEED puts special emphasis on the property’s indoor environmental quality, BREEAM focuses more on the management side of the property. Apart from that, BREEAM has more evaluation categories what allows it to make more precise distinctions in the evaluation process. In contrast to the two systems mentioned, the Energy Star label is more popular for existing properties than for projects in development phase. Furthermore, the evaluation process relies more specifically on the property’s energy performance.

Concerning the generally perceived advantages of certified green office buildings, most studies suggest that green properties account for lower operating costs, better employee productivity, and image advantages (Fuerst & Mc Allister, 2008). These benefits are recognized by owners as well as tenants. Hence, green office buildings provide an increased marketability according to several studies. However, besides all these advantages, green buildings also face certain burdens. The disadvantages of green properties mostly rely on cost issues coming along with achieving a green rating. Since a certification bears additional costs it is often questionable whether the benefits outweigh the costs. Apart from that, so far green buildings did not have specific risk and valuation estimation methodologies that are required by investors and lenders (Fulton, 2007).

The particular economic benefits will further be examined in the subsequent sections, where also costs and environmental benefits of green office buildings are discussed.

3 Empirical Analysis - Data

3.1 Source of Data

Data collection for this respective field of study is a rather difficult task. According to the fact, that the market for “green buildings” in the Netherlands, the United Kingdom, Germany and the rest of Europe is still in a development phase there is almost none or very little data on transaction prices, rental rates, and other performance-related facts of certified buildings available. This is due to the fact, that in the mentioned countries only a rather small number of certified green buildings exist. The only European country, which has a complete data collection of the certified buildings in its national market, is the United Kingdom. However, the data was collected by the Investment Property Databank (IPD) only for own research purposes. As a matter of fact, this data is, according to Christina Cudworth, the global head of Sustainability at IPD, not yet publicly available (this information is based on a conversation with Mrs. Christina Cudworth via email and telephone in May 2009). Hence, the data set used in the underlying study contains performance data from certified green buildings and non-certified comparables in the United States. The certified properties are rated by the LEED and the Energy Star system. All the data is retrieved from the CoStar Group, which claims to offer the biggest and most complete database of commercial real estate data in the U.S. (CoStar Group, 2009). The service provides micro data on a huge number of commercial properties in all U.S. markets. Most important for the underlying study is, that CoStar holds information regarding the buildings’ micro data, such as, exact geographic locations, tenancy and rental regulations, as well as hedonic features of the listed properties.

3.2 Data Description

In the following subsection, general and specific information concerning the data set used in the underlying study will be given. Therefore, distinctions are made between the complete data set and the cleaned regression or analysis sample. Further, specific characteristics and differences of certified green and non-certified properties are provided.

3.2.1 Data Set

As already mentioned at the beginning of this section, the complete data is retrieved from the CoStar database. Further, the observations used here focus on commercial office real estate in the entire U.S. market.

In the focus of the underlying study, the data of all collected office buildings is divided into two groups. The first sample contains certified, green-rated office buildings, whereas the other sample provides data on non-certified office comparables. The certification of the buildings in the data set corresponds to the rating of the specific property regarding to its environmental, economic, health, and productivity performance (USGBC, 2002). This individual performance rating and the following classification occurs according to the standards of the LEED and Energy Star rating systems, which are described in Section 2. The comparables sample, on the other hand, consists of conventional, non-certified office buildings that have no special features, which justify a green rating according to one of the two rating systems. Therefore, these observations serve as comparables for the hedonic regression analysis to point out positive or negative effects of a green certification against non-certified properties.

The complete data set was retrieved from the CoStar database in August 2009, and consists of altogether 10,881 U.S. office properties. These observations are spread out over 73 different U.S. markets. Further, the sample can be divided into 1,938 certified green buildings and 8,943 non-certified comparables. More precisely, 1,771 properties are Energy Star rated, 157 LEED certified, and 75 observations are labelled by both rating systems. The biggest U.S. markets for certified green office properties rated by LEED and/or Energy Star in the underlying sample, are: Los Angeles, Denver, Washington DC, Orange (California), Chicago, and San Francisco.

In comparison to the total numbers of LEED and Energy Star certified office properties, it can be added that in August 2009 there are 7,807 Energy Star rated properties in total, of which 3,136 are office buildings (Energy Star, 2009-c). Furthermore, the total number of LEED certified projects amounts 2,476, whereas a total number of 19,524 projects are registered and therefore await a LEED certification in the future (USGBC, 2009-c).

3.2.2 Analysis Sample

Due to the fact that some of the listed properties in the data set were lacking different property specific characteristics, like weighted average rent, total available space, building class, etc., these incomplete observations had to be dropped. Accordingly, from the 10,881 observations in the original sample, the final amount of 6,251 properties is matched in the actual analysis sample. These observations contain 1,608 certified green office buildings and 4,643 non-certified comparables. In order to quantify potential economic benefits of green certifications on the weighted average rents of office properties, the analysis sample had to be clustered into submarkets. Therefore, the initial 73 markets were subdivided into 571 submarket clusters. These refer to particular subdivisions of the U.S. markets and cohere economically and geographically together. The number of observations in each submarket cluster differs as a consequence of altering market densities.

3.2.3 Specifics of Certified Properties and Comparables

Besides the simple quantitative numbers summarizing the data sample, there are a couple more qualitative predictions that can be drawn from the statistical summaries of the underlying observations. Here, it is already possible to observe some indicative differences and specifications between certified and non-certified properties. To begin with, Table 2 depicts all building characteristics that serve as independent variables in the regression model and provides a description of the particular variables.

Independent Variable	Specification
Total Available Space	Complete space that is provided in the property expressed in square foot (SF)
Direct Vacant Space	Accounts for all current vacant space in the property expressed in square foot (SF)
Green Certification	Indicates whether a property is certified by one or both of the two certification systems *
LEED Certified	Indicates whether the property is certified by LEED *
Energy Star Certified	Indicates whether the property is certified by Energy Star *
Building Class	Specifies the quality of the building, divided into Class A and Class B * [<u>Class A</u> : "Extremely desirable investment-grade property with the highest quality construction, significant architectural features, first rate maintenance and management, etc." Mostly not older than 5 - 10 years, otherwise renovated, provides many amenities and excellent location. <u>Class B</u> : "Offers more utilitarian space without special attractions. It will typically have ordinary architectural design and structural features, with average interior finish, etc. This is generally considered to be a more speculative investment." (CoStar, 2010)]
Number of Stories	Specifies the height of the building expressed by the nr. of stories, 3 categories "Low" (1 - 26), "Intermediate" (27 - 52), and "High" (53 - 77) *
Age	Relates to the Year of construction, expressed in ages, 5 categories: <10 Years/10-20Years/21-30 Years/31-40 Years/41-50 Years *
Amenities Provided	Indicates whether the property provides specific extras of any kind * ["Special characteristics that can enhance a property's appeal. For example: 24/7 Building Access, Balconies, Concierge, Food Court, Retail Shops, Security, Waterfront, etc." (CoStar, 2010)]
Renovation Status	Indicates whether the property has been renovated *
Note: * indicates that the variable is a dummy variable. (All definitions provided in this table relate to the variable descriptions by the CoStar database.)	

Table 2: Independent Variables of the Regression Model. (Information adapted from CoStar, 2010)

The variables described in the figure above build up the independent variables for the following regression model. In Table 3, the data summaries of the underlying observations are provided. Table 3 provides some statistics of the weighted average rent, the total available space, the direct vacant space, the building height in stories, and the age of the observations in the sample. Statistics are given for the total number of properties, for the certified green buildings in the sample, and the non-certified comparables. First of all, it can be noted, that the green buildings in the sample have a higher mean of weighted average rents than the comparables. More precisely, the weighted average rents of certified office properties in the sample are 23.4 % higher than from the non-certified buildings. The green properties analyzed here have a rent of

about \$ 26.2 per square foot on average and the comparables account for an average of \$ 21.2 per square foot. Secondly, the non-rated properties are substantially smaller on average than the certified buildings. Here the mean of the green buildings' total available space is 62,083 SF (=5,767.7 m²), whereas the non-certified properties have 17,007 SF (=1,580 m²) on average. Apart from that, the vacancy rates in the data sample show quite huge differences between certified and non-certified observations. The green buildings in the sample show an average vacancy rate of 70.65 % in contrast to 2.44 % within the non-certified buildings. The reason for this very high vacancy percentage within the certified properties lies in the variable "Direct Vacant Space" that accounts for the vacancy, downloaded from the CoStar database. The variable refers to all space in a property that is currently unoccupied. Thus, also space that is contractually rented out but where the tenant has not moved in yet, is also counted as vacant. Since, the certified properties are mostly rather new buildings, a lot of space is rented out but the tenants have not moved in yet. That is why the vacancy rate stated here is abnormally high. As a consequence, the further regression will show no specific significance of this variable on the results. Additionally, sensitivity tests regarding the vacancy did not bring up any evidence for special influence by this variable. Furthermore, it can be observed that the green properties, analyzed here, are in most cases (77.9 %) class A rated and are therefore of a higher quality standard than the comparables (18.2 %). Another striking difference can be noticed within the building heights in the sample. It can be observed, that the green properties on average have around 13 stories, whereas the non-rated buildings account for 3 stories. In addition to that, all green buildings in the regression sample provide amenities. Of the non-certified properties only 53.3 % provide amenities. Finally, the two only hedonic characteristics, which do not show outstanding differences among the two groups of properties, are "Age" and "Renovation Status". The non-certified buildings in the underlying sample are 27 years old on average, whereas green buildings have an average age of 24 years.

