Working Papers

Doing Well by Doing Good? Green Office Buildings

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Doing Well by Doing Good?
Green Office Buildings

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This paper provides the first credible evidence on the economic value of the certification of "green buildings" in the commercial sector -- value derived from impersonal market transactions rather than engineering estimates. We match publicly available information on the addresses of Energy-Star and LEED-rated office buildings to a commercial data source detailing the characteristics of U.S. office buildings and their rental rates. We analyze the micro data on 694 certified green buildings and on 7489 other office buildings located within a quarter mile of the certified buildings. We find systematic evidence that rents for green offices are about two percent higher than rents for comparable buildings located nearby. Effective rents, i.e., rents adjusted for the occupancy levels in office buildings, are about six percent higher in green buildings than in comparable office buildings nearby. At prevailing capitalization rates, conversion of the average non-green building to an equivalent green building would add more than $5 million in market value. These results are robust to the statistical models employed.

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Keywords: environmental sustainability, energy efficiency, green labels

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I. Introduction

It was recently announced[1] that the Most Reverend Desmond Tutu, Archbishop Emeritus of Capetown, will be the keynote speaker at the annual conference and exposition on green building sponsored by the U.S. Green Building Council in November 2008. This announcement is the latest in the decade-long campaign by advocates of environmental conservation to draw attention to the imperative of "sustainability" in the construction and operation of buildings.

An appearance at the exposition by the Nobel Laureate, the recipient of the Gandhi Peace Prize, and the Albert Schweitzer Prize for Humanitarianism will highlight the moral and humanitarian aspects of energy conservation in buildings.

An emerging consensus on the consequences of global warming, reinforced by academics such as Schelling (1992), together with the growing importance of "corporate social responsibility" as an intangible asset for competitive firms, has given the proponents of the green building movement increased credibility over time and has increased the salience of the issues they raise.

In fact, the behavior of the building sector is potentially quite important in matters of environmental sustainability. It is reported, for example, that buildings account for approximately forty percent of the consumption of raw materials and energy. In addition, 55 percent of the wood that is not used for fuel production is consumed in construction. Overall, buildings and the associated materials produced for construction activity account for at least thirty percent of world greenhouse gas emissions (Royal Institute of Chartered Surveyors, RICS, 2005). And once a building is constructed, the energy consumption associated with it continues. The impact of energy costs directly affects the bottom-line of tenants and building owners. Energy represents thirty percent of operating expenses in a typical office building, which makes it the single largest and most manageable operating expense in the provision of office space.

These magnitudes suggest that real estate can play an important role in making our societies more energy efficient. Awareness of this fact is growing. The increasing emphasis on "green rating" systems for buildings - initiated by both government and industry - gives testimony to this development. In general, these ratings assess the energy footprint of buildings, and they may provide owners and occupants with a solid yardstick of the energy efficiency and sustainability of properties. However, the use of these ratings has so far been limited, and the global diffusion of rating systems is relatively slow. Moreover, both real estate developers and institutional investors are understandably uncertain about how far they should go in implementing environmental investments, since the business case for the development of sustainable buildings is based largely on anecdotal evidence. This contrasts with a growing body of evidence on the profitability of incorporating eco-efficiency measures in both strategic management and investment decision-making (Margolis and Walsh, 2003).

This paper provides the first systematic analysis of the impact of environmentally-sustainable building practices upon economic outcomes measured in the marketplace. We concentrate upon commercial property and investigate the relationship between investments in energy efficiency in design and construction and the rents and effective rents commanded by these properties. We analyze a large sample of buildings, some of

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[1] U.S. Green Building Council, *News Release*, January 7, 2008.

which have been certified as more energy efficient by independent and impartial rating services.

We assemble a national sample of U.S. office buildings which have been evaluated for energy efficiency by one of two leading agencies. For each building, we identify a control sample of nearby office buildings. For some 8,000 subject and control buildings, we relate contract rents and effective rents to a set of objective hedonic characteristics of buildings, holding constant the locational characters of properties. We find that buildings with a "green rating" command rental rates that are roughly two percent higher per square foot than otherwise identical buildings – controlling for the quality and the specific location of office buildings. Premiums in expected rents, i.e., rents adjusted for building occupancy levels, are even higher – above six percent. Beyond the average rental premium, our methodology also permits us to estimate the rental increment for each "green building" relative to the control buildings in its immediate geographic neighborhood.

We then use statistical methods to decompose this premium into several components. Our empirical results suggest that customers may be willing to pay a premium for the "socially responsible" attributes of green buildings. Alternatively, for owners it may be a successful marketing strategy to offer rated and labeled buildings in the marketplace. Our analysis provides a hint at evidence distinguishing the magnitude of these intangible marketing attributes from the energy efficiency attributes of the buildings.

Section II below provides a brief review of the emerging literature on corporate social responsibility and its relationship to environmentally sustainable buildings. We also discuss the sources of ratings for the environmental aspects of buildings.

In Section III we describe the data used in our analysis, a unique body of micro data on the economic and hedonic characteristics of office buildings. Section IV presents our methodology, and empirical results. Section V is a brief conclusion.

II. Social Responsibility

"Corporate social responsibility" (CSR, Waddock and Graves, 1997) has become a normative standard that describes firms' choices about inputs (e.g., the source of raw materials), internal processes (e.g., the treatment of employees), and outputs (e.g. community relations). Judgments about the social responsibility of private firms have become an investment criterion for some investors, and it is estimated that $2.7 trillion is currently allocated to socially screened portfolios (Social Investment Forum, 2007). However, the economic rationale for investing in companies or investment funds that rank high in corporate social performance is a matter of debate, and there is no consensus about the financial performance of these investments (Margolis and Walsh, 2003).

