Performance of LEED-Existing Buildings before and after their certification

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Executive Summary

Office buildings are a key feature of our urban and suburban fabric allowing the flourishing of economic activity; however, they also cause depletion of our energy sources and contribute significantly to the existing environmental pollution. According to the U.S. Environmental Protection Agency (EPA) commercial buildings alone accounted for 35% of the total U.S. electricity consumption in 2006 with a projection to almost 37% by 2025. The carbon footprint of commercial buildings was estimated at 7% of the U.S. total carbon dioxide emissions and the water consumption at 3.3% of the total water consumed based on research conducted in 2008 and 1996 respectively (EPA report). The EPA along with other non-government based environmental protection agencies have sounded the alarm many times in the past on the effect of our built environment on natural resource depletion and contamination for future generations, and commercial buildings have recently started to explore sustainability options more aggressively. Newly constructed buildings have less of a sustainability challenge than existing buildings as most are built to sustainability standards, but existing buildings depending on their building systems, and often require more extensive retrofitting while tenants are occupying the facility. Even before the recent financial crisis, owners of existing commercial buildings across the U.S. began to assess the sustainability profiles of their buildings (e.g. energy use, water consumption, recycling and reuse, air quality etc.) and started to pursue sustainability certifications to: a) create a competitive advantage over comparable properties, while using local and federal sustainability incentives, b) benefit from long-term cost savings and c) attract an increasing number of environmentally-conscientious tenants.

Understanding the challenges faced by owners of existing occupied buildings in the adoption a green standard was one of the key factors which triggered the study of existing rather than new properties from a property performance standpoint (vacancy and rents) before and after adoption of a sustainability standard. The next step was the selection of the most frequently used sustainability standard, which is the Leadership in Energy and Environmental Design for Existing Building (LEED-EB) by the U.S. Green Building Council (USGBC), because it encompasses a holistic assessment of a building's sustainability by reviewing a building's site, water efficiency, energy, recycling and re-use, materials and resources and indoor environmental quality.

LEED properties have been the focus of previous research, especially with a comparison emphasis of LEED vs. non-LEED performance (e.g. vacancy, rents and sale prices). This study, however, tries for the first time to explore existing private office building performance before and after they become LEED-EB for buildings of 50,000 square feet or more. These buildings represent 5.3% of the overall U.S. class A and B private office space based on Rentable Building Area (RBA).

The three questions explored in this study were: 1) Is it beneficial for properties to pursue LEED-EB comparing their before and after average vacancies and rents? If the answer is yes, is it for all or certain types of properties and has the recent recession affected this answer? 2) How do external and internal property conditions influence vacancies and rents before versus after certification? and 3) Which city has the largest concentration of LEED-EB office properties? Answering question three became the starting point for a case study on the performance of properties in that standalone city which was determined to be Chicago. Using a survey allowed the gathering of proprietary information on key costs and savings parameters for the LEED-EB process.

Answering the above questions required data gathering from multiple sources which included: the USGBC, the Bureau of Economic Analysis, National Bureau of Economic Research, CoStar Group and the DSIRE database. A development of a survey tool was also required for the inclusion of proprietary information for the Chicago case study. Considering buildings' marketing efforts, which focus primarily on the level of LEED-EB certification (Certified, Silver, Gold and Platinum) rather than the version under which it was achieved, the analysis controlled for that differentiation effect as well as for a property's classification (A or B).

In response to question one, it is observed that differentiations exist among the vacancy and rent performance of properties based on their LEED-EB certification level. Platinum Class A as well as Certified and Gold Class B properties achieved lower vacancy after their certification compared to their before trends. From a rent standpoint, only Gold Class B properties experienced decreasing average rents after their LEED-EB certification. Overlaying the recent recession on property vacancies, Platinum Class A and Certified Class B properties maintained their low vacancies after certification both during and beyond the recession. Gold Class B properties maintained their lower rents after certification both during and beyond the recession.

In response to question two, the results suggest that newer Class A properties, achieved lower vacancies than older buildings but vacancies of both Class A and B properties were affected by the recession and Class A properties suffered more than Class B. From a rent perspective, Class B properties are affected more by the recent recession than Class A, but Class A properties had lower rents in areas with higher energy efficiency incentives. Rents increased for Silver properties after their certification compared to any other levels of certification.

In response to question three, we discover that the city with the high ranking in both number of properties and rentable building area is Chicago. We find that in Chicago, only Gold Class A properties and Silver Class B properties achieve lower vacancies after their certification and that rents of Class A Certified properties increase after certification. In addition, Gold Class A properties maintain these differences during and beyond the recession. Exploring the results from question two on Chicago, we determine that with the exception of Platinum level properties each of the other certification levels achieved lower vacancies when compared to all others for Class A properties. In addition, although the recession did not affect Class A properties after they became LEED-EB, with the exception of the time during the recession, vacancies decreased one and two quarter lags for Class B properties after their certification. From a rent perspective, only Certified level Class A properties and Gold Class B achieve higher rents after certification compared to all other certification levels. The "view" from the building contributes to premium rent for Class B properties. The recent recession improved rents for Class B properties after their certification but only during the recession and one quarter lag after. Lastly, the Chicago survey results indicate an average retrofit cost of $0.21/sf and an average of 1.8 year simple payback period which is fairly low based on market standards. Operating expenses decrease on average by 8.09% while energy costs decrease by 7.02%. Recycling is also contributes an average of 57.6% and cost savings of $0.01/sf/year.

The results of this study provide a first look into the performance of LEED-EB properties before and after their certification. An increasing number of office properties are becoming LEED-EB and tracking their performance through time will help us determine the benefits by also being aware of the costs. The recent recession did not arrive at the best time for properties which were just certified creating an anomaly to owners' expectations. The Chicago survey results, however, suggest the existence of significant savings by becoming LEED-EB, which can offset some of the cost incurred, as well as possible vacancies generated by the recession. More

studies will follow in the future to determine how the LEED-EB market is evolving and contributing to making our country more sustainable.

Introduction

The U.S. Green Building Council (USGBC) launched the Leadership in Energy and Environmental Design for Existing Building (LEED-EB) in 2002 in an effort to promote and improve sustainability in the building environment. LEED has evolved through the years to encompass more building types and LEED-EB is currently one of the nine[1] ratings available. USGBC has grown in influence both nationally and internationally with a total of 1.7 billion square feet of commercial space certified across all ratings and 6.3 billion square feet registered and pursuing certification. An increasing number of owners and tenants are becoming aware of the savings (e.g. energy and water) from the adoption of sustainable practices such as those required for LEED certification (McGraw Hill Construction, 2011; Jones Lang LaSalle, 2008; Turner 2008). An increasing body of academic studies focuses on green versus non-green properties [Fuerst and McAllister (2011), Eichholtz et al. (2010a, 2010b), Wiley (2010) and Miller et al. (2008)] as well as green property evaluation (Dermisi, 2009). This research project attempts to compare for the first time vacancy and rent trends of LEED-EB properties before and after their certification. Our goals are threefold: 1) Understanding if it is beneficial for properties to pursue LEED-EB comparing their before and after average vacancies and rents. If the answer is yes, is it for all or certain types of properties and has the recent recession affected this answer? 2) Understanding how conditions external and internal to the property may influence vacancies and rents before versus after certification; and 3) identifying the city with the largest concentration of LEED-EB office properties and analyzing that city's LEED-EB performance in depth with the use of a survey tool to gather proprietary information not readily available in online databases. The survey focuses on key cost and saving factors individual to each building allowing us to include such factors in the assessment of the vacancy and rent trends of LEED-EB properties after they are certified.

[1] LEED ratings: New Construction (NC), Existing Buildings (EB). Commercial Interiors (CI), Core & Shell (C&S), Schools, Retail, Healthcare, Homes, Neighborhood Development (ND)

Literature review

Although USGBC launched the first rating systems in 2002, the academic community only recent began studying LEED and other sustainability ratings in more depth. This lag time in research was not caused by the absence of interest but the absence of data and evidence to judge the effects of sustainability on the real estate markets. A number of studies focus on sale prices and rent level differentiation between green and non-green properties [Fuerst and McAllister (2011), Eichholtz et al. (2010a, 2010b), Wiley (2010) and Miller et al. (2008)]. Other studies highlight higher occupancy rate for green versus non-green properties [Eichholtz et al. (2010c), Wiley (2010) and Fuerst and McAllister (2009)]. Most recently, the international commercial real estate firm CBRE, in collaboration with the University of San Diego and McGraw Hill Construction, has evaluated the performance of a sample of LEED versus non-LEED buildings throughout the U.S. with the help of tenants in the various buildings.

Elaborating more on some of the above studies, Fuerst and McAllister (2011) estimated the rental regression for a sample of LEED and Energy Star properties as well as other benchmark buildings. Their results suggest that LEED buildings have an average rental premium of 4–5%. Furthermore, based on a sample of sale prices, they found price premia of 26% and 25%, respectively, with higher levels of certification achieving higher premia. Eichholtz et. al. (2010a) findings indicated that rents for green offices are about 2% higher than rents for comparable buildings located nearby. Wiley (2010) identified 25 office markets with sales information available for Energy Star labeled and LEED certified properties. Rents were higher by roughly 7% to 17% while occupancies improved by roughly 10 to 18%. The price premium was estimated at an average of $30 and $130/sf for Energy Star and LEED certified properties, respectively. Miller et. al. (2008), compared LEED buildings versus non-certified properties. The average LEED impact on sales price per square foot was a positive 10%. The Energy Star impact on selling price was a positive 5.76%. Fuerst & McAllister (2009) developed a hedonic model that measured occupancy rate differences between labeled offices and randomly selected non-labeled offices in the same submarkets controlling for differences in lease contract, age, height, quality, sub-market, etc. Occupancy rates were 8% higher for LEED.

A joint study by the University of San Diego, CBRE and McGraw Hill Construction (2011) of CBRE LEED and non-LEED office buildings and their tenants in 10 major cities across the U.S. suggests that occupancy and rental rates are better than the market but the

downturn impacted the commitment to green. Buildings pursuing LEED certification increased by 35% from 2009 to 2011, with average LEED building occupancy rates also increasing by 2.4% (to 85.56%) during the same period. Comparing LEED building occupancy with market occupancy, LEED properties increased their occupancy by 3.14% over the three year period. Average rental rates of LEED properties also experienced increases compared to average market rates. A previous study by Miller (2009) in collaboration with CBRE, suggests that many tenants find sustainable space more productive. These buildings save money on energy costs although total operating expenses tended to run similar to the peer set.

All related studies until now focus on various aspects of sustainable real estate. Based on my knowledge, no study has been launched on the before and after effects of LEED for existing facilities. Considering the overwhelming number of existing buildings, among the questions rising are: Is LEED is worth the expense based on the performance change discerned from the data available to us today? Are all LEED certification levels equally successful in improving a property's rents and lowering the vacancy? The research questions pursued in this study try to answer these questions to help owners/managers benchmark their buildings if they received LEED-EB or if they are thinking of pursuing LEED-EB.

Methodology

The goal of this research project is the identification of the factors influencing office property total vacancy and rents before and after achieving LEED-EB. The research questions examined are:

1) ***How beneficial is the pursuit of LEED-EB at each level (Certified, Silver, Gold and Platinum) and property classification when comparing average vacancy and rent performance before and after certification? How did the recent recession affect the response to this question?***

   The answers to these questions provide a first look into average vacancy and rent trends without taking into account additional influences (e.g. property characteristics etc.) with the use of a basic t-test. It is an easy method of identifying differences in a meaningful way for property managers by applying basic descriptive statistics.

