The True Value of Green: Separating the Wheat from the Chaff

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Abstract

This study examines the actual environmental performance compared to the eco-certification label for office buildings with respect to the behavior of tenants and landlords. Using several recently available databases on individual tenant leases, tenant profiles, building-level environmental performance and building characteristics, we are able to assess which type of tenants are willing to pay a premium for occupying green space and also the incremental rent premium associated with a "named" green label in contrast to prior studies. We find that tenants have the ability to distinguish actual environmental performance from eco-certification; i.e., separating the wheat from the chaff.

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Keywords: sustainability; energy efficiency; eco-certification; real estate; product differentiation.

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"What's in a name? that which we call a rose
By any other name would smell as sweet"

From Romeo and Juliet, Act II, Scene II

I. Introduction

Buildings are one of the single largest contributors to global carbon emissions. Buildings not only consume 70% of the electricity load but also account for nearly 40% of CO_2 emissions in the United States.[1] Since environmental certification is widely accepted as a credible signal to mitigate information asymmetry between landlords and tenants with government regulations establishing a minimum benchmark for environmental performance, the purpose of our study is to examine actual environmental performance compared to the eco-certification designation for office buildings. In particular, we ask "what does it mean to go green?" Is green space from a tenant's perspective necessarily the same as green initiatives from a landlord's viewpoint? It is conceivable that green tenants do not necessarily want to pay for green certification *per se*, but are willing to pay for lower energy usage and a minimal carbon footprint.

A novel feature of our study is our ability to distinguish the actual environmental performance of an office building from its incremental brand value; e.g., green certification label. Intuitively, this is similar to buying the generic version versus the "brand" version of a drug wherein the difference in price represents the value of the brand.[2] Another contribution of the current study is the introduction and use of several new datasets, including one on environmental building performance, and two dealing with individual tenant leases and tenant characteristics, such as tenant age and the degree to which a tenant is likely to default. The added information from these new databases can address whether the green rent and price premiums that previous studies have documented merely reflect an omitted variable(s) bias. For example, it is plausible that the green rent premium is the result of smaller, riskier tenants with shorter leases located on

[1] http://www.eesi.org/files/climate.pdf

[2] Brand choices of generic or private-label versus brand-name products have been extensively studied (see, for example, Geyskens et al. 2010; Kim and Drolet 2009; Rizzo and Zeckhauser 2009). The focus of the existent studies is mostly about the preferences and choices of individual consumers. The current study, in contrast, is interested in the preferences and choices of corporate/institutional consumers.

higher floors. In a similar fashion the green price premium could reflect buildings that are more technologically advanced e.g., digital wired at a higher level. More importantly, the omission of building environmental performance such as energy use intensity (EUI), can result in overestimating the impact of eco-certification on office rents and transaction prices. This is important since in all prior green studies on office buildings, it is not known whether the comparable buildings used to examine eco-certified buildings had similar or different environmental performance attributes.

Our most salient finding is that large tenants and publicly-listed tenants care more about actual green performance than green certification *per se*. In particular, large tenants are more likely to occupy space in a non-certified, yet high performance building with low site EUI (energy usage) or low unit GHG (greenhouse gas emissions). However, we also find that who pays and who benefits from going green, the landlord or the tenant, depends in part on the contract mechanism used. Landlords favor gross/full service lease contracts for eco-certified buildings to recoup their incremental green investment outlay. Tenants in turn receive benefits when they sign a modified gross/net lease contract in a high environmental performance building that doesn't have a green label. Another notable result is that the widely documented rent premium noted in the previous literature is sensitive to the type of green labels and environmental performance criteria. The rent premium, as suspected, tends to rise with the height of leased space and with the number of elevators in the building, a proxy for more energy usage and a higher carbon footprint. We find that the previously documented sales price premium is also sensitive to the type of green labels and environmental performance criteria. Although we find that a price premium exists for Leadership in Energy and Environmental Design (LEED) certification at the Platinum and Gold levels, there is no price premium for Energy Star certification and "generic green" environmental building performance as proxied by site EUI and unit GHG. Consequently, the Platinum and Gold "labels" do have an intangible value while the Silver and Certified LEED labels do not have any intangible value.