Total	Rent \$/SF	Space SF	Vacancy %	Height Stories	Age Years
Mean	22.45	28597	20.00	5.81	26.78
Std. Dev.	9.79	50474	51.00	8.33	24.85
Observations	6254	6254	6254	6254	6254
Certified	Rent \$/SF	Space SF	Vacancy %	Height Stories	Age Years
Mean	26.16	62084	71.00	13.17	24.23
Std. Dev.	9.80	70345	56.00	12.32	16.78
Observations	1608	1608	1608	1608	1608
Comparables	Rent \$/SF	Space SF	Vacancy %	Height Stories	Age Years
Mean	21.17	17007	2.00	3.26	27.66
Std. Dev.	9.46	34569	34.00	3.96	27.03
Observations	4646	4646	4646	4646	4646

	Building Class A %	Amenities Pr. %	Renovation %
Total	33.53	65.27	16.77
Certified	77.86	100.00	22.57
Comparables	18.19	53.25	14.77

Table 3: Differences and Specifications between the Hedonic Characteristics of Certified and Non-certified Properties in the Data Sample.

The graphs in Figure 3 show the densities of the observation's characteristics, weighted average rent, number of stories, and age of the property for certified and non-certified buildings graphically. Figure 3 a) indicates the weighted average rent, 3 b) the distribution of the number of stories, and 3 c) the age of the properties.

4 Economic Benefits of Green Office Buildings – The Hedonic Model & Results

This section provides a detailed description of the methodology and of the results retrieved from the empirical analysis of the underlying data set. First, the empirical model and its construction are described. Second, the results of the conducted regression are summarized and explained referring to the actual effects of green certifications on the average rents of office buildings.

4.1 The Empirical Model

The underlying study is meant to quantify and investigate the effects of a green certification by the LEED and / or Energy Star system on the average rent of an office property. Hence, a hedonic price model is constructed. By means of the constructed regression model, the characteristics of certified office properties are matched with the ones of non-certified comparables to investigate the differences in rents of office buildings.

In order to quantify the rental differences between the green certified office buildings and the non-certified comparables, several hedonic characteristics of the properties are tested for their specific impact on the rents. Thereby, the dependent variable in the regression model is the “Weighted Average Rent” of the buildings. The set of hedonic characteristics that is tested for the specific impact on rents in the analysis sample contains the following variables which serve as independent variables in the model: total available space, direct vacant space, certification by LEED & Energy Star, building class, stories, amenities provided, and renovation status. Additionally, another dummy variable for a general certification by either LEED or Energy Star or both rating systems was created. The independent variables included in the regression model are already explained in Table 2 in Section 3.2.3. To account for regional differences between the observations in the sample, the data is clustered into regional “Submarket Clusters”. As explained before, these submarkets refer to particular subdivisions of the U.S. markets and cohere economically and geographically together. As a matter of fact, the division of the data into a total number of 571 submarket clusters allows the creation of more definite regional comparisons and stresses closer coherences between the observations. This is due to the fact that submarket clusters refer to geographically and

economically closer regions than, for instance, a division of the data according to complete markets.

4.1.1 Model Specification

To investigate the precise impact of a green rating on the rents of the office buildings in the data set a hedonic regression model is constructed. In the model, the hedonic characteristics of the office buildings, including variables for a green rating by the LEED or Energy Star system, are matched with the particular rents of the observations in the data sample.

The variables used in the underlying model can be summarized as follows. As mentioned above, the aim of the constructed model is to measure the main impacts on the rental rates of the office properties in the data sample. Hence, the dependent variable is the weighted average rent. Secondly, the independent variables tested in the model include total available space, direct vacant space, building class, number of stories, age of the property, amenities provided, and renovation status. In addition to these explanatory variables, dummy variables for a green certification by the LEED and Energy Star label are tested. Apart from that, the variables building class, number of stories, age of the property, amenities provided, and renovation status are included in the model as dummy variables that are clustered further into subdivisions. Building class is divided into Class A and B properties, Number of Stories has three categories (low, intermediate, high) and age is clustered into five categories (<10 years, 10-20 years, 21-30 years, 31-40 years, 41-50 years). Thereby, some of the dummy variables are omitted the regression as default variables. The dummy variables that were chosen to be left out as default variables are the ones that have the least frequencies or observations in the particular category. In the underlying model, the variables “Building Class A”, “Number of Stories – Low”, and “Age 41-50 Years” are omitted and, therefore, serve as default variables to avoid the dummy trap.

To precisely measure the effects of a green certification on the office rents in the sample, the chosen variables are related in a hedonic regression model. Since the location of a property is a very important explanatory variable for the rental rate, a Fixed Effects Model is used here. Due to the fact, that underlying analysis sample contains a large number of observations, it is possible to perform a rather detailed

location classification in the model. For each location, more precisely for each of the 571 submarket clusters, a fixed effect dummy variable is used.

The general Fixed Effects Model is based on the basic condition that the omitted effects, c_i , are correlated with the included variables in the model (Greene, 2008). Hence, the basic model equation looks as follows:

$$Y_{ij} = D_{ij} \alpha_i + X_{ij} \beta + \varepsilon_{ij} \quad (1)$$

According to this fixed effects model equation, the dependent variable Y_{ij} refers to the weighted average rent of observation i in submarket cluster j . It is determined amongst others by the dummy variable D_{ij} in connection with the unknown parameter α_i that serves to apprehend discrepancies across the groups (Greene, 2008). Further, $X_{ij} \beta$ expresses the variant regressor for the different submarket clusters and ε_{ij} represents the error term. As explained above, the Fixed Effects Model is chosen since it accounts for the location which is an important variable for predicting the rent. This relates to the supposition of the Fixed Effects Model that differences in the constant term explain differences between groups (Greene, 2008), to account for the effects on rental rates in the submarket clusters. In the underlying model log variables are used to account for the location classification in the regression. Hence, the actual model equation used is Equation (2) beneath.

(2)

$$\begin{aligned} \ln Y_{ij} = & D_{ij} \alpha_i + \ln tas_{ij} \beta_1 + \ln dvs_{ij} \beta_2 + LEEDC_{ij} \beta_3 + EnergyStarC_{ij} \beta_4 + BC_A_{ij} \beta_5 \\ & + SInt_{ij} \beta_6 + SHigh_{ij} \beta_7 + Age < 10_{ij} \beta_8 + Age10 - 20_{ij} \beta_9 \\ & + Age21 - 30_{ij} \beta_{10} + Age31 - 40_{ij} \beta_{11} + Am_Pr_{ij} \beta_{12} + Ren_{ij} \beta_{13} + \varepsilon_{ij} \end{aligned}$$

The explanation of the different variables in the equation refers to the definitions given above. Equation (2) further expresses the use of log variables and shows the specification of the abbreviations for the explanatory variables.

In the end, three models containing different variables are conducted. The main Model (1) contains all mentioned variables and tests the impact on the weighted average rent. In the second Model (2), the effects of a green rating by both certification systems,

LEED and Energy Star, at the same time are tested. This regression is constructed in order to investigate whether a rating by both systems at once has further positive effects on the rent. The third Model (3) contains only the following variables: total available space, direct vacant space, building class and a variable for the building's green certification in general are tested. Different to the first main regression, no distinction is being made between a green certification by LEED or Energy Star in Model (3). Only the value of a green certification in general is tested. The intention of the Model (3) is to make inferences about the impact of a green certification and to compare the magnitude of the impact of a certificate in general to the impact of a particular rating system. Furthermore, it is intended to investigate whether one of the included variables in the second regression is altering if the rest of the variables are omitted.

4.1.2 Model Estimation

The final regression is accomplished by the ordinary least squares technique. With respect to the Fixed Effects Model equation explained in the previous subsection, the model was built up according to the subsequent steps: after cleaning the data set due to incomplete observations, dummy variables for the characteristics LEED and Energy Star certification, building class, number of stories, age, amenities provided, and renovation status were constructed. Additionally, the dummy variables building class, number of stories and age are clustered further into subdivisions as expressed above. In the second step, the natural logarithm of the dependent variable "Weighted Average Rent" and the independent variables "Total Available Space" and "Direct Vacant Space" were calculated. Further, the means of all observations in each submarket cluster are calculated for all existent clusters and the complete set of variables including the dummy variables.

In the next step, the deviation of each property from the mean of the referring submarket cluster was determined. This is done by subtracting the submarket cluster's mean from the actual observation. It is important to mention again, that the dummy variables with the least frequencies were omitted as default variables to avoid the dummy trap. Finally, the deviations of the natural logarithm of the dependent variable weighted average rent and the independent variables total available space and direct vacant space formed the

input for the final regression together with the deviations of the dummy variables specified before.

4.2 Hypotheses

In coherence with the data retrieved, the model construction and the testing of the hedonic characteristics, it is expected that certified green buildings provide rental premia. Hence, the regression is conducted to prove that the independent variables LEED and Energy Star certification have a significant impact on the weighted average rent as dependent variable Y_{ij} . It is assumed, that the office properties with a green certification by the LEED and/or Energy Star certification system charge significantly higher rents than the conventional non-certified office buildings in the data sample. In connection to that, it is expected that in general vacant space and total available space affect the rent of office properties negatively. Furthermore, the variable for high quality class A properties is supposed to have a positive effect on the rent.

With respect to Equation (2) depicted in Section 4.1.1, the hypotheses stated above can be expressed more precisely by their corresponding coefficients. Thus, the subsequent hypotheses for the following regression are drawn:

- LEED Certification $\beta_3 > 0$
- Energy Star Certification $\beta_4 > 0$
- Total Available Space $\beta_1 < 0$
- Direct Vacant Space $\beta_2 < 0$
- Building Class A $\beta_5 > 0$

To sum up, the regressions conducted here, are designed to provide evidence that a green certification of office properties by either the LEED or Energy Star rating systems increases the rents and therefore augments financial benefits. Further, the precise magnitude of the particular certification on the average weighted rent is depicted numerically. Apart from that, the results should serve as support for existing studies on this respective field of research.