Companies with well-defined and aggressive CSR policies might be able to outperform others for several reasons: improved corporate reputation (Turban and Greening, 1997), less intrusion from activists and governmental organizations (Baron, 2001, Lyon and Maxwell, 2006), reduced threat of regulation (Maxwell et al., 2000), and improved profitability through lower input costs and higher employee productivity. The latter two represent the most tangible elements of corporate social responsibility. These factors have been defined as the so-called 'eco-efficiency,' or greenness of firms

(WBCSD, 1992). Elements included in eco-efficiency are, for example, the costs and use of natural resources, the costs of wastes created in and after the production process, and the costs associated with the labor environment (Vandermerwe and Oliff, 1990). Besides cost reduction, eco-efficiency may be incorporated in strategic decision-making to co-opt regulation and to differentiate products in final demand. Recent studies seem to suggest that operating performance and stock performance are enhanced by taking eco-efficiency measures into consideration (Derwall et al., 2005, Guenster et al., 2005).

In the real estate sector, issues of eco-efficiency are confounded with straightforward capital budgeting decisions involving choices between the levels and types of initial investment and consequent operating inputs to maximize investor returns. In this context, the investment in eco-efficient or green buildings could lead to economic benefits in at least four ways.

First, investments at the time of construction or renovation may: save current resources expended on energy, water and waste disposal; decrease other operating costs; insure against future energy price increases; and simultaneously decrease greenhouse gas emissions. The financial benefits of energy savings and waste reduction are relatively easy to measure, but existing empirical studies focus on environmental performance rather than financial performance. For example, Khanna and Damon (1999) study how reductions in releases of chemicals influences financial performance in the chemical industry; they find that firms that reduce the release of toxic chemicals suffer losses in the short run, but gain in the long run. For real estate, the evidence on energy savings in green buildings is typically based upon engineering studies of energy usage. There seems to be a consensus that a variety of capital expenditures improving energy efficiency in property are cost-effective at reasonable interest rates, given current and projected energy costs.

Second, an improved indoor environmental quality in green buildings might result in higher employee productivity. But while energy and waste savings can be measured fairly precisely, the relation between employee productivity and building design or operation is far more complicated. The financial impact of healthier and more comfortable green buildings is hard to assess, in part because the cost of poor indoor environmental quality (for example, lower productivity and higher absenteeism) may simply be hidden. However, there is popular recognition of health and productivity costs that are imposed by poor indoor environmental quality in commercial buildings (http://www.epa.gov/iaq). Consequently, tenants may be willing to pay a higher rent for buildings in which indoor environmental quality is better.

Third, locating corporate activities in a green building can positively affect the corporate image of tenants. Leasing space in a green building may send a concrete signal of social awareness, and of the superior social responsibility of tenants. This may be important for some tenants, and may be a determinant of corporate reputation (Frombrun and Shanley, 1990). Favorable reputations may enable firms to charge premium prices (Klein and Leffler, 1981), to attract a better workforce (Turban and Greening, 1997), and to attract investors (Milgrom and Roberts, 1986). As a result, tenants may be willing to pay higher rents for green buildings.

Fourth, sustainable buildings might have longer economic lives – due to less depreciation – and lower volatility – due to less environmental and marketability risk – leading to reduced risk premiums and higher valuations of the properties. Orlitzky and

Benjamin (2001) address the relation between corporate social performance and risk, and find that the better a firm's social reputation, the lower its total market risk. If this relationship holds for the real estate sector, building green may result in a lower cost of capital and higher building valuation. So even if green buildings did not command higher spot rents, they could still be valued higher.

Economists are quick to point out that many of the advantages of eco-efficiency could be obtained if energy inputs were appropriately priced (to reflect their social and environmental costs). Appropriate investments in energy efficiency would minimize life cycle costs discounted at market rates, maximize developer returns, and correctly economize on energy costs (Quigley, 1984, 1985, 1989, 1991). But to the extent that productivity, corporate image, and intangible or hard-to-measure returns are important, simple adjustments of input prices are just that -- too simple.

If the economic benefits of green building for commercial property are indeed reflected in tenants' willingness to pay a premium on net rent for green space or in lower risk premiums for green buildings, this would enable investors to offset the higher initial investment required for sustainable buildings, or even to command higher risk-adjusted returns. However, for real estate investors, hard evidence on the financial performance of green buildings is limited and consists mainly of industry-initiated case studies. Prominent among these is an influential report for California's Sustainable Building Task Force (2003) on the costs and financial benefits of green buildings. For a sample of 33 buildings with a green rating in California, it was estimated that the financial benefits of green design are ten times as large as the incremental outlay to finance the green investment. However, the sources of the financial benefits identified in this study are diverse, hard to quantify, and ultimately not credible. To persuade real estate developers and investors in the global marketplace of the benefits of "eco-investment," the payoff of investment in green buildings needs to be identified in the marketplace.

III. Data on Commercial Buildings

In the U.S., there are two major programs that encourage the development of energy-efficient and sustainable buildings through systems of ratings to designate and publicize exemplary buildings. The Energy Star program is jointly sponsored by two federal agencies, the U.S. Environmental Protection Agency and the U.S. Department of Energy. Energy Star began in 1992 as a voluntary labeling program designed to identify and promote energy-efficient products in order to reduce greenhouse gas emissions. Energy Star labels were first applied to computers and computer equipment and were later extended to office equipment, to residential heating and cooling equipment, and to major appliances. The Energy Star label was extended to new homes in 1993 and has been marketed as an efficient way for consumers to identify builders as well as buildings constructed using energy-efficient methods. The Energy Star label is marketed as an indication of lower ownership costs, better energy performance, and higher home resale values. The label is also marketed as an indication of better environmental protection, and the Energy Star website for new homes stresses that "your home can be a greater source of pollution than your car." The Energy Star label was extended to non-residential buildings in 1995.