The rest of the paper is organized as follows. A discussion on the two most popular types of eco-certification is first presented, followed by a brief literature review. Our hypotheses and empirical strategy is discussed in the subsequent section. Next, we provide a description of the data. Our empirical results are then reported. In the final section, we conclude and offer some policy recommendations.

II. Eco-Certification Systems

In the U.S. real estate market, LEED and Energy Star are the two most popular eco-certification systems. The non-profit United States Green Building Council (USGBC) developed the LEED green building rating system in 1993 to evaluate the design and construction of a building. The aim of the rating system is to promote an industry transformation towards environmentally responsible development. The rating system is credit-based, allowing buildings considerable flexibility to earn up to 100 base points across 6 categories: sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, and innovation in design. A building can also earn up to 10 additional points for various reasons such as regional priority credits. Based on the points earned, buildings are placed into four levels of certifications: Certified (40–49 points), Silver (50–59 points), Gold (60–79 points), and Platinum (≥ 80 points). Because energy efficiency does not necessarily play an essential role in LEED certification, Newsham et al. (2009) found that 28–35% of LEED buildings actually incur more energy usage than non-LEED buildings.

Energy Star certification, on the other hand, focuses on the relative ranking of energy efficiency among comparable buildings. The Environmental Protection Administration (EPA) launched this voluntary program in 1992. Currently, the EPA and the Department of Energy (DOE) jointly manage this program. Another feature that differentiates Energy Star from LEED is that, whereas LEED certification is largely based on design and construction, Energy Star focuses on the actual performance of energy usage when a building enters its operational phase. Therefore, Energy Star certification is given on an annual basis. Each year, an applicant is required to provide actual site energy usage data for the trailing 12 months. An Energy Star score, ranging from 1 (the worst) to 100 (the best), is computed based on an efficiency ratio defined as the ratio of actual source energy use intensity (EUI) to predicted source EUI. EUI is energy usage per square foot of the gross floor area of the building per year. There are two primary divisions of energy usage: site EUI and source EUI. Site EUI, reflects energy usage of heat and electricity consumed on site, is never higher than source EUI, which also includes all estimated off-site transmission, delivery, and production energy losses.

The process of calculating an Energy Star score is called "benchmarking" because the predicted source EUI is estimated using only a subset of buildings that are similar to the applicant's building in the nation-wide Commercial Building Energy Consumption Survey (CBECS) conducted by the DOE. As such, an office building is only compared to another office building, not another building type such as a hotel building. The Energy Star's algorithm also takes other relevant factors into consideration, such as location, building size, number of computers, and number of occupants. A building is certified as an Energy Star building for a given year if it outperforms at least 75% of its algorithm-adjusted peers or, equivalently, it earns an Energy Star score of 75 or above. Since the Energy Star certification is awarded based on relative performance within the top quartile, the penetration rate or market share of Energy Star never exceeds 25% in terms of the number of buildings.

III. Literature Review

The current study is related to four strands of existent literature. The first strand of literature focuses on whether green certification yields pecuniary value increments with most studies focusing on office buildings (see, for example, Eichholtz et al. 2010; Fuerst and McAllister 2011; Reichardt et al. 2012; Wiley et al. 2010).[3] In their seminal paper, Eichholtz et al. (2010) document that LEED and Energy Star office buildings command a 3% (16%) premium in terms of asking rent (sold price) relative to comparable office buildings. The asking rent premium and sales price premium for LEED and Energy Star office buildings are further validated in the subsequent studies of Wiley et al. (2010) and Fuerst and McAllister (2011). However, these authors have found that the rent premium and sales price premium declines as the market share of green office space increases.[4] A problem with these studies is that comparable office buildings are *not defined nor compared* with respect to environmental building performance. As such, the previously documented premiums could reflect this omitted variable bias.