2) ***How do property, office market, economic, and sustainability variables affect vacancies and rents of LEED-EB properties before and after LEED-EB status is granted while controlling for the different MSAs?***

The objective of this question is to identify any underlying factors internal and external to the property influencing vacancy and rent trends before and after certification. To answer this question a fixed effect regression model is applied to control for properties within the same MSAs. Because of the time series repetition, clustering of the properties is also needed. Two equations are applied: 1) one equation is used for both before and after the certification with the only difference being the addition of the property vacancy rate under the property variables when the model is for the after certification period (Eq. 1); and 2) a slight variation of Eq.1 is used when focusing on Chicago, eliminating the fixed effects due to the unique MSA (Eq. 2). The after certification model for Chicago also includes the property vacancy.

$$\ln(\text{vacancy rate}_{\text{Before}_{i,t}\text{or After}_{i,t}} \; or \; \text{rents}_{\text{Before}_{i,t}\text{or After}_{i,t}}) = a + \beta_1 Pr_i + \beta_2 EE_i \quad \text{Eq. 1}$$
$$+\beta_3 RE_{i,t} + \beta_4 UN_{i,t} + \beta_5 LR_t + \beta_6 LVC_i + \eta_i + c_i + \varepsilon_{i,t}$$

Where:
- Vacancy rate: is the quarterly building vacancy rate
- rent: quarterly building rent
- i: takes values from 1 through 578 representing each of the buildings
- t: takes values from the first quarter of 2003 through the second quarter of 2011 on a quarterly basis
- Pr: is an umbrella variable which includes:
  a) Typical floor plate: typical floor size in square feet (Mid-rise and high-rise properties have various size floor-plates because of the setbacks required in downtown areas. CoStar reports the typical floorplate size).
  b) Year built: the year the building was completed.
  c) Number of stories in each of the LEED-EB properties.
  d) Downtown dummy: if the property is downtown takes the value 1 otherwise 0.
  e) Duration to certification: time to LEED-EB certification.
  f) Registered and certified during 2009 recession dummy: takes the value 1 if a property was both registered and certified during the recession or otherwise 0.
- EE: is an umbrella variable which includes the number of property tax and green building incentives for which properties can qualify at the different areas around the U.S. – as published at the DSIRE database. Discussion on this variable is offered in the data section.
- RE: is another umbrella variable which includes the quarterly market net absorption in square feet and the ln (quarterly market vacancy rate) for mainly Class A properties in the market the LEED property is located. If the LEED property is Class B then the market trends represent that property classification.
- UN: is the quarterly unemployment rate at the MSA where the property is located.
- LR is an umbrella variable representing three dummy variables: Recession which takes the value 1 all quarters of 2008 and the first two quarters of 2009 otherwise zero. Recession 2009 lag 1, which is one quarter lag after the recession began and is another dummy; and recession 2009 lag 2, which is two quarter lags from the recession.
- LVC: is an umbrella variable which includes dummy variables for each of the certification levels (Certified, Silver, Gold and Platinum).
- η: reflects the MSA specific characteristics which are time invariant. Each city is within one MSA throughout the time series and therefore is time invariant.

- c: is the property clustering.

$$\ln(\text{vacancy rate}_{\text{Before}_{i,t}\text{or After}_{i,t}} \; or \; \text{rents}_{\text{Before}_{i,t}\text{or After}_{i,t}}) = a + \beta_1 Pr_i + \beta_2 EE_i + \beta_3 RE_{i,t} + \beta_4 UN_{i,t} + \beta_5 LR_t + \beta_6 LVC_i + c_i + \varepsilon_{i,t} \quad \text{Eq. 2}$$

Where:
- Vacancy rate: is the quarterly building vacancy rate
- rent: quarterly building rent
- i: takes values from 1 through 29 representing each of the buildings
- t: takes values from the first quarter of 2003 through the second quarter of 2011 on a quarterly basis
- Pr: is an umbrella variable which includes:
  a) Typical floor plate: typical floor size in square feet (Mid-rise and high-rise properties have various size floor-plates because of the setbacks required in downtown areas. CoStar reports the typical floorplate size).
  b) Year built: the year the building was completed.
  c) Number of stories in each of the LEED-EB properties.
  d) Duration to certification: time to LEED-EB certification.
  e) View: takes the value 1 if the property is on Wacker Drive or by the Chicago River otherwise 0.
- EE: is an umbrella variable which includes the number of property tax and green building incentives for which properties can qualify at the different areas around the U.S. – as published at the DSIRE database. Discussion on this variable is offered in the data section.
- RE: is another umbrella variable which includes the quarterly market net absorption in square feet and the ln (quarterly market vacancy rate) for mainly Class A properties in the market the LEED property is located. If the LEED property is Class B then the market trends represent that property classification.
- UN: is the quarterly unemployment rate at the MSA where the property is located.
- LR: is an umbrella variable representing three dummy variables: Recession which takes the value 1 all quarters of 2008 and the first two quarters of 2009 otherwise zero. Recession 2009 lag 1, which is one quarter lag after the recession began and is another dummy; and recession 2009 lag 2, which is two quarter lags from the recession.
- LVC: is an umbrella variable which includes dummy variables for each of the certification levels(Certified, Silver, Gold and Platinum).
- c: is the property clustering.

3) Which cities achieve the largest concentration of LEED-EB designated properties and how are they spatially allocated?

Answering this question required a simple ranking of the overall dataset and sorting by city. The results identify Chicago as the city with a high ranking on both number of properties and Rentable Building Area. Therefore, a more in depth study of the Chicago LEED-EB properties was done to determine the spatial allocation as well as other factors which might affect the LEED-EB properties. ArcGIS was used to determine the spatial allocation of all LEED-EB properties and a directional distribution – defined in this case by one standard deviation from the mean - of the two most frequently attained certification

levels (Silver and Gold). As a next step, the two questions above were answered for the City of Chicago and a survey tool[2] was developed. An effort was made to survey all buildings after the development and testing of a questionnaire (Appendix) in an effort to capture information not readily available but significant in the pursuit of LEED-EB certification by buildings. The survey included fifteen questions, which were a combination of closed and open ended questions including both qualitative and quantitative data. Some key questions regarding LEED-EB included the overall and retrofit average costs to achieve LEED-EB, the simple payback period, the energy consumption decrease after LEED-EB compared to before as well as the cost savings. These variables, gathered through the survey, allow the assessment of their individual effect on rents with the use of a third model, after merging them with the rest of the Chicago dataset, showing for the first time any impact they might have:

$$\ln(\text{rent}_{\text{After}_{i,}}) = a + \beta_1 Pr_i + \beta_2 SQ_i + c_i + \varepsilon_i \qquad \text{Eq. 3}$$

Where:
- rent: quarterly building rent
- i: takes values from 1 through 12 representing each of the buildings
- Pr: is an umbrella variable which includes:
  a) Property vacancy rate: takes different vacancy rate variables each quarter.
  b) Typical floor plate: typical floor size in square feet – (mid-rise and high-rise properties have various size floor-plates because of the setbacks required in downtown areas. CoStar reports the typical floorplate size).
  c) Year built: the year the building was completed.
  d) Number of stories in each of the LEED-EB properties.
  e) Duration to certification: time to LEED-EB certification.
  f) View: takes the value 1 if the property is on Wacker Drive or by the Chicago River otherwise 0.
- SQ: is an umbrella variable which includes the information gathered from the survey on:
  a) ln(Overall cost of LEED-EB certification/sf).
  b) Exclusive building retrofit cost for LEED-EB/sf.
  c) Max simple payback period for LEED-EB certification (all inclusive).
  d) Average operating expense decrease after LEED-EB.
- c: is the property clustering.

[2] The author would like to thank Ms. Susan Hammer - General Manager at 330 N. Wabash - for her insightful comments in the development of the questionnaire.

Data

The study focuses on private office[3] properties which are already certified at the Leadership in Energy and Environmental Design – Existing Building (LEED-EB) rating by the U.S. Green Building Council (USGBC). Since the first release of LEED-EB, properties receive their certification under four versions (Exhibit 1). Although there are differentiations among the points received in the various LEED-EB versions through time, owners/managers always highlight the level achieved rather than the version or actual points; therefore, our analysis focuses on the certification level (Certified, Silver, Gold and Platinum) rather than the LEED-EB version or actual points.

The key variables extracted from the USGBC database included only the list of LEED-EB properties, their addresses, location (city, state, zip code), timing of registration and certification, and level of LEED-EB achieved. The study includes LEED-EB properties certified by July 5, 2011. The property information was cross-referenced with the CoStar Group database for the inclusion of property characteristics (e.g. classification, number of stories, year built, etc.) and historical/current performance indicators (total vacancy rate and rent). There were 711 LEED-EB buildings, identified with the restriction 50,000 sf or more, totaling 314 million sf across the U.S. (Exhibit 2). These buildings represent 8.6% and 1.8% (based on sf) of the overall Class A and B stock, respectively, with a minimum of 50,000 sf throughout the U.S. (Exhibit 1). As expected, the vast majority of LEED-EB properties are classified in CoStar Group as Class A (Exhibit 2). Year that the property was built was available for all LEED-EB properties, with the majority of them being constructed after 1980 (Exhibit 3).

The review of the LEED-EB certification dates indicated that all properties received one of the four certification levels (Certified, Silver, Gold or Platinum) between 2004 and 2011 (Exhibit 4), with the majority of them being awarded in 2009 or later (Exhibit 5). To create a balanced before and after certification period dataset a decision was made to follow the historical performance (vacancy and rents) for these properties (CoStar Group data) from the first quarter of 2003 and not before. The inclusion of socioeconomic data led to the restriction of the dataset to properties only within MSAs, which is the lowest geographical area where consistent data were available throughout the U.S. (Exhibit 4). This decision led to the reduction of the initial

[3] The study will focus only on private office properties with Rentable Building Area (RBA) of 50,000 sf or more throughout the U.S.

dataset to 578 properties of the initial 711.

As analyzed in the methodology section, the data required for this study are aggregated from multiple sources and under the following umbrellas:

- ***Sustainability data:*** Registration date for LEED-EB participation, LEED-EB certification date and certification level (Certified, Silver, Gold and Platinum) were established from the USGBC database. This information allows us to determine the length of time it took properties after registration to obtain certification. The different certification levels allow us to examine different effects the various levels might have on property vacancy and rents. Two energy efficiency incentives from the DSIRE database were used - property tax and green building incentives to offset some of the investment cost. Using these variables will help us understand if they can or cannot be considered in LEED-EB..
- ***Economic data:*** Quarterly unemployment rates and employment levels were gathered from the Bureau of Economic Analysis. The data were gathered to assess the health of the business environment, since increases in unemployment affect vacancy levels. Dummy variables were created based on the 2008/2009 recession (2008/2009 great recession: all 2008 quarters as well as first and second quarters of 2009) based on the National Bureau of Economic Research. These variables were generated to determine differences between the recession and non-recession periods.
- ***Real Estate:*** Beyond the real estate property information available on the CoStar Group website (e.g. Rentable Building Area (RBA), classification, year built, vacancy rate and rents), additional data gathered from the same website including: market vacancy conditions for the cities in which properties are located and quarterly net absorption. The property specific variables were gathered to determine a property's internal profile and assess it based on external influences by other variables. The additional market condition data were included to assess if the LEED-EB properties followed the market or not.
- ***Other national data:*** A dummy variable was created based on a property's location in a downtown versus the suburbs (the determination was made based on CoStar Group database and the location of a property on a map) to assess if these locations make a difference on LEED-EB building vacancies and rents. Each property within the same MSA was designated the same MSA code to allow for clustering of properties within the same MSA.