Non-residential buildings can receive an Energy Star certification if the site energy use, the energy intensity, and the greenhouse gas emissions of the building, as certified by a professional engineer, achieve certain specified benchmark levels. The

Energy Star label is marketed as a commitment to conservation and environmental stewardship. But it is also touted as a vehicle for reducing building costs and for demonstrating superior management skill. Indeed the Energy Star website draws attention to the relationship between energy conservation in buildings and other indicia of good "corporate governance."

As of December 2007, 4,113 buildings in the U.S. had been awarded the Energy Star designation, including 1,514 office buildings.

The U.S. Green Building Council (USGBC), a private non-profit organization, has developed the LEED ("Leadership in Energy and Environmental Design") green building rating system to encourage the "adoption of sustainable green building and development practices." Since adoption in 1999, separate standards have been applied to new buildings and to existing structures. The requirements for certification of LEED buildings are substantially more complex than those for the award of an Energy Star rating, and additional points in the certification process are awarded for such factors as "site selection," "brownfield redevelopment," and the availability of "bicycle storage and changing rooms," as well as energy performance.

It is claimed that LEED-certified buildings have lower operating costs and increased asset values and provide healthier and safer environments for occupants. It is also noted that the award of a LEED designation "demonstrate[s] an owner's commitment to environmental stewardship and social responsibility."

As of December 2007, there were 1,228 buildings certified by the LEED Program of the USGBC.

Energy Star-rated buildings and LEED-rated buildings are identified by street address on the websites of Energy Star and the USGBC respectively. We matched the addresses of the rated buildings in these two programs to the office buildings identified in the archives maintained by the CoStar Group. The CoStar service and the data files maintained by CoStar are advertised as "the most complete source of commercial real estate information in the U.S." The CoStar Group maintains an extensive micro database of approximately 332,000 U.S. commercial buildings, their locations, and hedonic characteristics, as well as the current tenancy and rental terms for the buildings. A separate file is maintained of the recent sales of commercial buildings. Our match yielded 1,360 green office buildings which could be identified in CoStar, of which 286 were certified by LEED, 1,045 were certified by Energy Star, and 29 were certified by both LEED and Energy Star.

Figure 1 provides a geographic summary of our match between the Energy Star-certified buildings, the LEED-certified buildings, and the universe of commercial buildings identified in CoStar. The figure reports the number of certified commercial office buildings in each state, as well as an estimate of the fraction of office space in each state which has been rated for environmental sustainability.[2] About four percent of U.S. office building space is green-labeled. As the map indicates, in some states – notably Texas, Washington, and Minnesota – more than five percent of office buildings are rated. The incidence of green office space is almost nine percent in California – 122 million square feet of office space are labeled. In a large number of states, however, only a small

[2] This probably overstates the fraction of green office space in the U.S. inventory, since CoStar's coverage of smaller and older office buildings is less complete.

fraction of office space is certified by Energy Star or the USGBC. States with extreme temperatures are apparently more likely to have rated office buildings.

A. The Analysis Sample

Of the 1,360 rated buildings identified in the CoStar database, current information about building characteristics and monthly rents were available for 694 buildings. To investigate the effect of energy efficiency on the rents and values of commercial buildings, we matched each of the 694 rated buildings in this sample to nearby commercial buildings in the same market. Based upon the latitude and longitude of each rated building, we use GIS techniques to identify all other office buildings in the CoStar database within a radius of one quarter mile. In this way, we create 694 clusters of nearby office buildings. Each small cluster -- 0.2 square miles -- contains one rated and at least one non-rated nearby building. On average, each cluster contains about 12 buildings. There are 8,182 commercial office buildings in the sample of green buildings and control buildings.

Table 1 compares the average characteristics of the green buildings with the nearby buildings selected for comparison. The green buildings are substantially larger, on average than the control buildings. They have slightly higher occupancy rates, and the cross-sectional variability in occupancy is lower for green buildings than for the control buildings. They are also more likely to have a net rent contract, in which the tenants pay directly for utilities. On average, the green buildings are slightly taller, by about two stories. The green buildings are much newer, averaging about 24 years in age while the control sample of buildings is about 44 years old, on average. Because they are older, the control buildings are much more likely to have been renovated than the green buildings.

The overall quality of the green buildings is substantially higher. 79 percent are rated as "class A," while only 35 percent of the control buildings have that rating. Only about one percent of the green buildings are rated as class C, while over 16 percent of the control buildings have this rating. A larger fraction of green buildings have on-site amenities such as retail shops, mail rooms, and exercise facilities.

Figure 2 further illustrates the difference in the distributions of characteristics between the green buildings and the control sample. As reported in panel A, the age distribution of the control sample is bimodal, with a substantial fraction above 75 years of age. Panel B illustrates the small differences in leasing rates between the green sample and the control sample, while panel C illustrates the differences in rent distributions between the samples of buildings.

IV. Empirical Analysis and Results

A. Methods

To investigate how energy efficiency influences rent and value in commercial office buildings, we use the standard valuation framework for commercial real estate. Our analysis of energy rated office buildings, combined with a control sample consisting of one-or-more nearby nonrated office buildings, is conducted in two steps. First we estimate a semi-log equation relating office rentals per square foot to the hedonic characteristics of the buildings (e.g., age, amenities provided, parking, etc.) and the location of each building:

$$\text{(1a)} \qquad \log R_{in} = \alpha + \beta_i X_i + \sum_{n=1}^{N} \gamma_n c_n + \delta g_i + \varepsilon_{in}$$

$$\text{(1b)} \qquad \log R_{in} = \alpha + \beta_i X_i + \sum_{n=1}^{N} \gamma_n c_n + \sum_{n=1}^{N} \delta_n \left[c_n \cdot g_i \right] + \varepsilon_{in}$$

In the formulation represented by equation (1a), the dependent variable is the logarithm of the rent per square foot R_{in} in commercial office building i in cluster n. In other results presented, the dependent variable is the logarithm of effective rent per square foot, i.e., the rent per square foot multiplied by the occupancy rate. X_i is a vector of the hedonic characteristics of building i. c_n is a dummy variable with a value of 1 if building i is located in cluster n and zero otherwise. g_i is a dummy variable with a value of 1 if building i is rated by Energy Star or USGBC and zero otherwise. α, β_i, γ_n and δ are estimated coefficients and ε_{in} is an error term. In expression (1a) there are 694 location coefficients which may affect office rents, one for each of the N distinct 0.2-square-mile clusters.[3] The increment to rent associated with a rated building is exp[δ].