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[3] These empirical results also spurred research interest in the role of rent and sales price premium on commercial financing and securitization (An and Pivo 2019) and whether rent and sales price premium exists in other property sectors, such as condominiums and multifamily properties (Yoshida and Sugiura 2015; Bond and Devine 2016).
[4]See for example, Chegut et al. (2014), Holtermans and Kok (2019), Reichardt et al. (2012), and Robinson and McAllister (2015).

Typically, the prior studies have used average asking rent for the entire building with "effective" rent calculated as average asking rent for a building multiplied by the occupancy rate, which is, at best, a very noisy proxy of effective rent. This implicitly presumes that all tenants in a building are homogeneous with respect to the terms of their lease; e.g., the same rent is paid regardless of the floor occupied, their credit risk, the term of their lease, or the amount of space that they occupy.[5] In contrast, the current study focuses on individual leases; it does not aggregate leases within a building. We employ each tenant's effective rent across a general set of office buildings regardless of whether they are LEED or Energy Star certified. Using individual leases facilitates greater comparability when ascertaining whether rent premiums exist for eco-certified buildings.

The second strand of literature relating to eco-certification addresses the question of whether green certification, *per se*, matters. That is, after accounting for rent premium and the presumable pecuniary benefits of energy saving, this line of inquiry examines the question of whether green certification has nonpecuniary benefits, such as public relationship, legitimacy, or brand improvement, and whether nonpecuniary benefits are dynamic because of time variations in the supply and the demand of green space in a localized, segmented space market (Chegut et al. 2014). These research questions are important because if eco-certification per se does not add additional benefits, value-maximizing real investors and operators may simply embrace value-added sustainable practices while bypassing costly certification requirements and processes.

The challenge with this line of inquiry is measuring actual energy usage. Until recently, actual energy usage data across a general set of buildings was unavailable. As such, previous studies used operating expense as a coarse proxy for energy usage.[6] The idea is that if green certification is associated with a lower energy usage and thus a lower energy bill, *ceteris paribus*, one would expect a lower operating expense for an eco-certified building. Szumilo and Fuerst (2014) found that eco-certified buildings actually have higher operating expenses, and coined the term "operating expense puzzle." Reichardt (2014) also found significantly higher operating expenses in Energy Star certified buildings, but significantly lower operating expenses in LEED rated buildings. Moreover, Scofield (2009) found no evidence that LEED buildings have

[5] In theory and in practice, landlords charge tenants higher rent if they are located on higher floors, have a higher risk of default, have shorter leases, and occupy less square feet.

[6] In a typical office building, energy costs account for around 30% of operating expenses.

collectively lower energy usage than non-certified buildings. Scofield (2013) used 2011 New York City local benchmarking data to document that the sampled LEED buildings have a slightly higher average EUI and unit GHG than non-LEED buildings. In contrast, Eichholtz et al. (2010) use energy usage data available on 122 of their initial 199 sampled transacted office buildings certified as Energy Star buildings, and found that *among* eco-certified buildings there is a negative relationship between energy use intensity and sales prices. Since non-certified buildings were not sampled, it is not immediately clear whether the authors' results are generalizable. To mitigate the operating expense puzzle and to control for building environmental performance in our set of comparable buildings, we hand-collect publicly available environmental performance benchmarking data for Boston, Chicago, Minneapolis, New York City, Philadelphia, Portland (OR), San Francisco, Seattle, and Washington, D.C. These cities require building owners whose buildings are of a certain size to report the environmental performance of their buildings, such as EUI and GHG.