- ***Survey data:*** In addition to the data readily available from government sources and CoStar Group, a survey tool was developed, as outlined in the methodology section (see Appendix), which allowed for property specific data gathering such as LEED-EB overall and retrofit costs, payback periods, operating expenses, recycling and public transportation trends. These data were also gathered to assess possible impact difference in property vacancy and rents

  The survey tool was applied to the city with the combination of high number of LEED-EB properties and a large Rentable Building Area. The city with these two characteristics was determined to be Chicago, based on the USGBC dataset. The Chicago case study was conducted by applying the survey tool. The survey response rate was 59.3% based on the number of properties and 70% based on the Rentable Building Area (Exhibit 6). Downtown Chicago has 29 LEED-EB buildings with 26.5 million sf and a balanced distribution between A and B properties based on square footage. This Chicago case study was enhanced with a variable – named "view" which reflects the prominence of a street in downtown Chicago (Wacker Drive) and the view of the Chicago River.

Results

The study of the LEED-EB performance before and after certification and the comparison with overall market conditions provides some preliminary insights on the trends these properties are experiencing. In response to the research questions, the following is a mix of the expected and surprising results obtained:

1) ***How beneficial is the pursuit of LEED-EB at each level (Certified, Silver, Gold and Platinum) and property classification when comparing average vacancy and rent performance before and after certification? How did the recent recession affect the response to this question?***

   The comparison of the average vacancy levels of Class A buildings, before and after achieving LEED-EB at the various levels, shows a statistically significant effect for two levels (Silver and Platinum) (Exhibit 7). The average vacancy decreased substantially (by 61.57% to 3.85%) after LEED-EB compared to before LEED for Platinum properties while it increased for Silver properties by 41.85% (to 18.71%). Being mindful of the impact the recent recession had on the performance of the real estate market, makes it a necessity to analyze its effect on the LEED-EB performance before and after certification. Overlaying the recession on the average vacancy trends of Class A properties before and after LEED-EB, it is evident that

Platinum properties consistently during and after the recession achieve lower average vacancy (0% and 4.48% respectively) after certification compared to the vacancy before LEED. Silver level properties, however, are not as consistent with a statistically significant effect (similar to the overall effect) only beyond the recession period. In contrast to the overall assessment, the average vacancy after LEED-EB for Class A Certified level properties during and beyond the recession was lower by 53.5% (at 5.50%) and 11.6% (at14.8%) respectively.

The comparison of the average vacancy performance of Class B properties before and after LEED suggests that vacancies decreased on average after LEED-EB for both Certified level and Gold level properties while vacancy increased for Silver properties. Specifically, the decrease was 33.3% (at 11.63%) for Certified and 29.9% (at 6.22%) for Gold properties. In contrast, Silver level properties experienced an increase in average vacancy after achieving LEED-EB by 43.1% (at 14.03%). The effect of the recession on Class B average vacancy performance is consistent during and after the recession for only the Certified level properties. In both cases average vacancy decreased after certification by 85.9% (to 2%) and 32.6% (to 12.29%), respectively. LEED-EB Silver level properties achieved a lower average vacancy rate by 50.3% (to 4.17%) during the recession compared to properties which had not yet achieved LEED while the direction reversed to higher levels by 42.3% (to 14.46%) beyond the recession.

The combined analysis of building class, certification levels and recession suggests that lowest average vacancies after certification are achieved consistently by Class A Platinum and Class B Certified properties. Class B Gold properties share the same result as previously mentioned with the only exception being the period beyond the recession.

Assessing the average rent levels before and after LEED-EB for both Class A and B properties, we find that only Class B Gold level properties achieve a statistically significant effect. Unfortunately, their average rent level decreases after certification by 9.9% to $24.8 per square foot (sf) compared to the properties not yet achieving LEED-EB. Exploring the effect of the recession on average rents of Class A properties, the results suggest that rents decreased by 18.37% (to $30.4/sf) for Silver and by 13.3% (to $30/sf) for Gold properties after LEED-EB. Class B properties share the same effect during the recession for three out of the four certification levels. The Certified level properties decreased by 39.7% (to $12.8/sf), the Silver by 12.2% (to $25.4/sf) and the Gold by 25.4% (to $23.12/sf). In contrast, the results

for the period after the recession suggest that rents of Class A properties increased for Gold level properties by 4.4% (to $30.54/sf).

The analysis of property class, certification level and recession on the average rents suggests that Class A and B Silver and Gold level properties presented lower rents after their certification and during the recession, a trend not consistently shared with other LEED levels. Beyond the comparison of the before and after LEED-EB performance without the evaluation of other factors the response to question two will further examine the effect of conditions external to the property (e.g. market vacancy rate and net absorption) on the actual property vacancy.

2) ***How do property, office market, economic, and sustainability variables affect vacancies and rents of LEED-EB properties before and after LEED-EB status is granted while controlling for the different MSAs?***

The models applied allow the analysis of the interaction among multiple internal and external factors affecting a property's vacancy and rent. A quick assessment of the results suggests that the vacancy of Class A LEED-EB properties is worse than the market both before (76% worse) and after (107% worse) certification, therefore, questioning the effectiveness of LEED-EB for this class. In contrast, Class B properties perform similarly to market levels making certification more appealing given the additional energy savings achieved by LEED. In an effort to mitigate the increased vacancy of Class A LEED-EB properties, an expected decrease in rent levels is observed as market vacancy increases. More specifically, as market vacancy increases, Class A LEED-EB buildings are combating it by a decrease in rents by 25.6% before and 28% after certification. These decreases, however, do not mitigate the higher-than-market vacancy rates (Exhibit 8). Another interesting relationship is that an increase in market net absorption is associated with an increase of Class B vacancy after LEED-EB. This small but statistically significant increase can be caused by tenant flight to new construction.

Assessing the effect of internal and external variables on Class A properties, both before and after becoming LEED-EB, the results suggest that buildings with certain characteristics can benefit more than others when a comparison is made within the same classification category and time frame (before or after LEED-EB) (Exhibit 8, columns 1 and 3). Focusing on the impact of property characteristics on class A vacancy levels, the results suggest that a 1

square foot increase of the typical floor-plate[4] is associated with a statistically significant decrease in vacancy both before and after LEED-EB. The effect of property age on vacancy levels both before and after LEED-EB is similar, with the results suggesting that newer properties experience lower vacancies compared to older ones for both LEED-EB cases (before and after certification). Specifically, when comparing the trends of all properties before becoming LEED-EB, indicators are that a one year newer property is associated with a 0.51% lower vacancy compared to older ones, while the decrease almost triples to 1.45% if the comparison is made after LEED-EB is achieved. This result clearly suggests the positive advantage newer existing buildings have over older buildings, both before and especially after achieving LEED-EB, in attaining a significant capture rate which allows for their vacancies to decreases within the two time frames (before and after LEED-EB). This positive effect is shared by taller versus shorter buildings but only before LEED-EB is achieved. The results suggest that a one floor increase is associated with a vacancy decrease by 0.59%, when comparing properties before LEED-EB based on their number of stories. Assessing the recession effect on properties before their LEED-EB certification, the results suggest that Class A properties achieved lower vacancy rates during the recession when compared to any other time period (column 1). This effect is maintained for Class A properties one quarter lag after the recession began. Specifically, vacancy decreased for Class A properties before achieving LEED-EB and during the recession by 7.89% (1- exp(0.076)) compared to any other period (column 1). The vacancy decrease was 5.65% (1- exp(0.055)) for one quarter lag after the recession began (column 1). These recession effects on vacancy are not sustained after LEED-EB certification, with vacancy levels increasing during the recession by 34.04% (1- exp(0.293)) compared to any other time period while one lag after the recession lacks any statistically significant effect (column 3). Finally, in an effort to better understand possible differentiations in vacancy levels among the four LEED-EB levels (Certified, Silver, Gold and Platinum) their isolated study before and after LEED-EB suggests that properties which eventually became Platinum achieved lower vacancy levels by 29.6% (1- exp(0.26)) before their certification when compared to properties of any other level (column 1).

The comparison of Exhibit 8, columns 2 and 4 with 1 and 3, respectively, indicate the existence of differences between the effect of the internal and external variables on Class B

[4] Typical floor-plate: "the size of the floor area that occurs most often in the building" CoStar Definition

and A properties, respectively. Focusing on the effect of various property characteristics on Class B vacancy levels, the typical floor-plate effect on vacancy is consistent between the two classes (columns 2 and 4). Taller buildings, however, are associated with a 4.8% increase in vacancy compared to shorter buildings after becoming LEED-EB (column 4). The results also indicate that Class B properties which became registered and certified during the 2009 recession, achieved 109% (1- exp(0.738)) lower vacancy compared to any other period. This result suggests not only that Class B properties were well prepared when submitting their material for LEED-EB certification (achieving certification without delays) but that they also adopted strategies which allowed their vacancy to decrease during the worst recession after the Great Depression. Exhibit 8, column 6 provides some evidence of this strategy which includes a rent level decreased by 62.2% (1- exp(0.484)) for these properties. The effect of market trends on property vacancy levels suggests that an increase in net market absorption is associated with a $3x10^{-5}$% increase in vacancy after LEED-EB is achieved (column 4). Although this result seems surprising, the increase in vacancy in Class B vacancy can possibly be caused by the fleeing of tenants to newer construction and even though rent levels were decreased (column 8) the fleeing to other non-Class B properties did not stop. The recession affected only the vacancy levels of Class B properties after their certification. Similar to Class A properties (column 3), vacancy increased for Class B (column 4) by 46.8% (1- exp(0.384)) after they became LEED-EB and during the recession compared to any other time period. Finally, looking at the four LEED-EB levels, the results suggest that properties which achieved the LEED-EB Certified level had higher vacancies, both before and after certification, compared to all other certifications by 63.2% (1- exp(0.490)) and 90% (1- exp(0.642)), respectively (columns 2 & 4).

Focusing on the effect of external and internal variables on Class A (columns 5 and 7) rents, before and after their LEED-EB certification, provides some interesting findings. Analyzing the effect of property characteristics on rents, it is observed that a 1% increase in property vacancy before as well as after properties become LEED-EB is associated with a 14.9% decrease of their rents before their certification and a 21.2% decrease after LEED (columns 5 and 7). This result is proof of the rapid response of property managers in mitigating potential vacancies with lower rent levels. Other property based factors, such as the year the property was built and building height, suggest that newer and taller properties are associated with a 0.33% increase in rent levels but only for properties before they become

LEED-EB (column 5). Neither of these factors seems to affect rent levels after properties become LEED-EB.

Analyzing the effects of two different energy efficiency incentives on rents suggests that both of them have a strong statistically significant effect before and after properties become LEED-EB. Specifically, an increase in property tax incentives is associated with an 8.6% decrease of rents for properties before they become LEED-EB and 11.4% after LEED-EB (columns 5 and 7). The effect is similar for green building incentives with 39.6% and 29.4% decreases, respectively, (columns 5 and 7). Acknowledging that in the last few years the number of energy efficiency incentives has increased. More buildings are pursuing these incentives and initially becoming energy efficient and subsequently LEED, therefore, increasing the size of the market supply of these properties. This can create downward pressures for rents if the tenant demand is not sufficient to maintain the rents at high levels. Further assessment of exterior market effects on rents, before and after properties become LEED-EB, suggests that an increase in net market absorption is associated with a $3.74*10^{-6}$ decrease in rents (column 7). This effect can be explained by keeping in mind that the properties studied are existing and tenants have the option to moving into new supply or other non-green properties, which can trigger the decrease in rents among properties even if they are LEED-EB. The results also indicate that as overall market vacancy increases, rents decrease both before and after properties become LEED-EB by 25.6% and 28%, respectively, (columns 5 and 7). This performance of buildings before becoming LEED-EB follows the expected outcome of rent downward adjustment when market vacancies increase in order to remain competitive. The maintenance of the same effect after properties become LEED-EB suggests that LEED-EB buildings are not immune to the external market conditions because they are green. Finally, focusing on the effect of the recent recession on rents, the results suggests that properties before becoming LEED-EB achieved higher rents during the recession as well as one and two quarter lags after the recession occurred compared to any other period in time (column 5). Although this result might seem surprising, column 1 indicates that vacancy was lower during the recession for properties which had not yet become LEED-EB. Specifically, rents increased by 10.29% (column 5) during the recession, 3.97% one quarter lag after and 40.0% two quarter lags after the recession when compared to other time periods. Examining the effect of the different LEED-EB levels (Certified, Silver, Gold and Platinum) on rents

(columns 5 and 7), only Silver level properties achieved a 9.3% increase in their rents compared to all other certification levels after becoming LEED-EB (column 7).