In equation (1b), the locational measure is further generalized. In this formulation, the effect on commercial rents of a green rating may vary separately for green buildings in each of the 694 clusters in the sample.

Our formulation generalizes the treatment of spatial variation in the real estate asset pricing literature. In this literature, spatial variation is commonly analyzed in one of three ways: first, by including location dummies for submarkets (Glasscock et al., 1990, Wheaton and Torto, 1994); second, by studying a specific MSA or city and thereby isolating the influence of spatial variation (Gunnelin and Söderberg, 2003, Rosen, 1984, Webb and Fisher, 1996); or else by using Geographic Information System (GIS) methods to specify the distance of a property to specific locations, for example the CBD, airport, highway or railway station (Bollinger et al., 1998, Öven and Pekdemir, 2006,

[3] In this way, the equation recognizes the old adage about the three most important determinants of property valuation: "location, location, location."

Sivitanidou, 1995, Sivitanidou, 1996). Our analysis generalizes these methods by treating each of the small geographic clusters as distinct.

In the second part of the analysis, we seek to distinguish the effects of the energy-saving component of the rating from the intangible effects of the label itself. These latter effects may arise from the reputational or marketing benefits of the labeled building or from other unmeasured aspects of quality in rated buildings.

These models take the form:

$$\hat{\delta}_n = \alpha + \beta_j Z_{jn} + \gamma_{ji} \sum_{i=1}^{I} \sum_{j=1}^{J} X_i Z_{jn} + \varepsilon_n \quad \text{(2a)}$$

The dependent variable $\hat{\delta}_n$, is the estimate of the increment to rent commanded by the green building in cluster *n,* relative to the control buildings in that cluster, holding constant the hedonic characteristics of the buildings. Z_n is a vector of the thermal and climatic attributes *j* of cluster *n*. $X_i Z_{jn}$ is the interaction of the climatic attributes of cluster *n* and selected hedonic attributes of building *i.*

As before, the Greek letters α, β_j and γ_{ji} denote estimated coefficients, and ε_n is an error term. Note that the dependent variable is itself a regression estimate obtained from Equation (1b). Thus Equation (2) is appropriately estimated by generalized least-squares, incorporating the variance-covariance matrix of estimated parameters from equation (1b). See Hanushek (1974).

B. Results

Table 2 presents the basic results, relating the logarithm of rent per square foot in commercial office buildings to a set of hedonic and other characteristics of the buildings. Results are presented for ordinary least squares regression models corrected for heteroskedasticity (White, 1980). Column (1) reports a basic model relating rent to building quality, measured by class designation, size, and occupancy rate. The regression, based upon 8,182 observations on buildings (694 rated buildings and 7,488 control buildings each located within 1,300 feet of a rated building) explains some 71 percent of log rent. When rents are quoted gross, they are about four percent higher than when they are quoted net of utilities. Higher quality buildings, as measured by building class, command a substantial premium. Rent in a class A building is about twenty-four percent higher than in a class C building, and about fourteen percent higher than in a class B building. Rent is significantly higher in larger buildings, as measured by square footage, but the magnitude is quite small, about one percent for an additional 100,000 square feet. The 694 dummy variables for location are highly significant with an F-ratio of 22.96**.** Importantly, holding other factors constant, the estimated rent premium for a green building is about 2.6 percent.

In column (2), the green certification is distinguished by its Energy Star or its LEED rating. The results suggest that the LEED rating has no effect upon commercial rents, but the Energy Star rating is associated with rents higher by 2.8 percent.

In column 3, a set of variables measuring building age in four categories is added to the model. The coefficients of the other variables are quite stable. The results indicate that there is a substantial premium associated with newer buildings. *Ceteris paribus,* rents in a commercial office building less than ten years old are twelve percent higher than those in a building more than forty years old.

Column (4) adjusts for differences in the number of stories and the presence of on-site amenities. There is evidence that rents in very tall buildings, greater than twenty stories, are slightly lower. On-site amenities are associated with higher office rents.

Importantly, when the specification of the hedonic variables is changed in various ways, the magnitude and the statistical significance of the green rating is unchanged. *Ceteris paribus,* the rent in a green building is significantly higher by 1.9 to 2.6 percent than in an unrated building.

Column (5) presents the results from estimation of equation (1b). In this formulation, the specification includes 1,388 dummy variables (not reported in the table) – one for each of the 694 clusters, and one for the specific green building identified in each cluster. When the model is expanded in this way, the coefficients of the other variables are unchanged. Of course, in this more general specification, the rent premium for a green building varies in magnitude for each separate cluster.

Table 3 presents the results when the dependent variable is measured by the logarithm of effective rent. In this formulation, we multiply the rent per square foot of leased space by the fraction of the building which is leased.[4] When endogeneous rent-setting policies are taken into account, the results suggest that the effect of a green rating is even larger. In the simplest model, column (1), the statistical results suggest that a green rating is associated with an 8.5 percent increase in effective rent. When the other hedonic characteristics and amenities of buildings are accounted for in column (4) – as far as possible – the results still indicate an effective premium of more than six percent for rated buildings.

Figure 3 presents the distribution of the rent premiums for each of the 694 green buildings in the sample. Figure 3A reports the premium in rent per square foot, using the results reported in column (5) of Table 2; figure 3B reports the premium in effective rent per square foot, using the results reported in column (5) of Table 3. The figure demonstrates that the values of the estimated rent premiums vary across buildings, and in at least a few cases, the estimated effects are negative. However, a simple t-test indicates that the probability that the rent premium is negative for a green building is only 0.0017.