With the exception of Eichholtz et al. (2009), none of the previous studies have investigated whether tenants who occupy eco-certified buildings receive nonpecuniary benefits, such as legitimacy or brand improvement. Eichholtz et al. (2009) use the CoStar database to gather the names, Standard Industry Classification (SIC) codes, and total squared feet leased of the *five* largest tenants for each sampled building. The authors find that tenants in certain industries, such as oil, banking, and non-profit industries, are more likely to occupy eco-certified space. Using a newly available tenant lease database known as Compstak in conjunction with tenant information from Dun and Bradstreet in addition to CoStar and benchmarking performance data, we are able to obtain more granular information on each tenant — including firm size, sales of the firm, firm risk, firm age, building class, their North America Industry Classification System (NAICS) industry code, net effective rent, lease type, lease term, and more — for *all* tenants. We also include the actual energy usage and greenhouse gas emissions for both eco-certified and non-certified sampled buildings. As a result, we can explore unresolved and unaddressed issues regarding green buildings. The hypotheses section of the paper provides further discussion on these issues.

Another emerging strand of literature relates to the optimal design of the lease contract to mitigate environmental externalities. Practitioners have traditionally argued that "benefits accrue to property owners in terms of growth in top line, bottom line and asset valuations, and to tenants in terms of operational efficiency and productivity" (Deloitte 2014). However, Jaffee et al. (2019)

have argued that from a contract theory perspective, the tenant (landlord) should realize energy saving benefits under a net (full service) lease contract. Thus, a tenant would prefer a net lease contract if the tenant is able to control the amount of energy usage, is more informed about likely energy costs, and/or is better able to absorb energy risk. From the landlord's perspective, in contrast, a building's energy efficiency is endogenous. Thus, if going green has a non-negative NPV, a full service lease contract will provide the optimal level of incentive alignment, particularly when the tenant's expected occupancy horizon does not equal the expected economic life of the capital investment or when the time patterns of amortized costs and energy-saving benefits differ.[7] Unfortunately, Jaffee et al. (2019) are unable to formally investigate the role of contract design on energy usage at the lease level since the authors have missing observations "on the dominant leasing structure for more than 57% of the transactions." As such, their *dominant* leasing contract data is used as an additional set of controls. The current study differentiates itself from Jaffee et al. (2019) in that we assemble lease-level leasing structure for our lease (not transaction) dataset. We are thus able to formally explore the determinants of lease contract forms.

The fourth related strand of existent literature focuses on the "energy paradox", the reluctance of economic agents to adopt energy efficient technologies (Jaffe and Stavins 1994a, 1994b). The prevalence of gasoline-thirsty sports utility vehicles and the slow adoption of energy efficient vehicles over the past half of century are major concerns for transportation policy makers (Allcott and Wozny 2014; Busse et al. 2013; Knittel 2012). Explanations proposed for this apparent paradox include information asymmetry, transactions costs, some form of bounded rationality, capital constraints, and irreversible investment under uncertainty (see DeCanio 1993; Gerarden et al. 2015; Hassett and Metcalf 1993). The energy paradox is less prevalent in the commercial real estate sector. Holtermans and Kok (2019) document that the market share of eco-certified space in the 30 largest U.S. office markets increased from 5% in 2005 to nearly 40% in 2014.

[7] Fuerst and McAllister (2011) also argued that "tenants with net rental contracts pay these costs directly and therefore should be attracted to premises with lower operating costs, whereas tenants on gross rental contracts will not benefit directly from such savings."

IV. Hypotheses

We are initially interested in whether green initiatives favor the tenant's desire for sustainable space or the landlord's strategic investments in sustainability. This inquiry involves two sets of hypotheses. The first set of tenant centric hypotheses is based on the notion that heterogeneity among tenants leads to differential choices for the use of space. Consistent with the notion of scale economics, Kiron et al. (2017) document that large firms/tenants are more likely to adopt sustainable practices given advantages in scaling up sustainability initiatives. The legitimacy theory[8] provides implications on tenants' choice toward sustainable space. The theory argues that firms/tenants are bounded by a social contract under which they need to deliver socially desirable outcomes to legitimize their continued existence (see Brown and Deegan 1998; Gray et al. 1995; and Perrow 1970). Prior evidence suggests that large firms are more visible and are more incentivized to engage in sustainability solutions (see, for example, Cowen et al. 1987; Gray et al. 1995; and Watts and Zimmerman 1986). These empirics motivate our first hypothesis.