Finally, the effects of internal and external variables on Class B properties, before and after becoming LEED-EB (columns 6 and 8), suggest that external factors affect rent levels more than internal. Considering property characteristics, only property vacancy is associated with a decrease in rent by 16.1% before the properties become LEED-EB (column 6) similar to the Class A property effect (column 5); however, property vacancy after LEED-EB is not statistically significant, as expected, as well as the majority of the other property specific variables (e.g. year built) (column 8). This result suggests a lack of a consistent internal-to-the-property direction of influence on rent levels, which is overshadowed by external factors. Looking at the timeframe between a property's LEED-EB registration until certification and considering if it registered during the recent recession, the results suggest that those properties experienced lower rents by 62.2% (1- exp(0.484)) compared to any other property pursing LEED-EB which has registered and certified at another time frame (column 6).

Shifting the emphasis to the study of factors external to the property, it is observed that Class B properties, similar to Class A, experience a rent decrease by 14.7% as green building incentives increase for properties which have not yet received their LEED-EB certification (column 6). Net market absorption has an opposite effect between the before and after LEED-EB timeframe. The expectation is that an increase in net market absorption will increase rent levels; however, based on column 6, this is only the case for properties which have not yet received their LEED-EB certification. The increase is $3.19*10^{-6}$ (column 6) but when analyzing the properties after receiving their LEED-EB the results suggest that their rent decreased by $7.49*10^{-6}$ (column 8). Moving to the recession effect on rents, the results suggest that properties which had not yet achieved LEED-EB experience a 9.6% (1- exp(0.092)) rent increase when compared to any other time period (column 6) as did LEED-EB properties one quarter lag after the recession by 14.3% (1- exp(0.134)) (column 8). Rent levels, however, decreased by 19.3% for LEED-EB properties two quarter lags after the recession compared to any other time period (column 8). This rent decrease two quarter lags from the recession suggests that property managers of Class B properties possibly are trying to prevent a vacancy increase due to the recession by decreasing their rent and increasing their competitive advantage on the market.

The analysis of the performance of properties before and after they become LEED-EB, as well as their external influences, are important in helping us understand any underlying trends in sustainable existing building real estate; however, real estate is always local. The next step was, therefore, to ask the same questions in a specific market where LEED-EB has achieved a substantial presence. The question then became:

3) ***Which cities achieve the largest concentration of LEED-EB designated properties and how are they spatially allocated?***

In response to this question we find that although a city might rank high based on the number of properties the ranking might not reflect total LEED-EB square footage (Exhibit 9). The only high-ranking city in both cases is Chicago – third and second, respectively, which led to further analysis as a case study. Exhibit 10 identifies the certification level of the LEED-EB properties in downtown Chicago and provides the directional distribution of the most frequently attained certification levels (Silver and Gold). The spatial distribution of all certification levels suggests a significant concentration in the Loop area of the city with minimal presence north but an increasing presence west of the Chicago river, which is the area of the two main commuter train stations of Chicago. Both directional distributions (Silver and Gold) are elliptical; however, the Gold is more concentrated in the Loop area with a semi-major axis distance of 0.69 miles while Silver expands more much further west of the river with a semi-major axis distance of 0.83 miles.

Chicago case study

The analysis of the Chicago case study begins with the exploration of the two key questions asked at the national level.

1) ***How beneficial is the pursuit of LEED-EB at each level (Certified, Silver, Gold and Platinum) and property classification when comparing average vacancy and rent performance before and after certification? How did the recent recession affect the response to this question?***

The comparison of the average vacancy levels of Class A buildings, before and after achieving LEED-EB across all levels, indicates that only Gold level properties show a statistically significant difference (Exhibit 11). The average vacancy decreased by 51.2% (to 7.18%) after LEED-EB. Gold level properties maintain their decreasing vacancy trend after certification both during and beyond the recent recession by 83.2% (to 2%) and 42.4% (to

8.8%) respectively. Silver level properties also experience an average vacancy decrease after certification but this effect is based only on three observations. The average vacancy decrease by 23.4% (to 7.7%) is also shared among Silver level Class B properties after their certification. Certified level Class B properties, however, experience a major average vacancy hike 153% (to 25%) although we should be cautious interpreting the result because it is based only on six observations after certification. Overlaying the recent recession on the average vacancy, performance of class B properties shows a decrease at the silver level during the recession but an increase beyond the recession for the Certified level. Both results are obtained with a limited number of observations after certifications so we should be cautious analyzing them.

Shifting the focus to Class A average rents, Certified and Gold level properties experience statistically significant results in the comparison of the before and after trends. Certified properties experience a rent increase after certification at the Certified level by 14.2% (at $34.37/sf). In contrast, rents decreased on average for Gold level properties after their certification by 8.9% (to $29.16/sf). A possible reason is that LEED decreased expenses in the building enabling the rent decrease so that the property would be more competitive. The absence of complete information during the recession did not allow the application of t-tests for all the certification levels of Class A properties and the majority of B properties. Class B properties experience an average decrease in rents by 12.5% (to $22.8/sf) after certification for Silver level properties.

2) How do property, office market, economic, and sustainability variables affect vacancies and rents of LEED-EB properties before and after LEED-EB?

The interaction among factors internal and external to the property vacancy and rents before and after the buildings became LEED-EB, provides interesting insights on the commonalities and differences between the A and B Classes (Exhibit 12). In analyzing the effect of vacancy on property characteristics of Class A properties, when comparing older to newer properties, the results suggest that new properties achieve a 0.9% decrease in vacancy after a newer property is certified compared to an older property (column 3). Vacancy also decreases as duration to LEED-EB increases before and after properties become LEED-EB (columns 1 and 3). On the surface, this result is less expected; perhaps the reason for this effect is the inflow of tenants signing contracts before as well as soon after LEED-EB

certification prior to the rent increase, which is usual in LEED vs. non-LEED properties. Shifting the focus to external variables, it is observed that a 1% increase in the market vacancy rate is associated with a 21.1% increase in vacancy before a property becomes LEED-EB (column 1), an effect not sustained after a property receives the LEED-EB certification. Similarly, an unemployment increase is associated with a 2.6% increase in vacancy rate after the LEED-EB certification (column 3). The differentiation among the four LEED-EB certification levels suggests that vacancy levels decreased in three out of the four certifications after the properties were certified and when the comparison was between each of the certification with all the others. Specifically, the vacancy of Certified level properties decreased by 19.1% when compared to all other certifications, while the decrease was 16.7% for Silver properties and 17% for Gold (column 3).

Looking closely at Class B properties, the results suggest that larger floorplates are associated with decreased vacancies but only before certification (column 2). In contrast to Class A properties, vacancies increase for newer properties compared to older by 1.2% (1-exp(0.012)) after LEED-EB certification (column 4). Similar is the effect for taller buildings where the increase is 3.04% (1- exp(0.03)) (column 4). External factors affect Class B vacancy both positively and negatively. For example, a net absorption increase is associated with a vacancy increase after certification (column 4) which can be explained similarly to the national data by tenants fleeing to newer construction. An increase in overall market vacancy, however, is associated with a decrease in vacancy by 99% in Class B properties (column 2). The recent recession affected the Class B properties after their certification with an initial increase of vacancy by 28.1%, which quickly turned to a decrease one quarter lag (18.4%) and two quarter lags (18.17%) after the recession began when comparing with any other time period (column 4).

Assessing the impact of property factors on Class A rent, before and after their certification, indicates that properties with larger floorplates are associated with a rent increase only before certification as are newer properties where the increase is 10% (column 5). A duration increase from the time a property is registered until its certification seems to be associated with a 0.03% rent increase (column 5). Finally, the only LEED-EB level with a statistically significant effect on rent is the Certified level, which is associated with a 33.2% increase after certification (column 7).

Focusing on the Class B property trends, before and after certification (columns 6 and 8), the results suggest that properties with larger floorplates are associated with a decrease in rents both before and after LEED-EB. Class B properties with a "view" achieve higher rents compared to properties without a view both before and after LEED-EB (17.4% (1-exp(0.161)) and 59.36% (1- exp(0.466)), respectively) (columns 6 and 8). The effect of the real estate market trends on rents indicates that an increase in net absorption is associated with a decrease in vacancy (column 8). The effect of a market vacancy increase is opposite when comparing rents before and after certification. The effect before certification is expected with a decrease of 26.2% but after certification rents increase by 58% (columns 6 and 8). Another expected result is the decrease in rents during periods of increased unemployment (at 5.0%) (column 8).

Rents of Class B properties after their LEED-EB certification increased initially during and one quarter lag after the recession (by 5.5% and 22.5%, respectively) but they decreased two quarter lags after the recession began (by 22.2%) (column 8). Comparing the rent and vacancy trends in the same time periods (columns 8 and 4) suggest that property managers assumed their properties to be more immune to the crisis and sustained increased rent levels compared to the non-recession period but even though vacancies decreased one and two quarter lags after the recession. The lingering effects seem to push managers to decrease rents even though vacancies are lower. Assessing the effect of the four certification levels, the results suggest that only Gold Class B properties achieved a 19.96% higher rents compared to all other certification levels after certification.

3) Case study survey questions

As discussed in the methodology section, as part of this research a survey of all downtown Chicago LEED-EB office buildings was conducted with a response rate of 59.3% by number of buildings and 70.5% based on the overall LEED-EB Rentable Building Area in the downtown. The combination of quantitative and qualitative questions (see Appendix) allowed for a more in depth analysis of the selected market beyond the information readily available on commercial real estate databases (e.g. CoStar Group). The quantitative portion of the survey is presented in two formats which highlight the overall trends (Exhibit 13a) as well as the differences between Class A and B properties (Exhibit 13b). The results indicate that:

- The average overall cost per square foot for LEED-EB is $0.10/sf (Exhibit 13a). Comparing the average overall cost of pursing LEED-EB by both Class A and B properties, we find that it is more costly for Class B to achieve LEED than Class A (Exhibit 13b).
- Standalone retrofit costs are on average $0.21/sf (Exhibit 14a), which shows no evidence of statistical difference between the two classes (Exhibit 13b).
- The average simple payback period for all LEED-EB investments is estimated at 1.8 years (Exhibit 13a), which is lower than the range suggested by Lockwood (2009) which ranges from two to fifteen years. The comparison of the minimum and maximum simple payback periods with those of Lockwood (2009) suggests that both of them are lower (Exhibit 13b). The comparison between the two classes does not indicate any statistically significant differences (Exhibit 13b).
- Average operating expenses and energy consumption, which directly benefit tenants[5], because of triple net leases decreased by 8.09% and 7.02%, respectively (Exhibit 13a). Exhibit 13b shows that absence of statistically significant differences between Class A and B properties for the latter variable.
- The survey also included a question on recycling because it shows tenant engagement and continuing sustainability efforts by buildings towards improving the environmental impact on landfills. The results (Exhibit 13a) suggest an increase of 57.6% on average without any differences between the two classes (Exhibit 13b).
- On average, 76.84% of the tenants in LEED properties utilize public transportation decreasing pollution and traffic congestion in the city (Exhibit 13a). Exhibit 14b suggests the absence of difference between Class A and B properties (Exhibit 13b).