4.3 Estimation Results from the Fixed Effects Model

Subsequent to the antecedent summaries of the data sample and the explanation of the empirical model, the results of the hedonic regression are illustrated and interpreted in this section. Table 3 shows the output of the first Model (1) executed, including all necessary numbers concerning the model. All results are presented according to the ordinary least square regression model. Further, the outcome of the regression analysis has been tested for heteroskedasticity by the White-Test using Heteroskedastic-Consistent Standard Errors (White, 1980). According to the test, the heteroskedasticity hypothesis can be rejected in the underlying regression. With respect to the Gaussian distribution in the conducted regression, it must be noted that the χ^2 is a quite high and therefore it is not totally normally distributed. In the underlying model, a qui-squared test is conducted. The test relies on the methodology of Doornik and Hansen (1994), which uses skewness and kurtosis to test for normality (Doornik & Hansen, 2008). Thereby, slight corrections to the sample are made to select for the multivariate model here (Doornik & Hendry, 2009). Figure 4 in the appendix illustrates the residual density of the analysis sample. The steep red curve depicts the distribution of the residuals in the sample. On the other side, the lower blue curve is the standard normal distribution. The graph indicates that there is a difference between the distribution in the sample of the underlying regression and the standard normal distribution. The complete results of Model (1) are illustrated in Table 4:

Variable	Coefficient	Standard Error	T-Value	T-Probability	Part. R ²
Total Available Space in SF	-0.0394	0.0028	-14.3	0.0000	0.0318
Direct Vacant Space in SF	0.0000	0.0000	-0.619	0.5358	0.0001
Green Certification:					
LEED-Certified	0.0999	0.0185	5.16***	0.0000	0.0042
Energy Star Certified	0.1228	0.0106	10.9***	0.0000	0.0186
Building Class A	0.1583	0.0093	15.8***	0.0000	0.0383
Nr. of Stories:					
Intermediate [27 - 52]	0.0589	0.0216	2.65***	0.0080	0.0011
High [53 - 77]	0.1273	0.0570	2.1**	0.0355	0.0007
Age:					
< 10 Years	0.0614	0.0139	4.28***	0.0000	0.0029
10 - 20 Years	-0.0007	0.0140	-0.0534	0.9574	0.0000
21 - 30 Years	-0.0169	0.0127	-1.34	0.1791	0.0003
31 - 40 Years	-0.0147	0.0146	-1.02	0.3099	0.0002
Amenities Provided	0.0271	0.0081	3.29***	0.0010	0.0017
Renovation Status	0.0031	0.0101	0.301	0.7634	0.0000
Constant	0.0000	0.0031	-0.0155	0.9877	0.0000
Sigma	0.2459	RSS	377.0684		
No. Of Observations	6251	No. Of Parameters	13		
Mean (WAR)	0.0000	se (WAR)	0.2625		
R ²	0.5847				
Adj. R ²	0.5419				

Notation: Significance is indicated in the T-Value column as *,** and *** for the levels 0.10, 0.05 and 0.01 accordingly.

Table 4: Regression Results Model (1). Effects of Green Ratings on Average Rents of Office Properties (Dependent Variable: Weighted Average Rent per Square Foot).

To begin to explain these results, it is important to note that the regression was conducted on a total number of 6,251 observations (divided into 1,608 green buildings and 4,643 comparables). The retrieved R^2 is 0.5847 which implies that 58.47 % of the variation in the average rent of the office properties is explained by the independent variables included. Further, the adjusted R^2 is 54.19 %.

From the results in Table 4 it can be observed that the total available space has a negative effect on the rent but at 0.000013 % this effect is rather minimal. Thus, this can be rejected for the analysis done here, since it shows no significance at the 10 %, 5 % or 1 % level. Also the vacancy shows a negative coefficient and should therefore decrease the rent of the properties in the sample by 3.94 % at an increasing vacancy rate. Yet, the direct vacant space turns out to also be insignificant at all tested levels.

The building quality of the properties in the analysis sample is categorized into class A and B, but as mentioned previously B was omitted as a default variable. According to the results, building class A tested significant at the 1 % level. More precisely, high building quality has the biggest effect out of all the variables on the average rent. Properties evaluated within class A show 15.8 % higher rents than the lower quality class B buildings. The next tested characteristic is the building height, divided into three groups regarding the respective number of stories. Table 4 indicates that building height has a positive significant effect on the average rent. Higher properties show higher rents, while buildings with an intermediate height (27-52 stories) account for an increased rent of 5.9 % relative to properties with only 1 to 26 stories. In line with this outcome, buildings of the category “high” (53-77 stories) show an increase in rent of around 12.7 % relative to the intermediate height properties. In addition to this, the age of the properties has been tested for its influence on the average rent of the office properties in the sample. Of the five building age clusters only one category is positively significant, and three are negative and insignificant. The fifth and final category for buildings 41 - 50 years old is left out as a default variable. The category for buildings with an age of less than ten years is significant and positive. Consequently, newer properties (< 10 years) have an almost 6.1 % higher average rent relative to properties older than 10 years. Building ages of 10 - 20 years, 21 - 30 years and 31 - 40 years seem to decrease office rents by 0.07, 1.7, and 1.5 % relative to the newer buildings. However, these variables are not significant. Additionally, on-site amenities and the renovation status were matched in the sample with regards to the average rent.

On-site amenities are significant on the 1 % level and have a positive effect on the rent. According to the results, the provision of amenities in a building raises average rents by about 2.7 %. Surprisingly, the renovation of a property is proven to be insignificant in this regression. A possible reason for the insignificance of the renovation status might be that the sample contains a lot of properties, which are very old and have thus been renovated years ago, so their renovation quality is just barely up-to-date. However, there is no proven evidence for this assumption.

Besides the different variables tested for impact on the average rent, the main focus of the regression was the impact of a green certification on the rent of office buildings. In order to test the effects of a green rating of a property the variables LEED-Certification and Energy Star-Certification were matched in the model. Both variables are proven to be significant at the 1 % level and positive what serves as evidence for perceived premia in office rents through green certificates. A certification according to the LEED rating system raises the weighted average rents by 9.9 %. On the other side, the Energy Star certification has a slightly larger impact on rents than the LEED certification. Through an Energy Star rating rents rise by 12.3 % relative to the non-certified properties in the sample.

In the second Model (2), the particular impacts and potential benefits of a rating by both LEED and Energy Star at the same time are examined. In the underlying analysis sample 101 properties are labeled by both rating systems. In comparison to the first model, here the number of observations in the regression is only 4,744, since only 101 properties are rated by both certification systems. The results of Model (2) can be observed in the following table:

Variable	Coefficient	Standard Error	T-Value	T-Probability	Part. R ²
Total Available Space in SF	-0.0438	0.0032	-13.9	0.0000	0.0390
Direct Vacant Space in SF	0.0000	0.0002	-0.223	0.8235	0.0000
Green Certification:					
Both LEED & Energy Star	0.1686	0.0304	5.13***	0.0000	0.0055
Building Class A	0.1788	0.0112	14.7***	0.0000	0.0435
Nr. of Stories:					
Intermediate [27 - 52]	0.1226	0.0396	2.92***	0.0035	0.0018
High [53 - 77]	-0.1054	0.2027	-0.549	0.5828	0.0001
Age:					
< 10 Years	0.0842	0.0160	5.07***	0.0000	0.0054
10 - 20 Years	0.0112	0.0162	0.688	0.4916	0.0001
21 - 30 Years	0.0016	0.0147	0.112	0.9111	0.0000
31 - 40 Years	0.0013	0.0172	0.0733	0.9416	0.0000
Amenities Provided	0.0309	0.0087	3.51***	0.0005	0.0026
Renovation Status	0.0078	0.0126	0.612	0.5406	0.0001
Constant	-0.0183	0.0040	-4.64	0.0000	0.0045
Sigma	0.2580	RSS	314.8432		
No. Of Observations	4744	No. Of Parameters	13		
Mean (WAR)	-0.0265	se (WAR)	0.2712		
R ²	0.5439				
Adj. R ²	0.4800				
Notation: Significance is indicated in the T-Value column as *, ** and *** for the levels 0.10, 0.05, and 0.01 accordingly.					

Table 5: Regression Results Model (2). Testing the Effects of a Rating by Both LEED & Energy Star.

The results of Model (2), illustrated in Table 5, show results close to the outcome of Model (1), but also bring up specific differences. Firstly, it is striking that like in Model (1) the variables total available space and direct vacant space are proven insignificant and negative. Second, building quality A is significant at the 1 % level, and increases the average rent by 17.9 %. This impact equals the results of the first regression. Differences can be found within the impact of the different number of stories on the average rent. For example, buildings with an intermediate height increase the average rent by approximately 12.3 %. The variable is tested significant at the 1 % level. Further, the variable accounting for buildings with a high number of stories in between 53 – 77 is insignificant and negative. This is in direct contrast to the results from the first Model (1), which show that higher properties have the biggest impact on the rent. With respect to the variables reflecting the age of the property, the results suggest that buildings younger than 10 years increase the rent by 8.4 %; all other age related variables are tested insignificant. Apart from that, it is proven that properties providing amenities show around 3.1 % higher average rents, and tested significant at the 1 % level. The renovation status is tested insignificant in this regression as well, again coherent to the outcome of the first regression.

With respect to the impacts of a green certification, Model (2) focuses on the effects of a rating by both LEED and Energy Star at the same time. The variable “Both LEED & Energy Star” is tested significant at the 1 % level. In addition, the results suggest, that a green certification by both rating systems also has a positive impact on the office rents in the sample. It increases the rent by 16.9 %. In comparison to the results retrieved in Model (1), a rating by both systems has a greater impact on the rent than a rating by only one system with an increase that is 7 % and 4.6 % higher than a single rating by LEED and Energy Star respectively.