Hypothesis 1: Large tenants, as proxied by annual sales, are more likely to have a sustainability commitment; this increases the likelihood that they will tend to locate in green buildings.

To the extent that large tenants require more space, we also have the following hypothesis:

Hypothesis 2: Large tenants, as proxied by total square feet leased, are more likely to locate in green buildings.

Publicly-listed tenants might also have more social pressure exerted on them due to their public visibility. Moreover, one would expect both public and private firms to consider visibility and firm-image consequences in their locational choice of headquarters. Whether firms exhibit socially responsible behavior leads to the following two hypotheses.

Hypothesis 3: Publicly-listed firms are more likely to locate in green buildings to legitimize their public status.

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[8]well-established in the fields of accounting, management, law, and sociology

Hypothesis 4: Firms (public or private) are more likely to locate their headquarters in green buildings.

From the tenant's perspective, whether a tenant occupies a green building also depends on the extent to which savings on operating expenses accrue to the tenant. Fuerst and McAllister (2011) argue that since tenants are partially responsible for operating expenses with net rental contracts (modified gross or net lease), they should prefer green buildings. Tenants on gross rental contracts (gross/full service) do not benefit directly from such savings. Jaffee et al. (2019) point out that net rental contracts (modified gross or net lease) are conducive for energy efficiency because they provide tenants incentive to limit their energy use. The expected contractual incentive alignment yields the following hypothesis.

Hypothesis 5: Tenants on a modified gross/net lease are more likely to locate in green buildings relative to firms that are on a gross/full service lease since they are able to realize greater savings on operating expenses.

The second set of landlord related hypotheses is based on the view that landlords strategically invest in green certification to create product differentiation and to achieve a competitive advantage.[9] Specifically, a large building is better able to achieve economies of scale including cost advantages in offering amenities/services[10] that appeal to large, sought-after tenants especially those tenants who require more space (U.S. Energy Information Administration 2015). In contrast, the owner of a smaller building, given lower economics of scale, has a greater motive to address rent competition. Since product differentiation is useful in mitigating price competition (d'Aspremont et al. 1983), we expect that the owner of a smaller property is more likely to engage

[9]This view is related to the resource-based-view-of-the-firm (Barney 1991; Penrose 1959; Wernerfelt 1984) with the main idea being that, for certain types of properties, green certification can constitute a resource/capacity that creates product differentiation and competitive advantage (see Fombrun and Shanley 1990; Hart 1995; McWilliams et al. 2006). In the same vein, Chiang et al. (2019) find that real estate investment trusts stratetigically invest in corporate social responsibility disclosure when they have more growth opportunities.

[10] These advantages are present in our dataset wherein the univariate regression of the sum of all dummy variables of amenities on the natural logarithem of building size in sq. ft. yields a slope coefficient and *t*-stat of 1.368 and 51.13, respectively.

in green certification to position itself away from larger properties with more amenities. This leads to the following hypothesis that runs counter to Hypotheses 1 and 2:

Hypothesis 6: Big tenants (measured by a tenant's annual sales or total square feet leased) are less likely to occupy green-certified buildings because big tenants tend to occupy large buildings and owners of large buildings have less incentive for green certification as a means of product differentiation.

The intuition for considering green certification as a product differentiation strategy for smaller buildings with fewer amenities has a parallel in the literature of sequential product positioning.[11] Viewing green certification as a product differentiation characteristic is also consistent with the hedonic pricing paradigm of Rosen (1974).