To better understand the relationship between four of the most significant variables gathered from the survey on rents of properties after they were certified, the two datasets were merged allowing the evaluation of the (Exhibit 14): cost of LEED-EB certification, cost of retrofitting, payback period and operating expense on rents. The results suggest that an increase of the overall cost for LEED-EB/sf is associated with a decrease of rent by 26% (Exhibit 14). Although this effect might seem unexpected a possible reason is that these costs are higher than just the retrofit costs and if a property has undergone a significant renovation while pursuing LEED-EB, new lease agreements with lower rents as a result of the degreasing

[5] Tenants who pay their own energy bill would benefit and they would also benefit because the energy expense for the common areas would decrease and therefore, their share of CAM would decrease.

CAM costs encourage new tenants. In contrast, an increase in retrofit costs is associated with an increase in rents by 22%, again, because of the increased CAM costs as allowed by the various lease contracts. This result can be justified by assuming that the retrofits include building functions (e.g. HVAC systems, energy savings from interior light replacement etc.) from which tenants benefit immediately. Considering the maximum simple payback period, the results suggest that a one year increase is associated with a decrease in rents by 9%, further reinforcing the need for shorter payback. Finally, a decrease in operating expenses is associated with a 21% increase in rents reaffirming the tenant interest in efficient buildings with less operating cost burden due to application of the LEED-EB sustainability strategies.

Beyond the quantitative analysis, the qualitative data gathering through the survey suggests that several buildings from the ones surveyed have instituted tenant educational programs about sustainability, which can further help tenants apply sustainable practices, therefore improving further future building operating expenses (e.g. recycling etc.).

Conclusions

This is the first study of vacancy and rents of office properties at two points in time, before and after they became LEED-EB. To better understand these properties, they are differentiated by Class (Class A versus B) and LEED-EB certification level (Certified, Silver, Gold and Platinum). The initial goal was to determine if LEED-EB is a prudent option from an average vacancy and rent standpoint when comparing the property trends before and after certification. We find it to be true from a vacancy standpoint for Platinum Class A properties as well as Certified and Gold Class B, which achieved lower vacancy after their certification compared to their before trends. From a rent standpoint, however, there is no statistically significant difference between the two time periods (before and after certification) among the certification levels with the only exception being Gold Class B properties which experienced decreasing rents after their LEED-EB certification. Due to the significant number of properties achieving LEED-EB close to the recession, the same goal was examined both during and beyond the recession to identify any additional differences during these two time periods. Platinum Class A and Certified Class B properties maintained their low vacancies after certification, both during and beyond the recession. The results on other certification levels, however, were mixed as were the rent results with the exception of the Gold Class B properties which maintained their lower rents after certification both during and beyond the recession.

Focusing on the effect of internal and external variables affecting vacancies and rents after the LEED-EB certification, the results suggest that both Class A and B properties experienced vacancy increases during the recent recession with the increase in market vacancy rates affecting more Class A than B properties. Although only newer Class A properties achieved lower vacancies than older buildings, both Class A and B buildings with larger floor-plates achieved decreased vacancies. From a rent perspective, the results suggest that external factors, such as energy efficiency incentives, had a negative effect on rent levels of Class A properties as well as increasing overall market vacancy. The only positive effect among Class A properties after their certification was the improved rents of Silver properties compared to any other level of certification. Rents of Class B properties are affected more by the recent recession than Class A with Class B buildings experiencing a rent increase one quarter lag after the recession began due to possible tenant flight from Class A to B properties triggering demand increase but the rents turned negative from the second quarter lag after the recession began. This latter effect could be caused by the owner/manager's fear of the continuation of tenant flight to other buildings from the LEED-EB properties.

After the analysis of the overall market trends, the focal point shifted to the identification of the largest office building LEED-EB concentration in the U.S. The city achieving high ranking in both number of properties and rentable building area is Chicago where this research made a more in depth examination of the buildings' spatial patterns and a surveyed building managers. The results suggest significant spatial concentration within the center of the Central Business District with slightly different distribution patterns among the most frequently attained certification levels (Silver and Gold). When comparing the before and after average vacancies of the Chicago LEED-EB properties, only Gold Class A properties and Silver Class B properties achieve lower vacancies after their certification. From a rent perspective, however, only the rents of Class A Certified properties increased after certification. Gold Class A properties maintain their advantage during and beyond the recession while the recession has a mixed effect on the other certification levels. The analysis of the effects of internal and external factors on vacancies and rents of Chicago properties after they become LEED-EB, suggests that with the exception of the Platinum level properties each of the other certification levels achieved lower vacancies when compared to all others for Class A properties. In addition, although the recession did not affect Class A properties after they became LEED-EB, with the exception of the time during the recession vacancies decreased one and two quarter lags for Class B properties after their

certification. From a rent perspective, only Certified level Class A properties and Gold Class B achieve higher rents after certification compared to all other certification levels, while "view" allows for a premium rent for Class B properties. The recent recession also seems to improve rents for Class B properties after their certification but only during the recession and one quarter lag after.

Finally, the Chicago survey results indicate an average retrofit cost of $0.21/sf and an average of 1.8 year simple payback period, which is fairly low based on market standards. Operating expenses decrease on average by 8.09% while energy costs decrease by 7.02%. Recycling is also a positive influence with an average of 57.6% and cost savings of $0.01/sf/year.

In closing, this study helps create a benchmark on where the LEED-EB market is today. Unfortunately, a significant portion of the LEED-EB properties were certified in 2009 and 2010 in a period when the lingering effects of the recent economic crisis were evident not allowing them to fully capture/benefit from their sustainable profile. The recent recession, however, has pushed even more buildings to evaluate their operating systems and explore the possibility of becoming sustainable in an effort to decrease their operating expenses. Every quarter that goes by will allow future researchers to explore the vacancy and rent trends in a longer time frame and evaluate the progress of these buildings after their LEED-EB. We can hope that at some point detailed information on the LEED-EB checklists will be released helping identify the specific sustainability factors and levels of influence on a property's vacancy and rent performance.

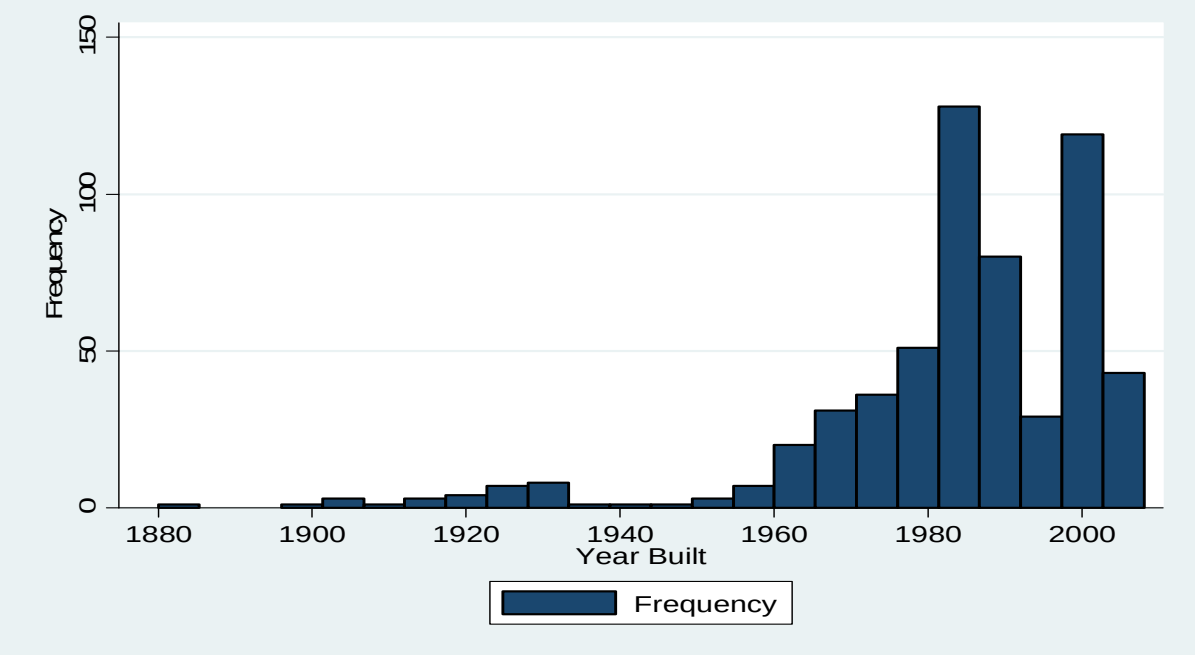
Exhibit 1. LEED - Existing Building rating history (point distribution by level achieved)

Year launched	Name	Certified	Silver	Gold	Platinum
1/2002	LEED-EB pilot 1.0				
10/2004	LEED-EB v2.0	32-39	40-47	48-63	64-85
9/2008	LEED-EB O&M	34-42	43-50	51-67	68-92
4/2009	LEED-EB 2009 O+M	40-49	50-59	60-79	80-110

Exhibit 2. Percent of the market that are LEED-EB buildings of 50,000 sf or more

	Total market		LEED-EB properties		% of LEED-EB compared to market	
Class	Number	sf of	Number	sf of	Number	sf of
A	14,793	3,055,332,330	553	262,774,142	3.74%	8.60%
B	23,778	2,820,458,190	155	50,610,435	0.65%	1.79%
C			3	853,309		
total A-B	38,571	5,875,790,520	708	313,384,577	1.84%	5.33%

Exhibit 3. Year built distribution of LEED-EB properties



Exhibits 4. Spatial distribution of LEED-EB properties by levels and state

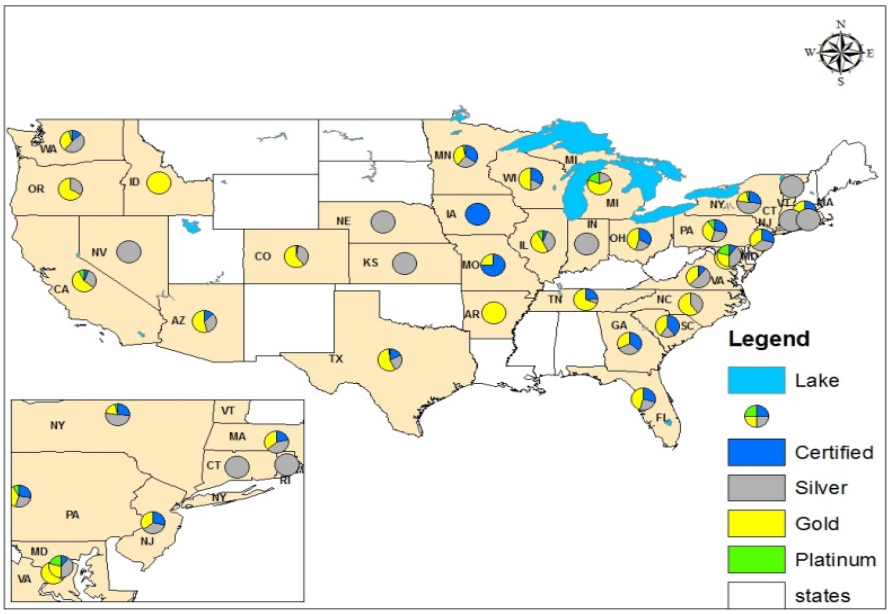


Exhibit 5. LEED-EB timing by certification level

	Certified		Silver		Gold		Platinum	
	Observations	Total sf	Observations	Total sf	Observations	Total sf	Observations	Total sf
2004					4	1747579		
2005	1	786,642			1	95,189		
2006	1	502,000			1	363,072	1	321,000
2007	1	140,605	1	4,000,000	8	4,113,110	2	259,100
2008	2	490,607	10	3,602,371	6	2,680,239	3	869,487
2009	25	10,966,155	52	26,659,796	78	39,106,992	1	372,000
2010	32	15,229,820	90	37,903,249	112	59,142,534	16	7,787,331
2011	16	5,330,275	42	22,161,502	69	29,829,393	3	989,645
Total	78	33,446,104	195	94,326,918	279	137,078,108	26	10,598,563