The rent premium associated with the label on any building represents the joint effects of the engineering efficiency of the building together with other unmeasured, but presumably important, attributes of the building. If we had access to the engineering attributes underlying the rating and the thermal conditions associated with each individual cluster, it would be possibly, at least in principle, to distinguish the engineering aspects of the Energy Star label from other valuable attributes of the label.

It is possible to obtain climatic information associated with each cluster (at the level of the CBSA, the Core Based Statistical Area), but it has not been possible to obtain access to the engineering properties of the rated buildings.[5] Thus it is not yet possible to distinguish between the effects on profitability of better engineering or design conditions and the profitability of other attributes of the label – including its signal value.

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[4] We may expect property owners to adopt differing asking rent strategies. *Ceteris paribus,* landlords who quote higher rents will experience higher vacancy rates.

[5] However, exactly the information required to analyze this important issue is maintained by the Energy Star program of the U.S. Environmental Protection Agency. For each rated building, Energy Star records a "Statement of Energy Performance" reporting the site energy use, energy intensity, and emissions of that building. It is precisely this information, which varies for each observation in our sample, that would distinguish the profitability of the engineering attributes of green-rated buildings from other valuable signals associated with a green rating.

A hint about the importance of the thermal properties in affecting profitability is contained in regression estimates of equation (2) of the following form:

$$\text{(2b)} \quad \hat{\delta}_n = -0.514 + 0.070 \log D$$
$$\qquad\qquad (0.300) \quad (0.037)$$

Where $\hat{\delta}_n$ is the estimate of the effective rent premium for the rated building in cluster n (as shown in Figure 3), and D is the number of degree days (i.e., heating and cooling degree days) associated with cluster *n.* As indicated by the standard errors (in parentheses), local climate conditions do make the label significantly more valuable – presumably the attributes measured by engineers at the time of the application affect the profitability of the label as well. But currently available data do not permit us to distinguish the economic effects of the ratings from the effects of the superior engineering attributes they symbolize.

V. Conclusions

This paper reports the only systematic evidence on the economic value of certification of green buildings to the U.S. economy. In contrast to the anecdotal evidence on the economic effects of investments in environmentally sustainable building, the research reported here is based upon impersonal market comparisons.

For each commercial building in the country which has obtained a LEED and or Energy Star label, we identified a control group consisting of all commercial properties located within about 1300 feet. For this sample – about 8000 buildings divided into 694 clusters, each containing one labeled building and nearby unlabeled buildings – we relate market rents of the properties to the hedonic characteristics of properties, within very small geographical areas.

The results clearly indicate the importance of a green label in affecting the market rents of comparable commercial space in close proximity. The results suggest that the otherwise commercial building with an environmental certification will rent for about two percent more per square foot; the difference in effective rent is estimated to be about six percent per square foot.

These are large effects. For example, the average effective rent for the 7488 control buildings in our sample is $23.53 per square foot. At the average size of these buildings, the estimated annual rent increment for a green building is almost $309,000. At prevailing capitalization rates of six percent, the incremental value of a green building is estimated to be about $5.1 M more than the value of a comparable unrated building nearby.

As noted, we do not have access to the information that would allow us to distinguish the market value of energy savings and conservation from the other valuable attributes of a label. But this should be a high priority for future research.

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Figure 1. Geographic Distribution of Green Office Buildings in the U.S., 2007