Supplementary to the results of the main Model (1) depicted in Table 4 and Model (2), explained previously, a third regression Model (3) has been conducted to make additional implications. These results are illustrated in Table 6 as follows:

Variable	Coefficient	Standard Error	T-Value	T-Probability	Part. R ²
Total Available Space in SF	-0.0387	0.0028	-14	0	0.0308
Direct Vacant Space in SF	0.0000	0.0000	-0.528	0.5974	0
Green Certified	0.1364	0.0101	12.6***	0	0.0251
Building Class A	0.1775	0.0091	18***	0	0.0496
Constant	0.0001	0.0031	0.0024	0.9981	0
Sigma	0.2473	RSS	379.0919		
No. Of Observations	6203	No. Of Parameters	5		
Mean (WAR)	0.0000	se (WAR)	0.2624		
R ²	0.5824				
Adj. R ²	0.5395				

Notation: Significance is indicated in the T-Value column as *,** and *** for the levels 0.10, 0.05 and 0.01 accordingly.

Table 6: Regression Results Model (3). Testing for Effects of Omitting Variables.

As mentioned previously, here only the variables total available space, direct vacant space, building class and one variable for a green certification by either LEED or Energy Star are tested for their impact on the rent. The results show that like in regression Models (1) and (2) the variable total available space has a negative and very small impact on the weighted average rent, but is tested as insignificant. The same applies to the direct vacant space, which is also tested negative and insignificant. Furthermore, with omitted variables, the results show again that the quality of a property has a positive impact on the rent. The variable building class A is significant at the 1 % level and increases the weighted average rent by 17.8 %. This percentage is slightly higher than in Model (1). With respect to the variable accounting for the general impact of a green certification on the average rent of an office building, the results show significance on the 1 % level. Additionally, a green certification by either the LEED or the Energy Star certification system increases the average rent by 13.6 %. Compared to the findings of the first regression where the impacts of both rating systems were tested

separately, here the rent increase is 3.7 % higher than the results retrieved for a LEED rating and 1.3 % greater for a certification by Energy Star.

After reviewing the results from Model (1), depicted in Table 4, it can be summarized that the three variables with the greatest effect on the variations in the rents of analyzed office properties are Energy Star certification, building quality class A and number of stories high. Hence, class A, Energy star certified properties with a number of stories of 53 to 77 should show the highest rents. Also, the third regression conducted shows the same results by omitting different independent variables. Moreover, the variable for a green certification in general, without distinction between a rating by LEED or Energy Star, resulted in a rent increase through a green certificate of 13.6 %. Striking are the results retrieved from Model (2), as empirical evidence finds, that a rating of an office building by both certification systems, LEED and Energy Star, has a positive impact on the rent relative to a single certification. The results suggest that properties rated by two labels show increased rents by approximately 17 %. This rental premium is about 5 % higher than for single certifications. The implications for this difference might be related to the fact that if a property is rated by two labels, it provides even higher green standards than a building certified by only one label. Therefore, higher rent may be charged. In general these results are in line with the studies of Fuerst & Mc Allister (2008) and Eichholtz, Kok & Quigley (2009-a). The results of the study by Fuerst & Mc Allister show a significant rental premium for LEED and Energy Star certified green buildings almost equal to the percentage rental premium of Energy Star rated properties in the underlying regression. With respect to the results retrieved by Eichholtz, Kok and Quigley (2009-a), however, no significance for positive effects of a rating by the LEED certification system was found. In contrast to this, the underlying regression showed a significant positive effect of a LEED certification on office rents of 9.9 % a relatively high premium for the office rents in the sample. Furthermore, the premiums for green certifications, figured out by Eichholtz, Kok, and Quigley amounts a 1.9 to 2.6 % rent increase (Eichholtz, Kok & Quigley, 2009-a). In the underlying study the rental premium for green office certifications is much higher, with 9.9 % and 12.3 % for a LEED and an Energy rating respectively. The difference in the results may be attributed to the characteristics of the data samples used in regression and slightly different methods used. In contrast to the data used by Eichholtz, Kok, and Quigley, the data of the underlying regression is newer and therefore includes more observations. In

addition, building class C properties were omitted in the regression. The analysis sample of the study by Eichholtz, Kok, and Quigley contains about 1 % (approx. 6 observations) class C properties within the green sample and about 16 % (approx. 2,620 observations) within the comparables. Class C properties are generally older buildings of lower quality than class A and B properties respectively. According to the description of the CoStar database class C offices provide “below average maintenance and management, mixed or below tenant prestige, and inferior elevators and mechanical/electrical systems” (CoStar Group Inc., 2010).

5 Costs, Environmental Issues and Overall Economic Benefits

In this section, costs arising from green certifications, environmental benefits, and potential intangible value benefits through green labels are linked to the economic benefits of green office buildings. With respect to other existing studies that mainly focus on the costs and energy consumption aspects, the underlying study focuses predominantly on the effects of green certifications on rents and revenues of green offices. More precisely, it is tried to provide the perspectives of investors, owners, and tenants of green office buildings. This is done firstly by investigating the effects of a green certification by LEED and Energy Star on rental rates through the hedonic regression model in the previous section. Thereby, the data set used in the regression model includes newer and a significantly higher amount of certified properties in the data sample than existing studies. Subsequently, in the next subsections, the costs, the environmental and intangible benefits of certified green offices are discussed, with the environmental aspects split up into eco-friendly construction and energy efficiency issues. Further, the last subsection of this section concentrates on the financial aspects of green certifications from the investors' and owners' perspectives. In contrast to other papers on this respective field of study, this paper provides insights for the perspectives of investors, owners, and tenants by focusing on rental effects in combination with costs and environmental aspects of green office buildings.

5.1 Costs of Green Certifications

Even though the underlying regression results and other reference articles provide empirical evidence that a green certification according to the LEED and, or Energy Star rating system has a significant positive impact on office rents, the set-up costs arising from a certification cannot be neglected. Since, green certifications come along with these specific set-up costs, it is necessary to outweigh the benefits of green certifications with their costs to make inferences about the feasibility of a certification. Considering the prevailing opinion that green buildings are “a lot more expensive than conventional buildings and often not worth the extra cost” (Kats, 2003), the necessity to clarify and quantify the exact cost for a green certification becomes rather evident. In addition, it seems that people often have difficulties with the apprehension of the costs arising from green certifications due to a deficiency of information concerning the financial force

(Suttell, 2006). As a matter of fact, it is essential to analyze the costs arising from the construction of a green office building with reference to the increasing economic productivity benefits of a certification.

The costs arising from green certifications can be attributed to two major sources, certification costs and costs for constructing green space according to the norms of the rating systems. For example, LEED registration costs can be divided and quantified as follows:

- Project registration fee: \$ 450 for members and \$ 600 for non-members.
- Certification fee based on the size of the project and square footage: \$ 1,750 to \$ 17,500 for members to \$ 2,250 to \$ 22,500 for non-members.
- Commissioning agent: Starts at about \$ 15,000.

(Source: Environmental Leader, 2009)

A more precise, relative illustration of the costs coming along with a green certification according the LEED rating system, including registration costs, is depicted in the following table. With respect to a recent study, the total costs of a LEED certification amount to between 2 % and 11 % of a property's construction costs. Thereby, these costs are divided into costs for changing the current energy systems of a property into alternative eco-friendly systems and into design costs, documenting and compliance, which can also be regarded as "soft costs" (Northbridge Environmental Management Consultants, 2003).

Soft Cost Estimates

(Incremental cost as a percentage of construction costs)

	Best Estimate	Range
Design Costs	0.5%	0.4% - 0.6%
Commissioning	1%	0.5% - 1.5%
Documentation & Fees	0.7%	0.5% - 0.9%
Energy Modeling	0.1%	0.1%
Total	2.3%	1.5% - 3.1%

Table 7: Soft Cost Estimates (Source: Northbridge Environmental Management Consultants, 2003).

The costs mentioned in the beginning and in Table 7 should serve as a general overview of the structure of costs arising from a green certification. In order to analyze and disprove the argument that not building green is a matter of economics the outcomes of several studies dealing with green costs will be presented.

In a study by Greg Kats, 33 buildings across the United States were compared and yielded in the result that the average cost premium for green buildings is slightly less than 2 %, or \$ 3-5/ft² (Kats, 2003). This outcome provides proof that the costs arising from building green are actually less than generally assumed and estimated. Figure 2 illustrates the average cost premium of green properties with respect to the level of LEED certification for office buildings and schools.

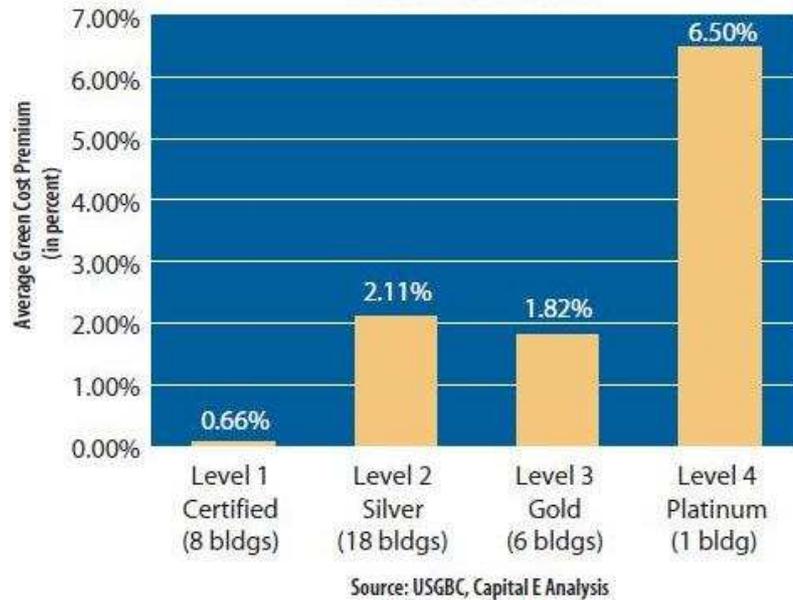


Figure 2: Average Green Cost Premium vs. Level of Green Certification for Offices and Schools (Source: Kats, 2003).