Properties in MSAs only

* Data until July 2011

Exhibit 6. Map of Chicago area of study and respondents

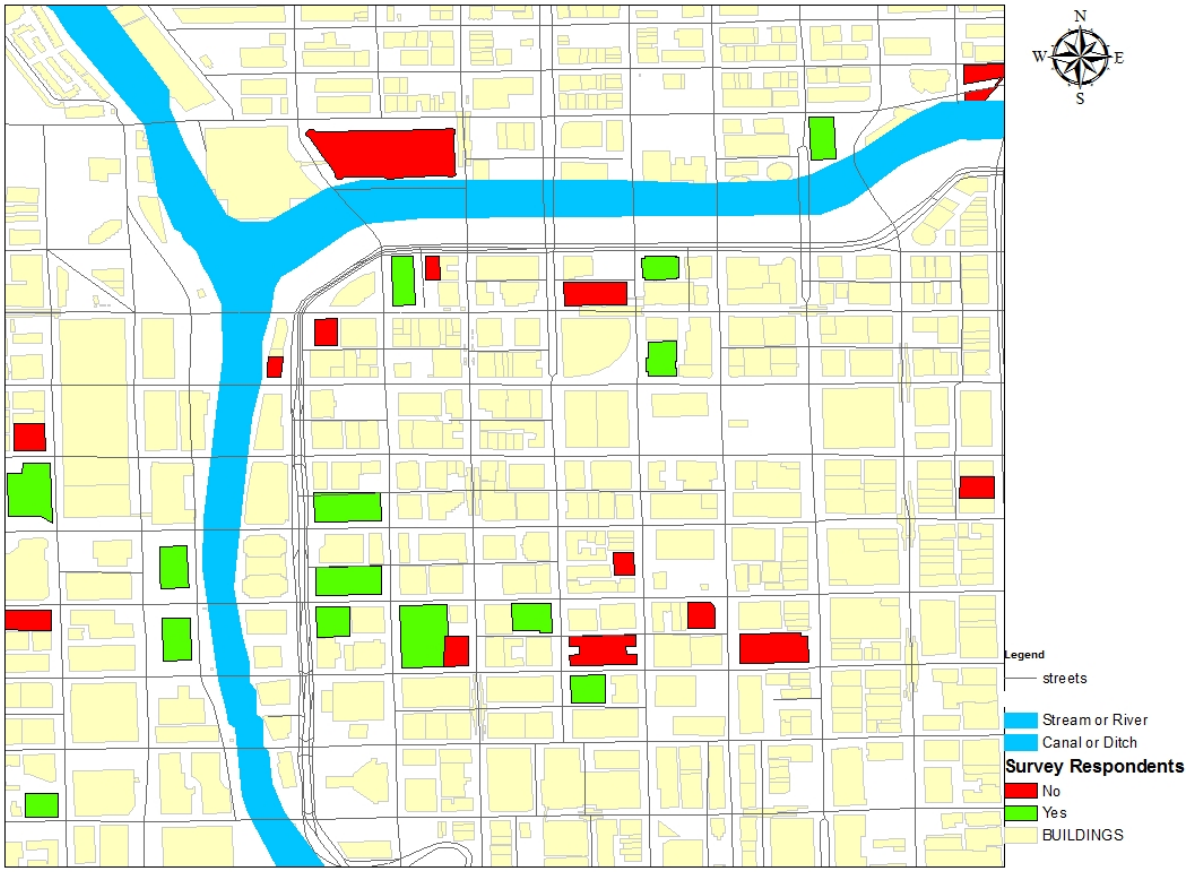


Exhibit 7. T-Tests on U.S. Data

Vacancy rate - Class A - Certified

	Number of observations	Mean vacancy	sd	t-statistic
Before LEED	1633	15.76%	18.50%	1.57
After LEED	278	14.24%	14.27%	
Class A - Silver				
Before LEED	4221	13.19%	15.97%	-6.16
After LEED	681	18.71%	22.50%	
Class A - Gold				
Before LEED	6545	11.94%	13.66%	-1.48
After LEED	1016	12.69%	15.17%	
Class A - Platinum				
Before LEED	588	10.02%	17.09%	6.27
After LEED	107	3.85%	7.10%	

Vacancy rate - Class A during recession - Certified

	Number of observations	Mean vacancy	sd	t-statistic
Before LEED	342	11.84%	13.15%	2.47
After LEED	18	5.50%	10.47%	
Class A during recession - Silver				
Before LEED	871	12.37%	16.29%	0.66
After LEED	26	10.42%	14.89%	
Class A during recession - Gold				
Before LEED	1321	9.82%	10.80%	1.17
After LEED	59	7.76%	13.26%	
Class A during recession - Platinum				
Before LEED	117	4.54%	5.57%	8.81
After LEED	15	0.00%	0.00%	

Gross Rents - Class A - Certified

	Number of observations	Mean vacancy	sd	t-statistic
Before LEED	1164	28.47	15.39	1.50
After LEED	199	27.17	10.40	
Class A - Silver				
Before LEED	3024	32.13	14.50	0.66
After LEED	477	31.71	12.97	
Class A - Gold				
Before LEED	4693	30.35	10.16	-0.34
After LEED	686	30.53	12.89	
Class A - Platinum				
Before LEED	298	32.46	10.06	0.86
After LEED	22	30.71	9.17	

Gross Rents - Class A during recession - Certified

	Number of observations	Mean vacancy	sd	t-statistic
Before LEED	262	32.39	20.98	0.14
After LEED	8	31.79	11.55	
Class A during recession - Silver				
Before LEED	619	37.27	19.37	2.44
After LEED	18	30.42	11.46	
Class A during recession - Gold				
Before LEED	959	34.64	11.93	3.50
After LEED	20	30.03	5.62	
Class A during recession - Platinum				
None				

Vacancy rate - Class A beyond recession - Certified

	Number of observations	Mean vacancy	sd	t-statistic
Before LEED	1291	16.80%	19.55%	1.88
After LEED	260	14.84%	14.32%	
Class A beyond recession - Silver				
Before LEED	3350	13.40%	15.89%	-6.07
After LEED	655	19.04%	22.70%	
Class A beyond recession - Gold				
Before LEED	5224	12.48%	14.25%	-0.97
After LEED	957	13.00%	15.23%	
Class A beyond recession - Platinum				
Before LEED	471	11.38%	18.65%	5.95
After LEED	92	4.48%	7.48%	

Gross Rents - Class A beyond recession - Certified

	Number of observations	Mean vacancy	sd	t-statistic
Before LEED	902	27.33	13.13	0.40
After LEED	191	26.98	10.34	
Class A beyond recession - Silver				
Before LEED	2385	30.76	12.54	-1.51
After LEED	459	31.76	13.04	
Class A beyond recession - Gold				
Before LEED	3734	29.25	9.34	-2.45
After LEED	666	30.54	13.05	
Class A beyond recession - Platinum				
Before LEED	238	31.50	9.08	0.39
After LEED	22	30.71	9.17	

Vacancy rate - Class B - Certified

	Number of observations	Mean vacancy	sd	t-statistic
Before LEED	423	17.30%	22.33%	3.22
After LEED	108	11.53%	14.81%	
Class B - Silver				
Before LEED	1286	9.80%	15.71%	-1.95
After LEED	142	14.03%	25.28%	
Class B - Gold				
Before LEED	1268	8.88%	15.86%	2.45
After LEED	275	6.22%	16.40%	
Class B - Platinum				
Before LEED	101	0.00%		-
After LEED	35	0.00%		

In yellow statistically significant differences

Vacancy rate - Class B during recession - Certified

	Number of observations	Mean vacancy	sd	t-statistic
Before LEED	100	14.23%	19.12%	5.28
After LEED	8	2.00%	3.70%	
Class B during recession - Silver				
Before LEED	264	8.38%	13.78%	3.72
After LEED	6	4.17%	1.83%	
Class B during recession - Gold				
Before LEED	229	7.53%	12.78%	7.90
After LEED	53	0.57%	1.83%	
Class B during recession - Platinum				
Before LEED	12	0.00%	0.00%	-
After LEED	12	0.00%	0.00%	

Gross Rents - Class B during recession - Certified

	Number of observations	Mean vacancy	sd	t-statistic
Before LEED	246	20.3826	5.04	0.58
After LEED	52	19.89	5.62	
Class B - Silver				
Before LEED	699	25.64	7.39	1.44
After LEED	76	24.56	6.12	
Class B - Gold				
Before LEED	602	27.59	8.27	3.38
After LEED	81	24.85	6.65	
Class B - Platinum				
None				

Gross Rents - Class B during recession - Certified

	Number of observations	Mean vacancy	sd	t-statistic
Before LEED	60	21.3428	6.51	10.09
After LEED	2	12.87	0.00	
Class B during recession - Silver				
Before LEED	138	29.02	9.43	4.37
After LEED	6	25.48	0.29	
Class B during recession - Gold				
Before LEED	110	31.03	8.56	9.26
After LEED	3	23.12	0.43	
Class B during recession - Platinum				
None				

Vacancy rate - Class B beyond recession - Certified

	Number of observations	Mean vacancy	sd	t-statistic
Before LEED	323	18.26%	23.18%	3.00
After LEED	100	12.29%	15.11%	
Class B during recession - Silver				
Before LEED	1022	10.16%	16.16%	-1.90
After LEED	136	14.46%	25.74%	
Class B during recession - Gold				
Before LEED	1039	9.18%	16.46%	1.23
After LEED	222	7.57%	17.97%	
Class B during recession - Platinum				
Before LEED	89	0.00%		-
After LEED	23	0.00%		

Gross Rents - Class B beyond recession - Certified

	Number of observations	Mean vacancy	sd	t-statistic
Before LEED	186	20.07	4.44	-0.12
After LEED	50	20.17	5.55	
Class B during recession - Silver				
Before LEED	561	24.81	6.55	0.42
After LEED	70	24.48	6.37	
Class B during recession - Gold				
Before LEED	492	26.82	8.01	2.25
After LEED	78	24.91	6.77	
Class B during recession - Platinum				
None				

Exhibit 8. Regression Modeling for U.S.