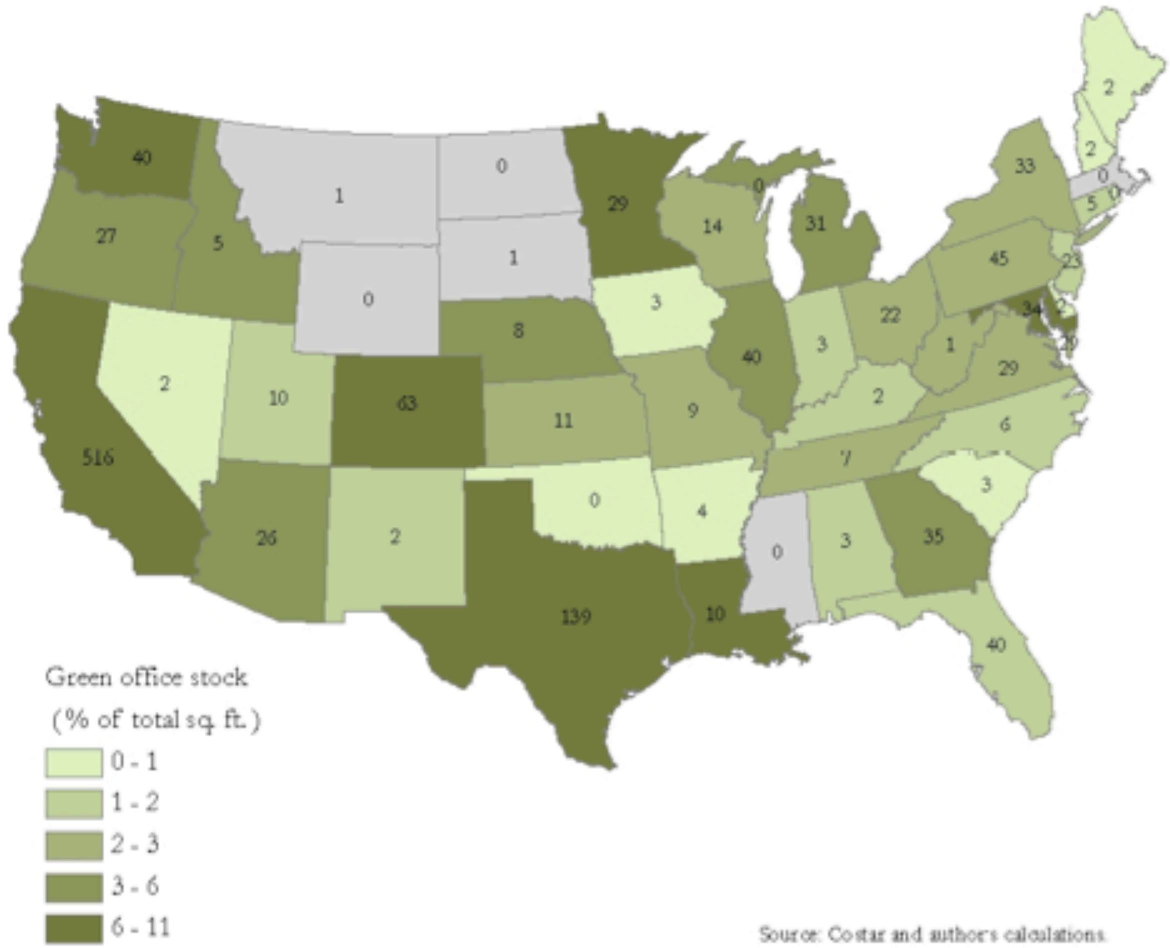
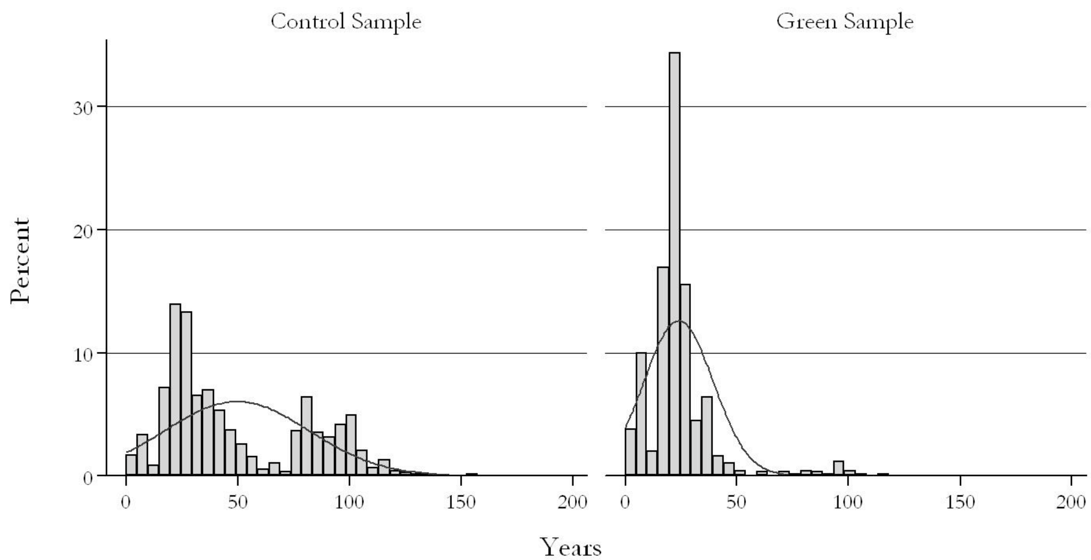
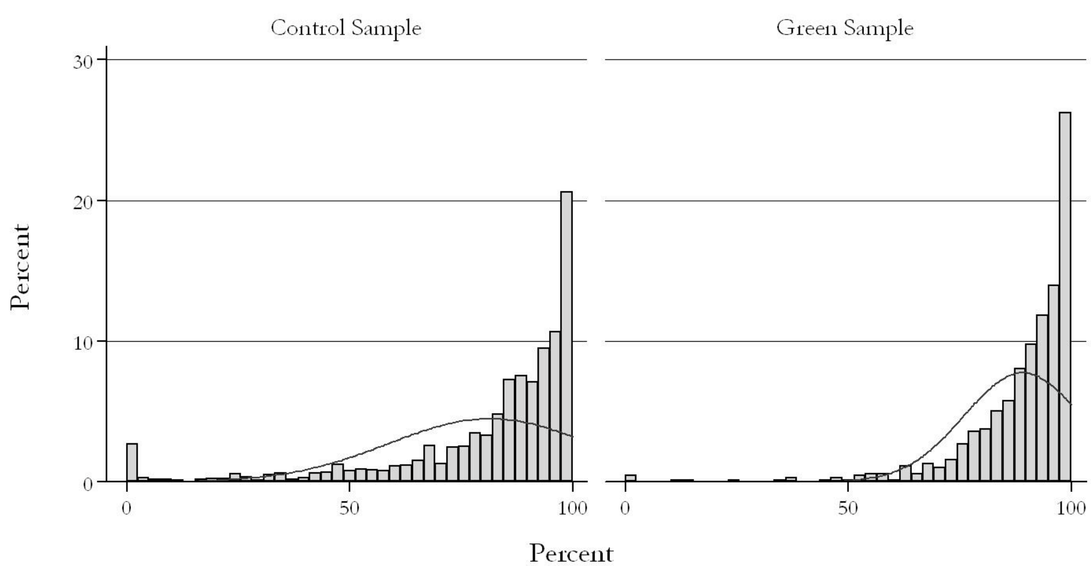