The numbers in the table indicate and empirically prove that the cost premium for green buildings amongst level 1 to 3 according to the LEED rating system is definitely lower than commonly expected. Only LEED level 4 has a comparably a rather high cost premium, but at 6.5 % it is still lower than the possible 11 % mentioned from other sources previously. However, after clarifying that the cost premium for green properties is contrary to general quotes quite low, another question concerning the costs arises. Consequently, it is questionable whether these additional costs arising from green certifications can be evaluated as an investment from a cash flow point of view.

In the paper of Kats, results suggest that sustainable green properties, certified by LEED, yield financial benefits of between \$ 50 and \$ 70 per square foot, which equals 10 times the additional costs arising from green construction (Kats, 2003). This effect was measured including the dimensions energy consumption, waste production, water usage, emissions and operational as well as maintenance costs. According to this, green properties provide financial benefits that dominate the arising costs (Kats, 2003). A further study conducted an analysis with an underlying sample of 643 buildings and concluded that both Energy Star and LEED certified properties produce net value gains that exceed the extra costs involved (Miller, Spivey & Florance, 2008-b). Additionally,

it was proven that besides energy savings, occupancy, rental values, and sales prices were positively affected by a certification.

These results from the different analyses clearly point out that the cost premium arising from green certifications do not constitute a financial burden that diminishes the rental premia achieved through a certification, as pointed out here in the empirical analysis. This conclusion is also underlined in another study by Eichholtz, Kok & Quigley, where it is stated that, “The higher initial outlay that may be needed for a newly developed sustainable office building, or for the refurbishment of an existing office building, can be reproduced through energy savings and lower risk premiums, or through higher net rents” (Eichholtz, Kok, & Quigley, 2009-c).

5.2 Sustainability and Environmental Benefits through Green Certifications

Since real estate is one of the world’s major energy consumers and is responsible for a large percentage of the greenhouse gas emissions, the implementation of green certification systems like LEED and Energy Star are seen as crucial part of the development of sustainable construction. According to different studies, real estate consumes 65 % of electrical use, 36 % of all energy use and is responsible for 30 % of greenhouse gas emissions in the United States (Guy, 2005). Politicians, the public and scientists have become aware of this fact, that the consumption of the earth’s resources exceeds the long-term capacity of available resources (Said, Osman, Mohd Shafiei, Razak & Rashideh, 2010). This stresses the importance of eco-friendly and sustainable development in the building sector to reduce energy consumption and greenhouse gas emissions. Thereby, sustainable development in this respect can be prescribed as, “the development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987). Sustainable development in the form of green office properties and green properties in general, is therefore a very important and efficient way of maintaining the needs of future generations and saving the natural environment.

Hence, green buildings can serve sustainable developments by providing three crucial characteristics (Alameda County, 2002):

- “Build for the long term – construct durable and long lasting buildings.
- Build for our children – provide a safe environment.
- Build for the planet – use materials from sustainable resources.”

Through the implementation of green certification systems like LEED and Energy Star construction companies, owners, and occupants are able to evaluate and measure the extent of “greenness” of a property. Especially for the construction industry this measurement is rather necessary to improve management and performance (Kühtz, 2007).

The potential environmental benefits of certified green properties mentioned previously above have been examined by several studies. The outcomes of the studies and the potential environmental benefits of green buildings can be expressed more precisely by different numerical results regarding savings and gains derived from certified buildings. Besides the general approach of maintaining sustainability, issues in the order of saving natural resources and protect the natural environment, certified green buildings provide a range of distinct environmental benefits which benefit owners or occupants as well as the environment. The environmental benefits of green properties are often closely connected with monetary savings through decreasing usage of resources and improved employee well-being. Hence, the key environmental benefits of green properties can be summarized as follows (Suttel, 2006):

- “Using key resources like energy, water, materials, and land much more efficiently than buildings simply built to code.
- They create healthier work, learning, and living environments by providing more natural light and cleaner air.
- They improve employee and student health, comfort, and productivity.
- They save money by reducing operations and maintenance costs, and also by lowering utility bills”.

With respect to energy consumption of certified green properties, the study of Kats points out that green buildings are 25-30 % more energy efficient than conventional buildings (Kats, 2003). Kats also mentions that this energy efficiency is characterized by electricity consumption. Additionally, green buildings are often designed to retrieve renewable energy on site and in general consume grid power from renewable energy sources (Kats, 2003). The following table illustrates the reduced energy consumption in certified green buildings relative to conventional non-certified properties:

	Certified	Silver	Gold	Average
Energy Efficiency (above standard code)	18%	30%	37%	28%
On-Site Renewable Energy	0%	0%	4%	2%
Green Power	10%	0%	7%	6%
Total	28%	30%	48%	36%

Table 8: Reduced Energy Use in Green Buildings as Compared with Conventional Buildings (Adapted from: Kats, 2003).

Through the numbers in the table, it is quite obvious that certified green properties, rated by LEED, are significantly more energy efficient and rely partly on renewable energy sources. In addition, other studies investigated that LEED certified properties decrease the energy consumption by 18-39 % per floor area compared to non-certified buildings on average (Newsham, Mancini & Birt, 2009). These numbers provide support for the results illustrated in Table 8. Besides this energy savings through improved energy efficiency, the usage of renewable energy sources benefits the environment due to cleaner and more sustainable energy production. Even though the percentage of use of renewable energy is still rather low, it clearly indicates a step into a cleaner environment through sustainable construction rated by the certification systems.

By having a closer look at the effects of indoor environmental quality on the productivity of the employees the importance and opportunities of a high indoor quality in offices becomes apparent. Green certificates in particular support high indoor environmental quality, which can be observed by looking at the rating categories described in section 2. In regards to addressing occupant productivity and health, in the study of Kats it was found that poor indoor environmental quality (IEQ) in commercial

properties causes quite severe health and productivity costs (Kats, 2003). Further, it was stated in the paper that these costs are assumed to amount hundreds of billions of dollars yearly. Since it is claimed that a LEED certification, for instance, creates a safer and healthier environment (Eichholtz, Kok & Quigley, 2009-b), this certification should thus provide the potential to save costs. Apart from that, several studies have investigated the connection between employee productivity and workplace design and, all came to the conclusion that a healthy workplace decreases absences and the occurrence of illnesses (Heerwagen, 2002). This consequently results in productivity increases among employees and therefore benefits the entire company. Numerically, these productivity gains can be quantified by quite exact percentages of productivity gains in relation with the adoption of green certificates like LEED. Thus, it is proven that a green certification according to LEED Certified and Silver level, results in 1 % productivity and health gains, whereas Gold and Platinum level LEED certifications incur a 1.5 % increase (Kats, 2003). In order to evaluate these percentage health and productivity increases, this can also be expressed by simple equations. Hence, the productivity gain of 1 % results in \$ 600 to \$ 700 per employee per year what equals \$3/ft² per year. Further, the 1.5 % gain yields \$ 1,000 per year (\$ 4 to \$ 5/ft²) each year. Taking these numbers for a period over a 20 year period with a given 5 % discount rate, Certified and Silver level buildings gain \$ 35/ft² and \$ 55/ft² for Gold and Platinum level properties respectively (Kats, 2003). In addition, the results of a further study suggest that these productivity benefits “are estimated to be as much as ten times the energy savings from green efforts” (Miller, Spivey & Florance, 2008-a). In stating the example calculations and the different numbers, it becomes rather obvious how important and significant the impact of green certification with respect to indoor environmental quality is. However, productivity gains due to more efficient behaviors of employees as a consequence of improved indoor environmental quality are not always numerically measurable. Nevertheless, the stated numbers provide quite reliable directions for the impact of raised workplace quality through a green certification.

The environmental benefits through improved energy efficiency and sustainable construction accompanying with certified green buildings can become apparent by having a closer look on the particular rating categories of a LEED certification. The current LEED V3 certification includes five categories. These categories are “Sustainable Sites”, “Water Efficiency”, “Energy and Atmosphere”, “Materials and

Resources”, and “Indoor Environmental Quality” (Biblow, 2009). In all these categories points are awarded for the final green rating for certain environmental improvements deriving from the development and construction of a specific property. The higher the percentage, of for instance, reduction of water usage, pollution reduction, improved energy performance, on-site renewable energy sources, increased ventilation or low emissions, is the more points can be rewarded and the higher is the LEED certification level (Biblow, 2009). Moreover, these categories and the whole certification system show that a green certification can be seen as a significant improvement to sustainable construction and the provision of major benefits to the environment.

Additionally, studies stress the opportunity of anticipation of future legislation and avoiding the risk of costly legislation in the future through adopting the highest legal standards concerning environmental regulations now (Kassinis & Vafeas, 2002). Furthermore, the importance of environmental developments in the construction industry is coherent to ongoing trends in the urbanization of economies in development, and it is assumed that there will be a significant increase in the necessity of energy efficiency of properties in the coming future (Glaeser & Kahn, 2008; Kahn, 2009).

Since most environmental benefits retrieved through certified green office buildings also affect properties` operating costs, the environmental benefits of certified green properties can also be evaluated in monetary terms as follows. In the table beneath, the savings through environmental issues in green buildings are depicted as savings on a 20-year net present value basis and related to the average extra cost of building green to receive:

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 Value	\$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

Table 9: Benefits of Green Buildings (Adapted from: Kats, 2003).

The results expressed in Table 9, show that the environmental benefits of green buildings can be translated into a 20-year net benefit as Dollars per average green property. All environmental benefits discussed in this section are also financial benefits, and can thus be translated into the respective monetary savings values. Therefore, the benefits of a green building, certified by the LEED rating system amount to approximately \$ 50 to \$ 70 per square foot (Kats, 2003).

By looking at the particular environmental benefits and the increased degree of evolving sustainability issues of certified green properties, it becomes clear that green buildings offer more than just economic benefits. More precisely, next to the rental income benefits the environmental effects of green buildings result in additional financial benefits. Hence, there is a connection between the economic and environmental benefits derived from certified green buildings. Through a green building certified by one of the rating systems, the environment is conserved by less resource consumption, lower energy use and less greenhouse gas emissions.