		ln(Total Vacancy Rate - Before LEED)		ln(Total Vacancy Rate - After LEED)		ln(Total Gross Rent - Before LEED)		ln(Total Gross Rent - After LEED)	
		1	2	3	4	5	6	7	8
		Class A	Class B	Class A	Class B	Class A	Class B	Class A	Class B
Porperty characteristics	Property Vacancy Rate					-0.149 -2.16*	-0.161 -1.78**	-0.212 -1.77**	-0.031 -0.13
	Typical Floorplates - in square feet	-6.65E-06 -2.21*	-7.33E-06 -6.21*	-1.33E-05 -2.46*	-8.43E-06 -2.98*	9.66E-08 0.08	-5.64E-07 -1.25	4.19E-08 0.03	3.71E-07 0.34
	Year Built	-0.005 -1.66**	4.51E-03 1.47	-0.015 -3.57*	0.007 1.18	3.31E-03 3.62*	2.47E-04 0.27	1.64E-03 1.50	-1.95E-04 -0.07
	Number of Stories	-0.006 -1.68**	-0.011 -1.21	-2.81E-03 -0.68	0.048 2.38*	3.35E-03 3.53*	-3.16E-03 -0.69	5.27E-04 0.37	1.77E-04 0.01
	Downtown dummy	-0.062 -0.46	0.266 1.33	-0.021 -0.13	-0.038 -0.06	-0.048 -1.42	0.084 1.10	0.054 1.29	0.159 0.49
	Duration to LEED designation	8.26E-05 0.49	2.17E-04 0.86	-9.36E-05 -0.33	7.17E-04 1.10	2.95E-05 0.61	2.16E-05 0.26	3.39E-05 0.44	-1.05E-05 -0.03
	Registered & certified during 2009 recession dummy	-0.099 -0.59	-0.738 -3.01*	3.07E-03 0.01		-7.96E-04 -0.02	-0.484 -2.75*	-0.007 -0.15	
Energy Efficiency Inventives	Property Tax Incentives	-0.027 -0.76	0.166 0.23	-0.090 -1.51	(dropped)	-0.086 -6.49*	(dropped)	-0.114 -7.27*	(dropped)
	Green Building Incentives	0.303 1.23	(dropped)	0.509 1.18	(dropped)	-0.396 -6.26*	-0.147 -2.01*	-0.294 -3.87*	(dropped)
R.E. Market Trends	Quarterly Market Net Absorption - in square feet	-2.87E-08 -1.04	2.80E-08 0.46	-1.39E-08 -0.33	2.95E-07 6.35*	-1.47E-08 -1.54	3.19E-08 2.13*	-3.74E-08 -2.33*	-7.49E-08 -2.32*
	ln(Quarterly Market Vacancy Rate)	0.767 8.08*	0.035 0.15	1.079 4.57*	0.698 1.47	-0.256 -7.26*	-0.065 -1.51	-0.280 -4.13*	0.016 0.06
	Quarterly Unemployment Rate	-0.021 -1.52	0.049 1.18	0.097 1.52	2.19E-03 0.04	0.006 1.52	0.013 2.29*	0.017 1.81**	-0.017 -0.98
Recession	Recession 2009 Dummy	-0.076 -2.24*	-0.097 -0.76	0.293 1.71**	0.384 1.79**	0.098 9.68*	0.092 4.49*	-0.028 -0.47	-0.022 -0.48
	Recession 2009 Dummy - Lag 1	-0.055 -2.35*	-0.132 -1.29	-3.15E-03 -0.04	-0.074 -0.59	0.039 4.25*	0.022 1.01	0.094 1.56	0.134 1.83**
	Recession 2009 Dummy - Lag 2	-0.001 -0.03	-0.124 -0.93	4.45E-04 0.01	-0.012 -0.16	0.040 3.12*	0.007 0.42	0.021 0.82	-0.177 -2.28*
LEED certification levels	Certified	(dropped)	0.490 1.8**	0.063 0.22	0.642 1.66**	(dropped)	-0.036 -0.25	(dropped)	(dropped)
	Silver	0.014 0.12	-0.131 -1.14	0.131 0.46	0.281 1.22	0.032 0.75	(dropped)	0.089 1.85**	-0.132 -0.69
	Gold	-0.077 -0.66	(dropped)	0.008 0.03	(dropped)	0.020 0.47	0.015 0.30	0.056 1.07	0.036 0.15
	Platinum	-0.26 -1.68**	(dropped)	(dropped)	(dropped)	0.11 1.43	(dropped)	0.18 1.35	(dropped)
	Constant	9.58	-11.31	27.48	-15.09	-3.19	2.62	-0.10	3.68
	MSA fixed effects	37	23	35	20	37	22	36	19
	Clusters - by property number	421	74	336	55	407	67	314	49
	Number of observations	10328	1699	1586	243	9171	1531	1382	201
	R-squared	18.73%	41.44%	24.38%	79.96%	55.74%	57.78%	53.73%	47.60%

first line coefficient & second line t-statistic

* statistically significant at 5% significance level

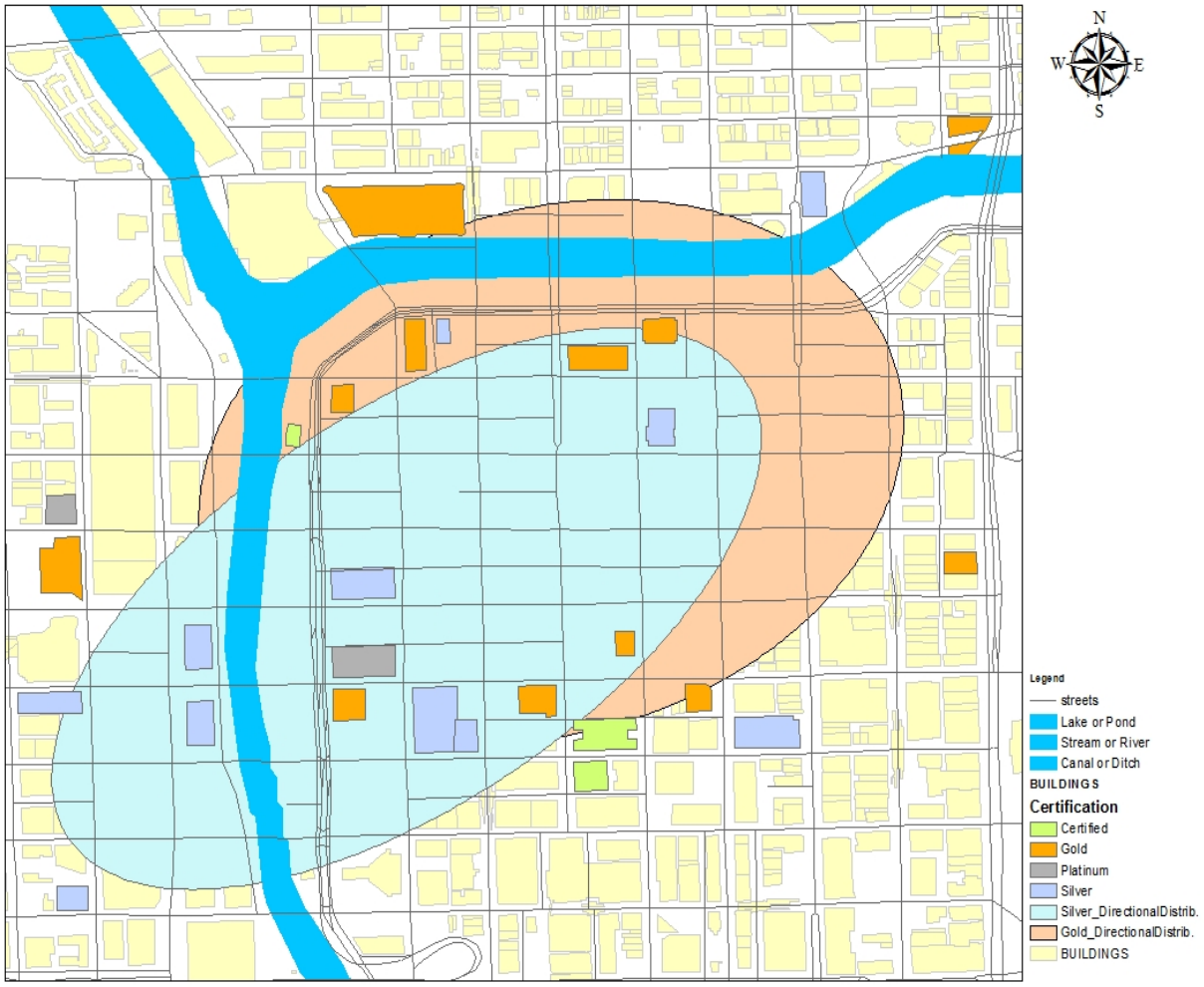
** statistically significant at 10% significance level

Exhibit 9. City rankings based on their LEED-EB properties

Cities	Number of properties	Rentable Building Area (square feet)
San Francisco	45	21,173,275
Washington	39	14,076,705
Chicago	34	27,335,937
Seattle	28	13,591,578
New York	27	30,008,651
Atlanta	25	9,762,381
Houston	21	26,372,175
Denver	21	10,576,781

Data as of July 2011

Exhibit 10. Spatial and directional distribution of downtown Chicago LEED-EB office properties



Data as of July 2011

Exhibit 11. T-tests for Chicago

Vacancy rate - Class A - Certified

	Number of observations	Mean vacancy	sd	t-statistic
Before LEED	58	17.02%	20.05%	-0.91
After LEED	10	19.80%	4.96%	
Class A - Silver				
Before LEED	179	12.63%	13.02%	-0.26
After LEED	25	13.60%	18.05%	
Class A - Gold				
Before LEED	203	14.72%	13.80%	5.43
After LEED	50	7.18%	7.04%	
Class A - Platinum				
Before LEED	51	13.59%	15.08%	-1.31
After LEED	9	16.78%	3.60%	

Vacancy rate - Class A during recession - Certified

	Number of observations	Mean vacancy	sd	t-statistic
Two groups required				
Class A during recession - Silver				
Before LEED	33	9.79%	8.35%	6.73
After LEED	3	0.00%	0.00%	
Class A during recession - Gold				
Before LEED	36	11.97%	9.66%	5.30
After LEED	12	2.00%	3.38%	
Class A during recession - Platinum				
Two groups required				

Vacancy rate - Class A beyond recession - Certified

	Number of observations	Mean vacancy	sd	t-statistic
Before LEED	46	16.72%	21.85%	-0.86
After LEED	10	19.80%	4.96%	
Class A beyond recession - Silver				
Before LEED	146	13.27%	13.81%	-0.53
After LEED	22	15.45%	18.51%	
Class A beyond recession - Gold				
Before LEED	167	15.32%	14.50%	4.03
After LEED	38	8.82%	7.13%	
Class A beyond recession - Platinum				
Before LEED	39	15.28%	16.84%	-0.51
After LEED	9	16.78%	3.60%	

Gross Rents - Class A - Certified

	Number of observations	Mean vacancy	sd	t-statistic
Before LEED	47	30.08	7.00	-3.40
After LEED	10	34.37	2.35	
Class A - Silver				
Before LEED	155	35.05	7.24	-1.48
After LEED	13	39.26	10.00	
Class A - Gold				
Before LEED	175	32.02	7.50	1.71
After LEED	20	29.16	7.04	
Class A - Platinum				
Before LEED	46	40.85	13.17	1.61
After LEED	9	33.10	13.23	

Gross Rents - Class A during recession - Certified

	Number of observations	Mean vacancy	sd	t-statistic
Two groups required				
Class A during recession - Silver				
Two groups required				
Class A during recession - Gold				
Two groups required				
Class A during recession - Platinum				
Two groups required				

Gross Rents - Class A beyond recession - Certified

	Number of observations	Mean vacancy	sd	t-statistic
Before LEED	36	28.62	7.19	-4.08
After LEED	10	34.37	2.35	
Class A beyond recession - Silver				
Before LEED	125	34.83	7.19	-1.55
After LEED	13	39.26	10.00	
Class A beyond recession - Gold				
Before LEED	141	31.75	7.49	1.53
After LEED	20	29.16	7.04	
Class A beyond recession - Platinum				
Before LEED	34	38.95	11.92	1.20
After LEED	9	33.10	13.23	

Vacancy rate - Class B - Certified

	Number of observations	Mean vacancy	sd	t-statistic
Before LEED	28	9.86%	3.32%	-7.52
After LEED	6	25.00%	4.69%	
Class B - Silver				
Before LEED	170	10.07%	10.41%	1.86
After LEED	34	7.71%	5.75%	
Class B - Gold				
Before LEED	151	10.31%	10.04%	0.11
After LEED	19	10.11%	7.75%	
Class B - Platinum				
None				

In yellow statistically significant differences

Vacancy rate - Class B during recession - Certified

	Number of observations	Mean vacancy	sd	t-statistic
Two groups required				
Class B during recession - Silver				
Before LEED	30	7.97%	6.42%	2.73
After LEED	6	4.17%	1.83%	
Class B during recession - Gold				
Two groups required				
Class B during recession - Platinum				
None				