Figure 2.
Age, Leasing Rate and Rent in Green Buildings and in Control Sample

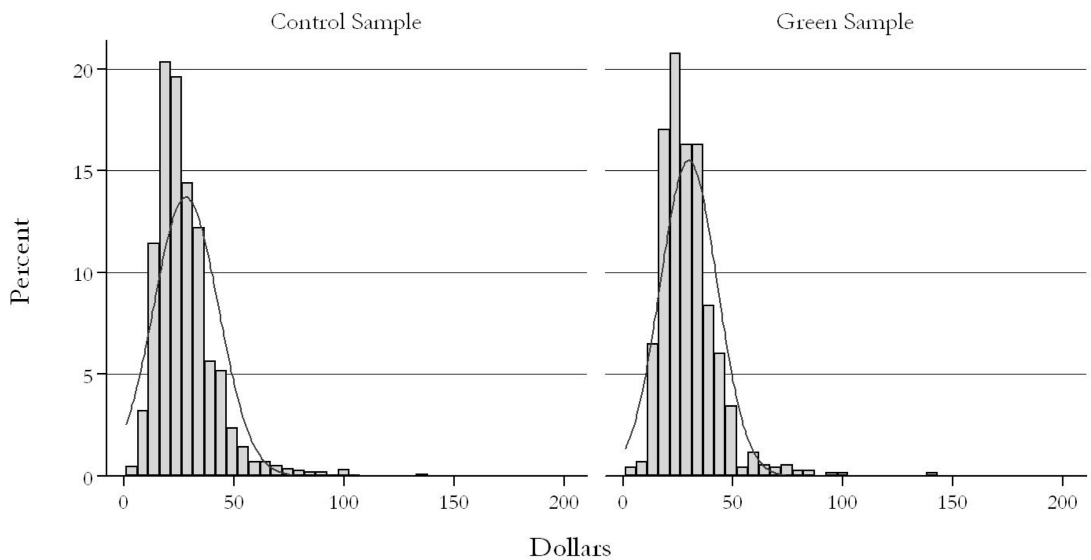
A. Age



B. Percent Leased



C. Rent



Control Sample
Green Sample
Percent
20
15
10
5
0
0
50
100
150
200
Dollars

Table 1
Comparison of Green-Rated Buildings and Nearby Control Buildings
(standard deviations in parentheses)

Sample Size	Green Buildings 694	Control Sample 7,488
Rent (dollars/sq. ft.)	29.80 (13.05)	28.16 (15.77)
Net Rent Contract* (percent)	5.76 (23.32)	3.15 (17.47)
Size (thousands sq. ft.)	324.08 (288.92)	218.69 (293.69)
Occupancy Rate (percent)	88.99 (13.19)	81.35 (22.74)
Stories (number)	15.31 (13.26)	13.07 (12.10)
Stories (percent)		
Low (<10)	14.27 (35.00)	21.26 (40.92)
Medium (10-20)	26.66 (44.25)	25.25 (43.45)
High (>20)	46.26 49.90	53.49 (49.88)
Age (years)	23.75 (15.75)	49.44 (32.50)
Age (percent)		
Less than 10 years	14.27 (35.00)	4.87 (21.53)
10 to 20 years	24.06 (42.78)	9.40 (29.18)
21 to 30 years	43.37 (49.59)	25.13 (43.38)
31 to 40 years	11.10 (31.43)	13.25 (33.90)
Over 40 years	7.20 (25.88)	47.34 (49.93)

Table 1

Comparison of Green-Rated Buildings and Nearby Control Buildings (standard deviations in parentheses) Continued

	Green Buildings	Control Sample
Building Class		
A	79.39 (40.48)	34.94 (47.68)
B	19.45 (39.61)	48.78 (49.99)
C	1.15 (10.68)	16.28 (36.92)
On-Site Amenities** (percent)	71.76 (45.05)	49.22 (50.00)
Renovated Bldg. (percent)	21.04 (40.79)	38.50 (48.66)

Notes:

The control sample consists of all commercial office buildings within a 0.25 mile radius of each rated building.

* Net Rent Contracts require tenants to pay separately for utilities.

** One or more of the following amenities are available on-site: banking, convenience store, dry cleaner, exercise facilities, food court, food service, mail room, restaurant, retail shops, vending areas, fitness center.

Table 2
Regression Results
Commercial Office Rents and Green Ratings
(dependent variable: logarithm of rent per square foot)

	(1)	(2)	(3)	(4)	(5)
Green Rating (1 = yes)	0.026		0.023	0.019	
	[0.011]**		[0.011]**	[0.011]*	
Energy Star (1 = yes)		0.028			
		[0.012]**			
LEED (1 = yes)		0.003			
		[0.037]			
Building Size (millions of sq. ft.)	0.112	0.112	0.100	0.109	0.109
	[0.013]***	[0.013]***	[0.014]***	[0.015]***	[0.016]***
Fraction Occupied	0.017	0.017	0.017	0.007	0.002
	[0.015]	[0.015]	[0.015]	[0.015]	[0.015]
Building Class:					
Class A (1 = yes)	0.237	0.236	0.197	0.177	0.177
	[0.011]***	[0.011]***	[0.013]***	[0.013]***	[0.014]***
Class B (1 = yes)	0.103	0.103	0.093	0.084	0.082
	[0.009]***	[0.009]***	[0.010]***	[0.010]***	[0.010]***
Net Contract (1 = yes)	-0.044	-0.044	-0.048	-0.048	-0.058
	[0.017]**	[0.017]**	[0.0170]***	[0.0170]***	[0.019]***
Employment Growth (fraction)	0.605	0.606	0.611	0.607	0.873
	[0.242]**	[0.242]**	[0.241]**	[0.240]**	[0.321]***
Age:					
< 10 years			0.121	0.134	0.131
			[0.018]***	[0.018]***	[0.020]***
10 – 20 years			0.083	0.089	0.083
			[0.014]***	[0.014]***	[0.015]***
20 – 30 years			0.049	0.051	0.048
			[0.010]***	[0.010]***	[0.011]***
30 – 40 years			0.046	0.048	0.043
			[0.011]***	[0.011]***	[0.012]***
Renovated (1 = yes)			-0.006	-0.007	-0.010
			[0.007]	[0.007]	[0.008]
Stories:					
Intermediate (1 = yes)				0.010	0.009
				[0.009]	[0.009]
High (1 = yes)				-0.029	-0.031
				[0.012]**	[0.013]**
Amenities (1=yes)				0.047	0.053
				[0.008]***	[0.008]***
Constant	2.745	2.744	2.721	2.727	2.566
	[0.139]***	[0.139]***	[0.138]***	[0.138]***	[0.193]***
Sample Size	8182	8182	8182	8182	8182
R^2	0.71	0.71	0.71	0.72	0.74
Adj R^2	0.68	0.68	0.69	0.69	0.68

Notes:

Each regression also includes 694 dummy variables, one for each locational cluster.