5.3 Intangible Value Benefits through Green Certifications

Besides the pure economic benefits discussed and empirically proven throughout this study, there is a further source of potential benefits arising from green office buildings, which is harder to assess numerically. Specifically, it is assumed that green certifications also provide intangible value benefits to owners or occupants of green

properties. Thus, with respect to green certifications of office properties, potential intangible value benefits arise through a better corporate reputation or image.

With respect to the intangible value benefits of raised employee productivity associated with green certifications, corporate reputation is the other essential part of the intangible value benefits of green certifications. Therefore, corporate reputation is seen as the result of the perceived corporate social responsibility promoted by firms. Since corporate social responsibility has gained relevancy as an intangible asset for companies, the credibility of developments of sustainable green properties has improved (Eichholtz, Kok & Quigley-a). Moreover, it is worth mentioning, that a company's corporate real estate is a major important part of its corporate social responsibility. As a matter of fact, strategic decision making in companies might be affected by the possible adoption of sustainable issues (Eichholtz, Kok, & Quigley, 2009-c). These facts clearly indicate the connection between green certifications of office buildings and potential intangible value benefits. Within the range of diverse companies in altering business sectors, it can be observed that firms have different preferences in managing and executing their individual corporate social responsibility. Consequently, the aim of most companies is it to maximize their profits. However, studies point out the presence of a particular group of companies for which the execution of an active corporate social responsibility outruns the costs connected to this policy (Wood, 1991). Now taking into consideration that corporate real estate is an important factor of a company's corporate social responsibility, green certifications for sustainable office properties have an effect on the corporate reputation. Consistent with these facts, in the study of Miles and Covin it was found out green that corporate headquarters can to some extent, serve as proof that a company is following a long-term corporate social responsibility-related management policy (Miles & Covin, 2000). In addition, their paper concludes that a company's reputation can be enhanced by occupying sustainable real estate, which might also improve the attraction for employees. An example of a branch that actively uses sustainable office space as an element of its strategic decision making to increase its corporate reputation is the oil industry (Eichholtz, Kok & Quigley, 2009-c).

According to the results of all the several studies quoted above, it becomes quite apparent that green certified office properties offer a range of potential benefits to their owners and occupants. Hence, sustainable buildings not only provide premia in rents, but also create intangible value benefits. These results show that certified green

properties provide productivity gains through better indoor environmental quality gains and in addition, improve corporate reputation.

5.4 Financial Benefits

After investigating the rental effects of a green certification and discussing the costs, as well as the environmental and intangible advantages of green office buildings, the monetary effects for owners and tenants are now provided.

The results of the regression model before suggest that office buildings certified by LEED show 9.9 % higher weighted average rents. Accordingly, a certification by Energy Star yields up to 12.3 % higher weighted average rents. If these numbers are translated into monetary amounts, the significant positive impacts of a green label become rather evident. The average building size of the comparables used here is 17,007 SF. Also, the building's average rent in the underlying sample of non-certified comparables amounts to \$ 21.17. Referring to prevailing cap rates of around 8 % for office buildings in major U.S. business districts at the beginning of 2010, the gains of the percentage increases in rents become apparent. According to percentage impacts of green certifications on rental rates, a LEED labeled office building gains a premium of about \$ 427,725 annually, while an Energy Star certified office building yields a rental increase of \$ 530,552 per year. At a cap rate of 8 % certified office properties have an increase in value of \$ 5.3 M and \$ 6.6 M for LEED and Energy Star certifications respectively, in contrast to non-certified properties.

On behalf of the tenant's perspective, environmental benefits concerning energy consumption and potential intangible value benefits seem to be more in the focus of attention when it comes to green office buildings. As reported before, several studies have found that certified green office properties account for a reduced energy consumption of approximately 36 % on average (Kats, 2003). More precisely, these energy savings can be expressed as \$ 3 per SF per year, what equals monetary savings of \$ 51,021 per year for a certified property with the average size mentioned previously. In addition, literature finds evidence for productivity improvements through better indoor environmental quality in green office buildings, as mentioned previously. A further issue that is important for tenants are potential intangible value benefits. Studies reveal that many huge corporations use green buildings in their real estate portfolios to

achieve an improved corporate social responsibility in form of corporate reputation and trust (Miles & Covin, 2000).

The facts reported above clearly indicate that green office buildings certified by LEED and Energy Star provide several benefits on the economic side, and also to the environment. These advantages count for investors, owners, and as well for tenants who all can profit monetarily from green certifications. Since, the benefits also include less energy consumption and sustainable construction, they can also be regarded as positive for the environment.

6 Conclusion

The underlying study provides empirical evidence for the economic benefits of certified green office buildings according to the LEED and Energy Star system in the U.S. market. Apart from this, the economic benefits of certified green office properties are related to the costs coming along with green certifications. Additionally, this study provides facts regarding the environmental benefits of green office buildings. Contrary to other studies, this paper not only provides empirical evidence for economic benefits but also contributes considerations about environmental benefits of certified green properties. Furthermore, the data set used in the regression model here contains newer property data and a significantly higher amount of certified green properties than other studies. In addition, the results of related studies regarding the costs accompanying green certifications and potential intangible value benefits are compared and evaluated. Thus, the underlying paper connects the empirical evidence for economic benefits of green certifications with the environmental benefits as well as its costs and potential intangible value benefits. That provides insights into the benefits of green office buildings for the perspectives of investors, owners, and tenants.

With respect to the stated research questions, the results of the regression models suggest that office buildings certified by LEED and/or Energy Star have significant impacts on the rental rates of office properties. Specifically, evidence implies that certified green office buildings provide rental benefits for owners and investors. Hence, the underlying study shows that green rated office properties yield approximately 9 % to 12 % higher rents than non-certified properties in the data sample. More precisely, a LEED certification increases the average weighted rent by 9.9 % and an Energy Star rating by 12.3 %. Therefore the main research hypothesis of the paper is approved. Further, it becomes apparent that an Energy Star rating provides slightly greater rental premia than a certification by LEED. Apart from that, office properties rated by both labels LEED and Energy Star show even higher increases in rents with 17 %. Concerning the monetary effects of a green certification for owners and investors the underlying study shows that green offices can yield to a value increase of up to \$ 5.3 M by a LEED certification and \$ 6.6 M through an Energy Star certification.

In connection to these empirical results, the environmental benefits and potential intangible value benefits of green office buildings are examined. With respect to the ecological aspects of green certifications it is found that certified green buildings also provide a range of environmental benefits. Labeled green office buildings have less energy consumption, lower greenhouse gas emissions, and create healthier work environments. These effects protect the environment on the one hand, and save money on the other hand. In addition, the results of several studies suggest that green office buildings serve as an important part of the corporate social responsibility of companies. This is an indication for potential intangible value benefits like corporate reputation and trust, being retrieved through certified green office buildings. Opposite to the economic and environmental benefits of green buildings stressed in the regression analysis and in the adhering parts, the costs of green certifications are reflected. It is found out, that the financial and economic benefits of green office buildings far outweigh the costs arising from it.

To conclude the findings of the underlying study, it can be said that green buildings, and especially certified office buildings, contribute an empirically proven economic value. Apart from higher rental values, the economic benefits of certified green office buildings also include cost savings and intangible value benefits. Owners, investors and tenants are thus able to profit from the certification of office buildings. While owners and investors can benefit from the rental premia, as empirically proven in this study, owners may strive for added the intangible value benefits and savings via the lower energy consumption of certified green office buildings. However, these financial benefits only reflect one side of the value creation within green buildings. Additional to the economic benefits for developers, owners and tenants, green buildings provide a broad spectrum of environmental prosperity. As a matter of fact, certified green office buildings provide several significant advantages in comparison to conventional non-certified buildings with respect to economic and environmental issues.

7 Future Prospects and Outlook

Since green and sustainable development in the real estate sector has been growing steadily over the last few years and even remained throughout the financial crisis, it is expected that this dynamic will continue. In the presence of a toxic load on the environment and an overconsumption of natural resources in particular, building green seems to be the only reasonable way to continue. Also for investors and owners of green office buildings, going green bears profitable financial opportunities.

The results of this study provide support for existing studies, and may add certain explanatory power for the positive effects of green certifications on the rents of office buildings by relying on a broader set of data of green properties. Apart from this, the underlying paper contributes a range of additional facts concerning the topic and therefore creates a broad evaluation of the benefits arising from certified green office buildings.

So far, all studies, including this paper, relate on the effects of green certifications on rents and values of office buildings. Hence, empirical evidence for the impacts of green labels on rents and values of other types of real estate like residential and industrial properties would be useful to make comparison and draw conclusions. Since these types of buildings form the two counterparts towards commercial real estate further research might bear interesting and profitable opportunities for future research. Furthermore, until now existing studies and the respective results and implications only refer to property data from the U.S. market. Therefore, an overview about the situation of the European market would be rather interesting, because besides the well known international green rating systems many national certification systems have developed in Europe. This bears potential opportunities and needs to be investigated further. Apart from that, an investigation of the percentage advantages of the different certification levels of the particular ratings systems on rents and property values would add scope for further research.