There are additional corollaries, closely related to Hypothesis 6, that naturally arise from the view that eco-certification is useful as a differentiation strategy for properties with fewer amenities. For example, one would expect that publicly-listed corporate tenants are less likely to occupy eco-certified space. Their greater space requirements can be satisfied only by large buildings with more amenities. Owners of these larger buildings have relatively less incentive to engage in green certification and product differentiation. This line of reasoning leads to the following hypothesis, which is the antithesis of Hypothesis 3.

Hypothesis 7: Publicly-listed firms/tenants are less likely to locate in eco-certifed buildings to the extent that eco-certified buildings tend to be smaller and are less likely to meet publicly-listed firms' greater needs for space.

Whether a landlord would invest in a green office builing depends on the extent to which operating cost savings accrue to the landlord,[12] which in turn depends on the type of lease contract used. As such, we have the following hypothesis that is the converse of Hypothesis 5.

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[11]Lilien et al. (1992) and Tabuchi and Thisse (1995) show that the first mover (better-endowed in terms of timing) will position at the most attractive location or characteristic space in the market because the second mover has motivation to avoid direct price competition by engaging in product differentiation.

[12]Practitioners have argued that, from the landlord's perspective, "sustainability investments result in even broader payback in the form of higher rental income and occupancy, improved valuation, easier and lower cost financing, lower operating expenses, property tax rebates, and discounts on insurance premiums (Deloitte 2014, pg. 8)."

Hypothesis 8: The landlord is more likely to mandate the use of a gross/full service lease for tenants of an eco-certifed building than for a conventional building since a gross/full service lease allows the landlord to realize operating cost savings.

V. The Data

To study energy efficiency and the going-green decision, we use multiple data sources. To ensure that our office buildings are comparable from an energy perspective regardless of whether they have a green label or not, we use the energy benchmarking data that various cities post on their respective websites.[13] Cities in our sample include Boston, Chicago, Minneapolis, New York City, Philadelphia, Portland (OR), San Francisco, Seattle, and Washington DC. The annual energy benchmarking report provides detailed energy and water use as well as the carbon emissions data for the larger buildings in the city. In particular, usage output metrics include but are not limited to the site EUI,[14] the weather-normalized source EUI, GHG,[15] the water use per square foot, and the ENERGY STAR scores for buildings where such a rating is applicable. Since only the site EUI

[13]The URL for each city's energy benchmarking data are as follows: https://data.cambridgema.gov/Energy-and-the-Environment/2017-Cambridge-Building-Energy-and-Water-Use-Discl/nepy-jbp2/data (Boston), https://www.cityofchicago.org/city/en/depts/mayor/supp_info/chicago-energy-benchmarking/Chicago_Energy_Benchmarking_Reports_Data.html (Chicago), http://www.ci.minneapolis.mn.us/environment/energy/WCMS1P-116916 (Minneapolis), https://www1.nyc.gov/site/finance/taxes/property-reports/nyc-energy-benchmarking-report.page (New York City), http://visualization.phillybuildingbenchmarking.com/#!/ (Philadelphia), https://www.portlandoregon.gov/bps/68329 (Portland), https://www.buildingrating.org/jurisdiction/San%20Francisco (San Francisco), http://www.seattle.gov/environment/climate-change/building-energy/energy-benchmarking/why-benchmarking-is-required#dataanalysis (Seattle), and https://doee.dc.gov/node/572252 (Washington, D.C.).

[14] Site EUI equals the annual amount of the energy consumed on site, measured in thousands of British thermal units, kBTU, per gross square foot of space, as reflected in utility bills. Site EUI is winsorized at 400 kBTU per gross sq. rt. There are two observations whose values are more than 60 times of the winsorizing threshold. The reported results in the current study is insensitive to winsorization treatment. The unreported results with the exclusion of the two observations are qualitatively similar. In the spirit of Eichholtz et al. (2010, 2013), we normalize site EUI for spatial variation in climate/temperature characteristics by the ratio of the number of degree days in the metropolitan area to the average number of heating and cooling degree days in all sampled metropolitan areas. Degree days are measured based on 65°F, and the data are retrieved from the National Oceanic and Atmosphere Administration's website. In our hedonic analyses, we use the natural logarithm of normalized site EUI as a measurement of energy efficiency performance.