Standard errors are in brackets. Significance at the 0.10, 0.05, and 0.01 levels are indicated by *, **, and ***, respectively.

Table 3
Regression Results
Commercial Office Rents and Green Ratings
(dependent variable: logarithm of effective rent per square foot)

	(1)	(2)	(3)	(4)	(5)
Green Rating (1 = yes)	0.085		0.082	0.064	
	[0.024]***		[0.024]***	[0.023]***	
Energy Star (1 = yes)		0.089			
		[0.024]***			
LEED (1 = yes)		0.044			
		[0.077]			
Building Size (millions of sq. ft.)	0.263	0.263	0.236	0.190	0.194
	[0.028]***	[0.028]***	[0.028]***	[0.031]***	[0.033]***
Building Class:					
Class A (1 = yes)	0.414	0.414	0.344	0.233	0.229
	[0.024]***	[0.024]***	[0.026]***	[0.028]***	[0.029]***
Class B (1 = yes)	0.227	0.227	0.203	0.153	0.148
	[0.020]***	[0.020]***	[0.020]***	[0.021]***	[0.021]***
Net Contract (1 = yes)	0.017	0.017	0.012	0.012	0.014
	[0.036]	[0.036]	[0.036]	[0.036]	[0.039]
Employment Growth (fraction)	0.754	0.690	0.762	0.671	0.473
	[0.896]	[0.904]	[0.896]	[0.887]	[0.929]
Age:					
< 10 years			0.138	0.181	0.148
			[0.037]***	[0.037]***	[0.042]***
10 – 20 years			0.144	0.151	0.150
			[0.028]***	[0.028]***	[0.031]***
20 – 30 years			0.116	0.116	0.126
			[0.022]***	[0.022]***	[0.023]***
30 – 40 years			0.100	0.093	0.088
			[0.023]***	[0.023]***	[0.025]***
Renovated (1 = yes)			0.021	0.018	0.021
			[0.016]	[0.016]	[0.016]
Stories:					
Intermediate (1 = yes)				0.145	0.155
				[0.018]***	[0.020]***
High (1 = yes)				0.085	0.089
				[0.025]**	[0.027]**
Amenities (1=yes)				0.119	0.125
				[0.016]***	[0.017]***
Constant	6.766	6.808	6.705	6.800	6.902
	[0.544]***	[0.549]***	[0.544]***	[0.539]***	[0.546]***
Sample Size	8182	8182	8182	8182	8182
R^2	0.71	0.71	0.71	0.72	0.74
Adj R^2	0.68	0.68	0.69	0.69	0.68

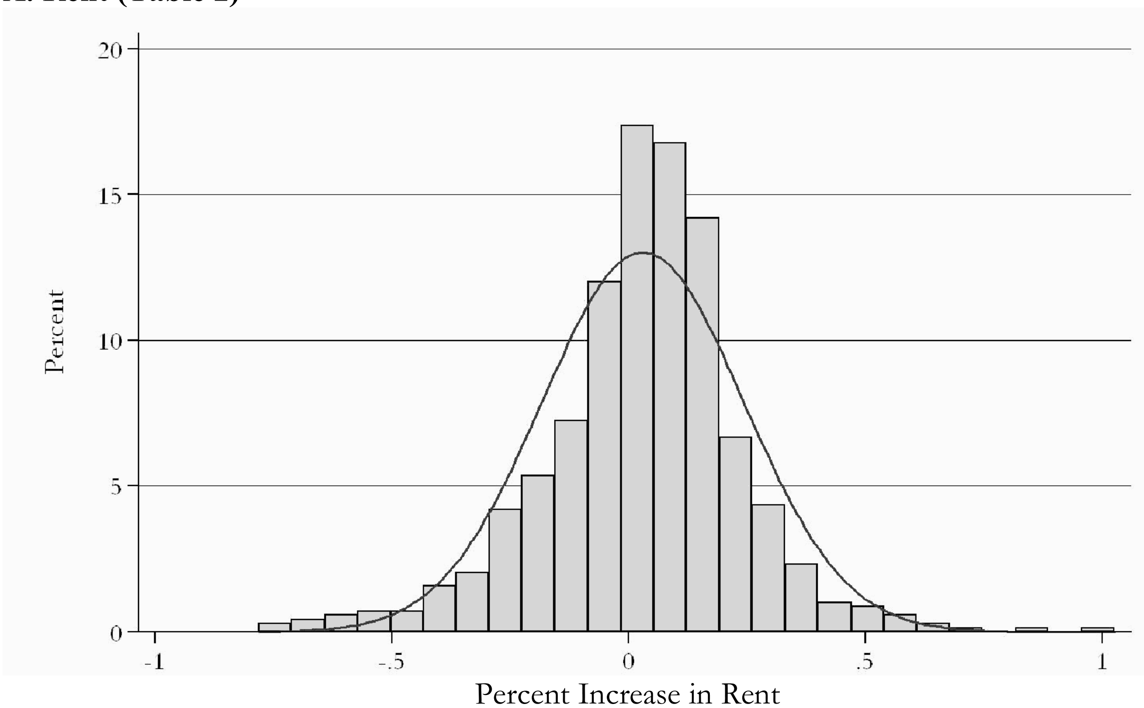
Notes:

Each regression also includes 694 dummy variables, one for each locational cluster.

Standard errors are in brackets. Significance at the 0.10, 0.05, and 0.01 levels are indicated by *, **, and ***, respectively.

Figure 3
Distribution of Regression Estimates of Rent Increments for Green Buildings
(Columns 5, Table 2 and 3)

A. Rent (Table 2)



B. Effective Rent (Table 3)