Reference List

- Alameda County (2002). *Alameda County Waste Management Authority. New House Construction: Green Buildings Guidelines*. Alameda County Waste Management Authority, California, USA. Retrieved 22. March 2010, from: <http://www.stopwaste.org/docs/newhomes.pdf>.
- Barista, D. (2008). *Selling Green in the Spec Office Market*. Building Design & Construction, March 2008, Vol. 49 Issue 4, pp. 26-35.
- Baum, M. (2007). *Green Building Research Funding: An Assessment of Current Activity in the United States*. 2006 Mark Ginsberg Sustainability Fellow, U.S. Green Building Council, p.1.
- Biblow, C. A. (2009). "Going Green" In Construction Offers Environmental Benefits – And Significant Financial Savings. Real Estate Finance (Aspen Publishers Inc.), Oct 2009, Vol. 26 Issue 3, pp. 13-15.
- BRE (2007). *BREEAM Fact File: Version 5*. Waterford. Building Research Establishment. Retrieved July 21, 2009, from: http://www.breeam.org/filelibrary/breeam_Fact_File_V5_-_Oct_2007.pdf.
- BRE (2008). A Record Year for Carbon-Cutting BREEAM. Building Research Establishment. Retrieved 28. April 2010, from: <http://www.breeam.org/newsdetails.jsp?id=530>.
- Cardin, M. (2009). *Green Building, Energy Efficiency, and the Economic Crisis*. Goodway Technologies Corporation. Retrieved 20. May 2010, from: <http://www.goodway.com/hvac-blog/?p=836>.
- Climate Change Corporation (2009). *Choosing green building Certification*. Retrieved 17. July 2009, from: <http://www.climatechangeCorp.com/content.asp?ContentID=6094>.
- CoStar Group Inc. (2009). *About CoStar Group*. Retrieved 29. July 2009, from: <http://www.costar.com/about/>.
- CoStar Group Inc. (2010). *About CoStar Group*. Retrieved 18. April 2010, from: <http://www.costar.com/about/glossary.aspx?hl=C>.
- Doornik, J. A., & Hansen, H, (2008). *An Omnibus Test for Univariate and Multivariate Normality*. Oxford Bulletin of Economics and Statistics, Oct. 2008 Supplement 1, Vol. 70, pp. 927-939.

- Doornik, J. A., & Hendry, D. F. (2009). *Empirical Economic Modelling – PcGive 13* Volume 1. Timberlake Consultants, 2009, pp. 286-287.
- Eichholtz, P., Kok, N., & Quigley, J. M. (2009-a). *Doing Well by Doing Good? Green Office Buildings*. UC Berkeley: Berkeley Program on Housing and Urban Policy. Retrieved from: <http://escholarship.org/uc/item/507394s4>.
- Eichholtz, P., Kok, N., & Quigley, J. M. (2009-b). *Sustainability and the Dynamics of Green Building*. Retrieved 02. March, 2010, from: <http://groups.haas.berkeley.edu/realestate/PhD%20Seminar%20articles/EKQ%20February%2022610.pdf>.
- Eichholtz, P., Kok, N., & Quigley, J. M. (2009-c). *Why Companies Rent Green: CSR and the Role of Real Estate*. Academy of Management Proceedings; 2009, p1-6, 6p, 1 Chart.
- Energy Star – Environmental Protection Agency (2009-a). History of ENERGY STAR. Retrieved July 24, 2009, from: http://www.energystar.gov/index.cfm?c=about.ab_history.
- Energy Star – Environmental Protection Agency (2009-b). *Criteria for Rating Building Energy Performance*. Retrieved July 24, 2009, from: http://www.energystar.gov/index.cfm?c=eligibility.bus_portfoliomanager_eligibility.
- Energy Star – Environmental Protection Agency (2009-c). *Energy Star Labeled Buildings and Plants*. Retrieved August 20, 2009, from: http://www.energystar.gov/index.cfm?fuseaction=labeled_buildings.showBuildingSearch.
- Energy Star – Environmental Protection Agency (2009-d). *Celebrating a Decade of Energy Star Buildings*. Retrieved April 20, 2010, from: http://www.energystar.gov/ia/business/downloads/Decade_of_Energy_Star.pdf.
- Environmental Leader (2009). Green Costs Create Roadblock to LEED Certification. Environmental Leader 13.03.2009. Retrieved 25.02.2010, from: <http://www.environmentalleader.com/2009/05/13/green-costs-create-roadblock-to-leed-certification/>.
- Falk, R. (2007). *Green Construction Standards Continue to “Build” Momentum*. Environmental Regulation, Land Use. Retrieved 20. April, 2010, from: <http://www.mofo.com/news/updates/files/9182.html>.

- Fuerst, F., & Mc Allister, P. (2008). *Green Noise or Green Value? Measuring the Price Effects of Environmental Certification in Commercial Buildings*. School of Real Estate and Planning Henley Business School, University of Reading.
- Fulton, O. (2007). *Financing Green Building*. *Environmental Design & Construction*, Jul. 2007, Vol.10 Issue 7, pp. 134-135.
- FY Power, (2010). *Commercial Office Buildings – Best Practice Guide*. Flex Your Power. Retrieved 28. April 2010, from: <http://www.fypower.org/bpg/index.html?b=offices>.
- Glaeser, E. L. & Kahn, M. E. (2008). *The Greenness of Cities: Carbon Dioxide Emissions and Urban Development*. National Bureau of Research, 2008.
- Gowri, K. (2004). *Green Building Rating Systems: An Overview*. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) Journal, November 2004, pp. 56-59.
- Greene, W. H. (2008). *Econometric Analysis*. Upper Saddle River, NJ: Prentice Hall 2008, Sixth Edition, pp. 180-200.
- Guy, G. (2005). *Going 'green' to require LEED certifications*. *Contractor Magazine*, Mar 2005, Vol. 15 Issue 3, pp. 21-51.
- Kahn, M. E. (2009). *Urban Growth and Climate Change*. *Annual Review of Resource Economics*, 2009, 1, pp. 333-349.
- Kassinis, G. & Vafeas, N. (2002). *Corporate Boards and Outside Stakeholders as Determinants of Environmental Litigation*. *Strategic Management Journal*, May 2002, Vol. 23 Issue 5, p. 399.
- Kats, G. (2003). *Green Building Costs and Financial Benefits*. Massachusetts Technology Collaborative, retrieved from: <http://www.cap-e.com/ewebeditpro/items/O59F3481.pdf>.
- Katz, A. (2009). *National Studies Show Green Building as Key Part of America's Economic Future*. *Environmental Design & Construction*, Feb. 2009, Vol. 12 Issue 2, p.10.

- Kühtz, S. (2007). Adoption of sustainable development schemes and behaviors in Italy, Barriers and Solutions – what can educators do? *International Journal of Sustainability in Higher Education*, 2007, Vol. 8 Issue 2, pp.155-169.
- Margolis, J. D., & Walsh, J. P. (2003). Misery Loves Company: Rethinking Social Initiatives by Business. *Administrative Science Quarterly*, 48(2), pp. 268-305.
- Miller, N., Spivey, J., & Florance, A. (2008-a). *Measuring the Green Premium for Office Buildings*. ICSC Research Review, 2008, Vol. 15 Issue 1, pp. 35-39.
- Miller, N., Spivey, J., & Florance, A. (2008-b). *Does Green Pay Off?* *Journal of Real Estate Portfolio Management*, Oct-Dec 2008, Vol. 14 Issue 4, pp.385-399.
- Mortgage Banking (2009). *It's not easy to be a (profitable) green building*. *Mortgage Banking*, Apr. 2009, Vol. 69 Issue 7, pp.86-87.
- Nelson, A. J. (2007). *The Greening of U.S. Investment Real Estate – Market Fundamentals, Prospects and Opportunities*. RREEF Research Report, Number 57, November 2007.
- Newsham, G. R., Mancini, S., & Birt, B. (2009). *Do LEED-certified buildings save energy? Yes, but...* *Energy and Buildings*, 41, (8), pp. 897-905.
- Northbridge Environmental Management Consultants (2003). *Analyzing the Costs for Obtaining LEED Certification*. Study prepared for the American Chemistry Council. Retrieved from: http://www.cleanair-coolplanet.org/for_communities/LEED_links/AnalyzingtheCostofLEED.pdf.
- Porter, M. E., & Van der Linde, C. (1995). *Green and Competitive: Ending the Stalemate*. *Harvard Business Review*, 73(5), pp. 120-134.
- RICS, Royal Institute of Chartered Surveyors (2005). *Green Value*. London and Vancouver.
- Schuster, A. (2009). *Possibilities for the Application for Ecological Certification Systems for Performance Increases in Large Real Estate Portfolios*. European Business School Working Paper, February 2009.

- Suttel, R. (2006). *The True Costs of Building Green*. Buildings, Apr. 2006, Vol. 100 Issue 4, pp. 46-48.
- Said, I., Osman, O., Mohd Shafiei, M. W., Razak, A. A., & Rashideh, W. M. A. (2010). *Identifying the Indicators of Sustainability in the Construction Industry*. International Journal of Organizational Innovation, Winter 2010, Vol. 2 Issue 3, pp. 336-350.
- SABD (2005). *Sustainable Construction*. Sustainable Architecture and Building Design. Retrieved 28. April 2010, from: <http://www.arch.hku.hk/research/BEER/sustain.htm>.
- Suttel, R. (2006). *The True Costs of Building Green*. Buildings Magazine, April 2006. Retrieved 04.03.2010, from: <http://www.buildings.com/ArticleDetails/tabid/3321/ArticleID/3029/Default.aspx>.
- The Nature Conservancy (2009). LEED Platinum Certification. State Headquarters for the Indiana Chapter of The Nature Conservancy. Retrieved July 23, 2009, from: http://www.nature.org/wherewework/northamerica/states/indiana/files/leed_platinum_information_sheet.pdf.
- Turner (2008). Turner 2008 Green Building Barometer. Turner Construction Company. Retrieved 02.03.2010, from: <http://www.turnerconstruction.com/greenbuildings/content.asp?d=6552>
- USGBC, US Green Building Council (2002). *Building Momentum, National Trends and Prospects for High-Performance Green Buildings*. Washington, April 2002.
- USGBC, U.S. Green Building Council (2008). *LEED for New Construction & Major Renovations: Version 2.2*. U.S. Green Building Council. Retrieved July 23, 2009, from: <http://www.usgbc.org/ShowFile.aspx?DocumentID=1095>.
- USGBC – U.S. Green Building Council (2009-a). Project Certification: LEED v3. U.S. Green Building Council. Retrieved July 23, 2009, from: <http://www.usgbc.org/DisplayPage.aspx?CMSPageID=64>.
- USGBC - U.S. Green Building Council (2009-b). Intro - What LEED Is. U.S. Green Building Council. Retrieved July 23, 2009, from: <http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1988>.
- USGBC – U.S. Green Building Council (2009-c). *Green Building Facts*. Retrieved August 20, 2009, from: <http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1718>.