[15] Unit GHG is the natural logarithm of annual direct and indirect greenhouse gas emissions measured in pounds per sq. ft. Unit GHG emissions is winsorized at 65 pounds per year per sq. ft. There are two observations that have values that are more than 30 times of the winsorizing threshold. Direct emissions are associated with on-site fuel combustion of natural gas or fuel oil. Indirect emissions arise because of purchases of electricity, district steam, district hot water, or district chilled water. Similar to site EUI, unit GHG is a normalized measure by degree days.

and GHG are consistently reported for each city, we use these two metrics in comparing green building performance. Depending on the city, a large commercial building is typically defined as one having at least 10,000 square feet of space that is heated or cooled. For purposes of lease (rent) transactions but not sales transactions, we limit our sample to Chicago, New York, and Washington D.C. given the available number of lease transactions for each city. These cities were among the first to require energy benchmarking. This allows us to compare a building's relative energy performance with other similar buildings which prior studies were unable to do given the only recent availability of this data.

Our second database that has also only recently become available as of 2012 is Compstak[16] which contains information on individual lease transactions for office buildings. Not only does Compstak report the identity of the tenant/establishment but also the actual (stated) rent paid, rent concessions including the number of months of free rent, the effective rent paid, the floor that they are located on, the amount of space rented, when the lease was executed and signed, the start date for the lease when the tenant moved in, when the lease expires, the lease term, the transaction type (new lease, renewal, expansion), whether it is a sublease, and the lease type[17] (gross lease, modified gross, or net lease).

Since the tenants are known, we use Dun and Bradstreet (D&B, vis-à-vis Hoover's and Mergent Intellect) to obtain information on each tenant including the industry that the tenant is in based on the North America Industry Classification System (NAICS), annual sales, the year of founding, the risk of the tenant[18], whether the location represents a headquarter, branch, or single location, and whether the company is a publicly-traded firm or a private company.[19]

Similar to Eichhotz et al. (2010, 2013) we use the CoStar database for our building attributes and sold transaction prices. Building attributes include building amenities for which we create a

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[16]Liu et al. (2018) have used Compstak to help document that firms having higher productivity tend to locate on higher floors in a tall building while less productive firms locate on lower floors.

[17]In a full service gross or gross lease, the rental rate paid by the tenant includes normal building standard services that the landlord provides and pays for e.g., the landlord pays operating expenses. In a modified gross lease, the tenant pays base rent at the start of lease but in subsequent years the tenant pays the base plus a proportional share of some of property expenses e.g. property taxes, utilities, insurance and maintenance. In a net lease, the tenant not only pays the base rent but also pays a pro-rata share of property expenses.

[18]Dun and Bradstreet rates tenants as low risk, medium risk, high risk or non-rated.

[19]In the event that one or more data fields were missing from Dun and Bradstreet, we used several websites to obtain this information including https://www.manta.com, http://www.buzzfile.com, https://start.cortera.com, https://www.crunchbase.com/, https://www.owler.com, https://www.bloomberg.com/research/stocks/, https://www.linkedin.com/company/, https://www.corporationwiki.com/, https://corporatesfinder.com, and https://pitchbook.com/profiles/company/ among others.