Vacancy rate - Class B beyond recession - Certified

	Number of observations	Mean vacancy	sd	t-statistic
Before LEED	22	9.36%	3.57%	-7.59
After LEED	6	25.00%	4.69%	
Class B during recession - Silver				
Before LEED	140	10.52%	11.05%	1.40
After LEED	28	8.46%	6.03%	
Class B during recession - Gold				
Before LEED	121	9.29%	8.61%	-0.42
After LEED	19	10.11%	7.75%	
Class B during recession - Platinum				
None				

Gross Rents - Class B during recession - Certified

	Number of observations	Mean vacancy	sd	t-statistic
Before LEED	28	30.0957	3.13	-1.08
After LEED	6	30.96	1.34	
Class B - Silver				
Before LEED	164	26.15	5.00	3.40
After LEED	33	22.88	5.06	
Class B - Gold				
Before LEED	135	25.84	4.44	-0.82
After LEED	16	26.92	5.05	
Class B - Platinum				
None				

Gross Rents - Class B during recession - Certified

	Number of observations	Mean vacancy	sd	t-statistic
Two groups required				
Class B during recession - Silver				
Before LEED	27	25.81	7.23	0.24
After LEED	6	25.48	0.29	
Class B during recession - Gold				
Before LEED				
After LEED				
Class B during recession - Platinum				
None				

Gross Rents - Class B beyond recession - Certified

	Number of observations	Mean vacancy	sd	t-statistic
Before LEED	22	28.89	2.27	-2.83
After LEED	6	30.96	1.34	
Class B during recession - Silver				
Before LEED	137	26.22	4.46	3.51
After LEED	27	22.30	5.44	
Class B during recession - Gold				
Before LEED	110	25.60	3.73	-1.01
After LEED	16	26.92	5.05	
Class B during recession - Platinum				
None				

Exhibit 12 Regression Modeling for Chicago

		ln(Total Vacancy Rate - Before LEED)+		ln(Total Vacancy Rate - After LEED)+		ln(Total Gross Rent - Before LEED)		ln(Total Gross Rent - After LEED)	
		1	2	3	4	5	6	7	8
		Class A	Class B	Class A	Class B	Class A	Class B	Class A	Class B
Porperty characteristics	Property Vacancy Rate					0.298 1.540	0.145 0.720	-0.471 -0.980	-0.068 -0.090
	Typical Floorplates - in square feet	-3.37E-07 -0.13	-7.19E-06 -3.32*	2.34E-06 0.64	-3.94E-06 -0.97	8.73E-06 2.15*	-1.34E-06 -2.12*	7.37E-06 0.85	-1.35E-06 -2.17*
	Year Built	-0.003 -1.61	0.005 1.34	-0.009 -3.87*	0.012 3.2*	0.010 4.4*	-3.597E-04 -0.34	0.004 0.55	-0.001 -1.62
	Number of Stories	-1.24E-04 -0.06	0.010 0.61	0.001 0.97	0.030 2.83*	0.009 1.45	-0.006 -1.23	0.009 0.84	2.987E-04 0.14
	Duration to LEED designation	-2.56E-04 -3.28*	-2.28E-04 -0.45	-3.98E-04 -3.28*	4.84E-04 0.70	2.66E-04 1.98**	4.52E-05 0.22	-1.65E-04 -0.41	1.52E-04 1.44
	View (River & Waker Dr.)	-0.006 -0.12	-0.127 -0.50	0.004 0.09	-0.067 -0.19	0.019 0.23	0.161 2.22*	0.226 1.24	0.466 10.81*
R.E. Market Trends	Quarterly Market Net Absorption - in square feet	-3.18E-09 -0.18	5.07E-08 1.12	6.65E-09 0.55	1.40E-07 4.54*	9.98E-09 0.43	-4.09E-09 -0.19	6.01E-08 0.47	-5.18E-08 -2.18*
	ln(Quarterly Market Vacancy Rate)	0.211 2.55*	-0.992 -1.9**	-0.267 -1.27	-0.366 -0.64	-0.180 -0.79	-0.262 -4.02*	2.199 1.10	0.588 3.38*
	Quarterly Unemployment Rate	-0.004 -0.40	0.133 1.77**	0.026 1.91**	-0.024 -0.38	0.017 1.26	0.005 0.41	-0.110 -1.43	-0.049 -3.63*
Recession	Recession 2009 Dummy	0.018 0.89	-0.081 -0.28	-0.012 -0.83	0.248 3.95*	0.037 1.05	-0.020 -0.54	(dropped)	0.054 2.74*
	Recession 2009 Dummy - Lag 1	-0.008 -0.27	-0.240 -1.12	-0.034 -1.62	-0.169 -2.54*	0.039 1.06	0.008 0.17	(dropped)	0.203 3.1*
	Recession 2009 Dummy - Lag 2	0.001 0.05	-0.204 -0.75	-0.001 -0.04	-0.167 -6.74*	-0.061 -1.19	-0.026 -0.68	-0.018 -0.33	-0.201 -2.82*
LEED certification levels	Certified	(dropped)	(dropped)	-0.191 -2.18*	0.856 1.40	(dropped)	0.076 0.51	0.287 2.26*	0.144 1.15
	Silver	-0.105 -1.46	0.082 0.17	-0.167 -2.68*	-0.066 -0.26	-0.039 -0.44		(dropped)	
	Gold	-0.066 -0.88	0.103 0.24	-0.170 -3.23*	(dropped)	-0.011 -0.12	-0.013 -0.28	-0.193 -1.01	0.182 5.5*
	Platinum	0.019 0.21	(dropped)	(dropped)	(dropped)	0.106 1.17	(dropped)	0.204 0.66	(dropped)
	Constant	6.47	-14.31	16.93	-27.78	-18.47	3.53	-0.31	6.79
	Clusters - by property number	18	12	16	11	15	12	14	10
	Number of observations	491	315	94	59	423	326	52	55
	R-squared	15.32%	38.11%	77.37%	84.81%	37.38%	36.49%	63.13%	78.76%

first line coefficient & second line t-statistic

* statistically significant at 5% significance level

** statistically significant at 10% significance level

+: ln was not used for class A properties

Ex 13a. Information from survey questions

		Observations	Mean	sd
Q.3	What was the overall cost per square foot for LEED certification (exclude the LEED consultant fee)?	16	0.10	0.15
Q.4	What was the retrofit cost for LEED certification (per square foot) ?	12	0.21	0.61
Q.5	What is your simple payback period on your LEED certification when considering all the types of	8	1.80	3.77
Q.6	How much did your average operating expenses decrease after your LEED certification?	6	8.09%	9.22%
Q.11	What is your current energy consumption decrease (due to LEED) compared to the before trend (provide a percentage)?	11	7.02%	8.73%
Q.12	How much of your current annual total building waste do you recycle - provide a percentage?	15	57.60%	20.06%
Q.13	How much cost savings do you currently realize per square foot per year from recycling?	12	0.01	0.01
Q.15	What percentage of your tenants commute using public transportation?	16	76.84%	13.78%

All questions were weighted with building RBA's

Exhibit 13b T-tests of Survey Questions

Q3: Overall cost of LEED-EB certification/sf				
	Number of observations	Mean	sd	t-statistic
Class A	10	0.05	0.05	2.26
Class B	6	0.30	0.26	
Q4: Exclusive building retrofit cost for LEED-EB/sf				
Class A	8	0.32	0.83	-0.59
Class B	3	0.13	0.23	
Q5: Min simple payback period for LEED-EB certification (all inclusive)				
Class A	4	0.78	0.84	0.35
Class B	3	1.13	1.63	
Q5: Max simple payback period for LEED-EB certification (all inclusive)				
Class A	4	3.68	2.80	0.98
Class B	3	6.67	4.73	
Q6: Average operating expense decrease after LEED-EB				
Class A	4	0.09	0.11	Limited
Class B	1			observati
Q11: Current energy consumption decrease (due to LEED) compared to the before trend (provide a				
Class A	9	6.96%	9.20%	1.14
Class B	2	10.50%	0.71%	
Q12: Recycled annual total building waste (%)				
Class A	9	58.57%	20.16%	-0.33
Class B	6	54.67%	23.49%	
Q13: Cost savings/sf/year per year from recycling				
Class A	7	0.02	0.02	-0.85
Class B	5	0.01	0.01	
Q15: Percentage of your tenants commute using public transportation?				
Class A	10	74.80%	13.97%	0.21
Class B	6	76.50%	16.91%	

Exhibit 14 Regression modeling of survey questions

		ln(Total Gross Rent - After LEED)			
		Question 3	Question 4	Question 5	Question 6
Porperty characteristics	ln(Property Vacancy Rate)	0.09 1.50	0.38 2.89*	-0.15 -1.42	-0.19 -11.67*
	Typical Floorplates - in square feet	-2.00E-05 -3.36*	-9.29E-05 -1.61	-1.51E-04 -4.25*	
	Year Built	0.02 5.24*	0.01 1.86**	-0.07 -3.05*	
	Number of Stories	4.87E-03 0.79	0.02 3.73*	0.02 2.35*	-0.04 -21.25*
	Duration to LEED designation	7.70E-04 4.35*	1.06E-03 2.65*		
	View (River & Waker Dr.)	0.50 4.4*	1.12 2.41*		
Survey questions	ln(Overall cost of LEED-EB certification/sf)	-0.26 -6.15*			
	Exclusive building retrofit cost for LEED-EB/sf		0.22 6.26*		
	Max simple payback period for LEED-EB			-0.09 -4.24*	
	Average operating expense decrease after				0.21 20.62*
	Constant	-37.13	-20.60	136.09	5.89
	Clusters - by property number	12	8	6	4
	Number of observations	45	31	27	16
	R-squared	86.66%	86.64%	81.57%	96.63%

first line coefficient & second line t-statistic

* statistically significant at 5% significance level

** statistically significant at 10% significance level

Appendix

Questionnaire

		Questions	Responses
		Respondent Name	
General indicators	1	Office building address	
	2	Why did the owners pursue LEED certification for this building (check as many as apply)?	☐ Improve competition with newer or existing properties ☐ Imrpove building cash flow (increase rents & decrease expenses) ☐ Attraction of tenants with green mission ☐ All of the above If other please explain
	3	What was the overall cost per square foot for LEED certification (exclude the LEED consultant fee)?	$/sf
	4	What was the retrofit cost for LEED certification (per square foot) ?	$/sf
	5	What is your simple payback period on your LEED certification when considering all the types of retrofits/changes (including HVAC, lighting, carpeting etc.) - in years ?	Minimum: y Maximum: y
	6	Did your average operating expenses decrease or encrease after your LEED certification?	What was the % decrease or increase?
	7	Which LEED benefits do you promote in your marketing campaign for the building (check as many as apply)?	☐ Energy cost decreases due to efficiency ☐ Commuter amenities (e.g. buses to transit stations, bikes/racks etc.) ☐ Trash removal cost reduction due to recycling ☐ Improved Indoor Air Quality ☐ All of the above If other please explain
	8	Do you charge a rent premium for existing & new tenants after receiving your LEED certification?	If yes, how much is it on average per square foot $
	9	What innovation credits did you receive from USGBC for your LEED certification?	
Energy	10	Is your tenant energy use metered separately?	
	11	What is your current energy consumption decrease (due to LEED) compared to the before trend (provide a percentage)?	%
Waste	12	How much of your current annual total building waste do you recycle - provide a percentage?	%
	13	How much cost savings do you currently realize per square foot per year from recycling?	$/sf
Other	14	How much did the Indoor Air Quality complaints reduce after your LEED certification (provide a percentage)?	%
	15	What percentage of your tenants commute using public transportation?	%

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