White, H. (1980). *A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct test for Heteroskedasticity*. *Econometrica* 48(4), pp. 817-838.

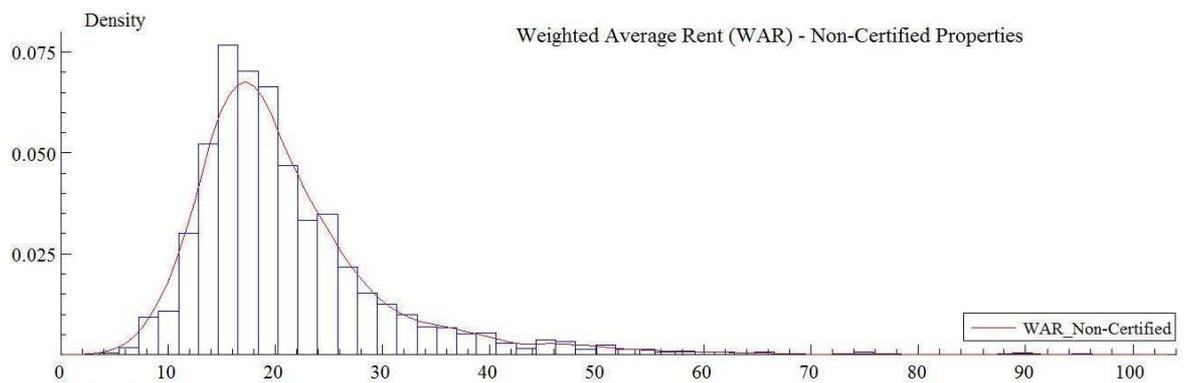
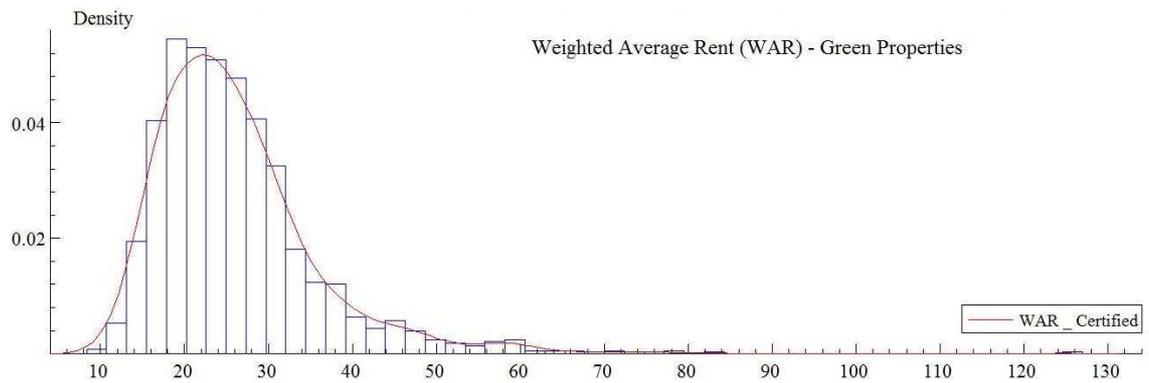
WCED (1987). *Our Common Future*. Oxford University Press. Oxford and New York.

Wood, D. J. (1991). *Corporate Social Performance Revisited*. *Academy of Management Review*, Volume 16, No. 4, pp. 691-718.

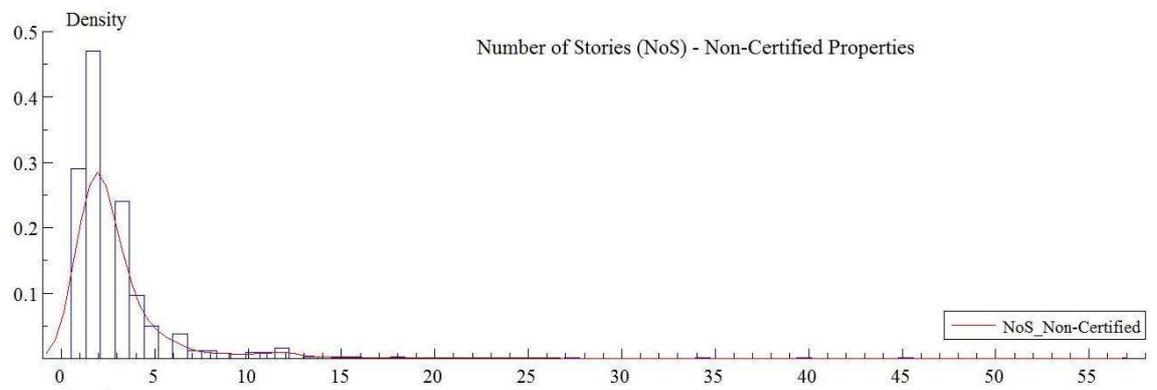
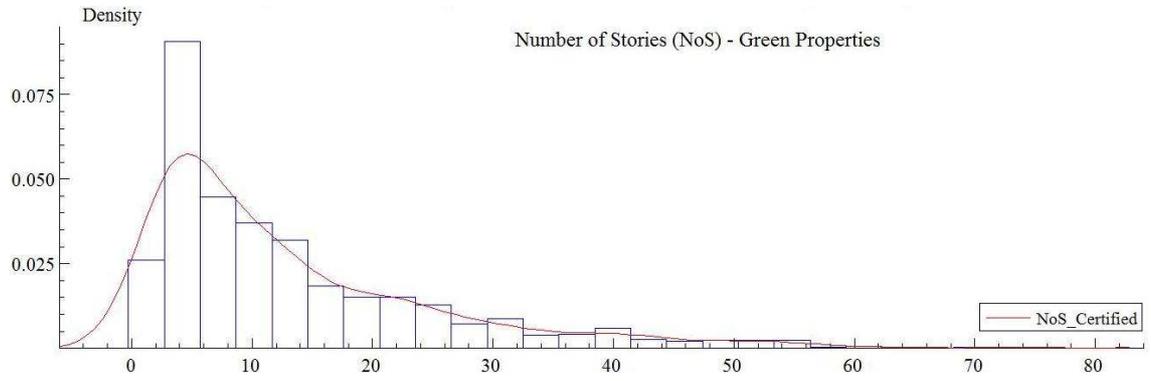
Appendix

Figure 3: Rent, Space and Vacancy between Green Office Buildings and Non-Certified Comparables in the Analysis Sample.

a) Weighted Average Rent (WAR)



b) Number of Stories (NoS)



c) Age

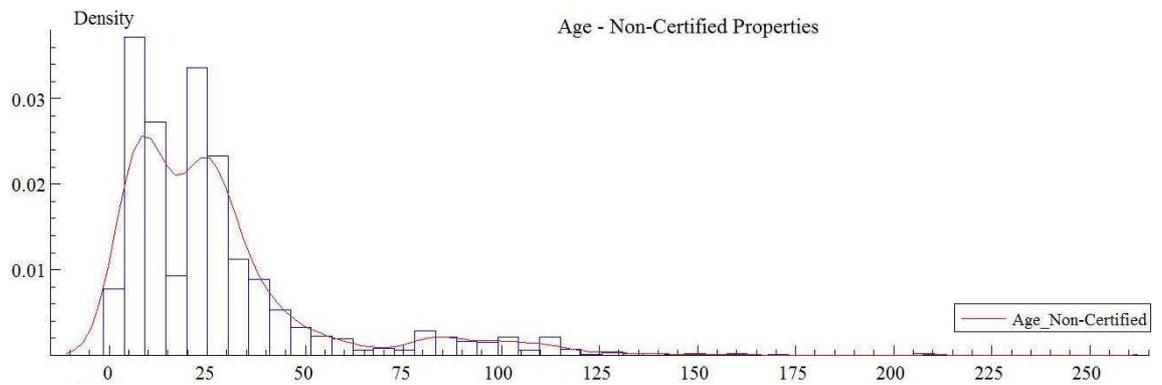
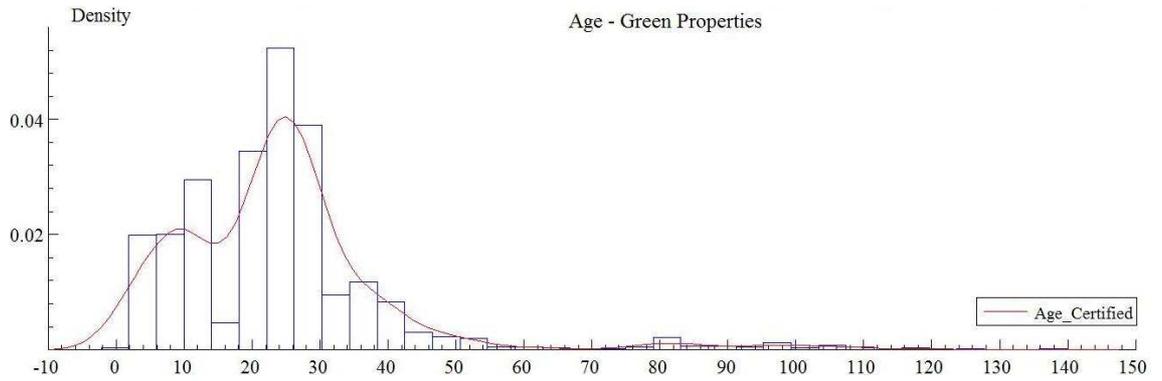


Figure 4: Residual Density of the Analysis Sample.