series of dummy variables and also locational factors inclusive of the walkscore[20], distance in miles and minutes to the nearest subway and the appropriate submarket. We also use two measures of building quality from CoStar, the building class (Class A, Class B, Class C) and the Building (star) Rating System. While the former classification reflects quality from a local perspective, the latter system is designed to reflect national quality and thus allows buildings to be compared across cities.[21] Other building characteristics that we collect from CoStar include the number of elevators[22], number of floors, total building square feet, the average square feet per floor (floorplate), whether the building is wired with respect to telecommunications and if so, is the building wired certified at the Platinum, Gold, Silver or Certified level based on the quality of digital connectivity. Wired certification is a commercial real estate rating system developed by WireScore in 2013. Finally, we collect from CoStar and verify with Energy Star (https://www.energystar.gov) and the U.S. Green Building Council (https://new.usgbc.org/) websites, whether the building has an Energy Star rating, the first year of that rating, whether a building is LEED certified, the year it became certified, and also the level of LEED certification (Platinum, Gold, Silver, or Certified).

The use of Compstak for rents is in contrast to the previous literature on green buildings which uses CoStar. The limitation with using CoStar data for rents is that the rents reported are *asking* (quoted) rent rather than the actual rent and effective rent paid. As such prior studies multiply the asking rents by the occupancy rate to proxy for the effective rent. This is an imperfect proxy at best. The actual rent is the rent stated in the contract while effective rent represents the actual rent averaged over the term of the lease adjusted for rent-free periods e.g., months of free rent (no rent is paid) and other up-front incentives. The CoStar data also does not report the terms of the lease, the riskiness of the tenant nor other tenant characteristics which could influence the amount of rent paid and therefore the rent premium associated with green buildings. For example,

[20]Pivo and Fisher (2011) find that greater walkability is capitalized into sales transactions of office buildings. Since values are capitalized net rent, this also suggests that rents should also reflect the effects of walkability. Walkscores range from 0 to 100 with higher scores reflecting better locations or location efficiency. More specifically, the walkscore reflects a normalized weighted average based on distance to various amenities. For a more detailed discussion on walkscores, please visit https://www.walkscore.com/ or https://en.wikipedia.org/wiki/Walk_Score.
[21] The reported results are based on the use of the building class as a measurement for building quality. The unreported results based on the Building Rating System are qualitatively similar.
[22]When the number of elevators is not reported, we either used the building department's property record for a given city or the floorplan layout if available in CoStar or by surfing the internet. For example, property records for New York City can be accessed using http://a810-bisweb.nyc.gov/bisweb/bispi00.jsp.

all else being equal, landlords should charge riskier tenants higher rents. Also, tenants that sublease space are charged lower rent since the lease is short term in nature.

Previous studies also used the average asking rent for the *entire* building which is troubling since rents tend to increase with the number of floors so taller buildings should have higher average asking rent. We avoid this problem by using the effective rents on individual leases and also control for lease terms and tenant characteristics. In this manner, we are better able to ascertain whether the rent premium attributable to green buildings reflects sustainability or an omitted variable bias.

Using the information on tenants from Compstak and Dun and Bradstreet we are able to assess not only whether tenants pay a premium for being in a green building, but also the incremental rent premium associated with a "named" green label – Energy Star, LEED, and EnergyStar/LEED. This is something that prior studies were unable to ascertain given data limitations. We are also able to determine what type of tenants choose to locate in generic green buildings. In setting up our data, we match the execution date of the lease (when the lease was signed) to a building's energy attributes in the prior year. For example, if a lease is signed in 2018, we used energy attributes from 2017 since the 2018 energy characteristics are not known. In this manner, tenants take into account the energy efficiency attributes of the building in their decision to locate in a particular building. A similar logic process is used with respect to the date of sale for sold transactions relative to the energy benchmarking year.

Table 1 provides a summary of variables and their definitions used in the current study. The sample period is from 2012 to 2017.[23]

VI. The Empirical Specification

Probit regressions are used to test the hypotheses developed in the hypotheses section. Since we have rather sparse observations on the lease type variable (approximately 40% of missing observations), we run two sets of probit regressions: the first set focusing on Hypotheses 1-4 and 6-7 without including the lease type variable. The second set of probit regressions adds the lease

[23] Our sample period of 2012 to 2017 does not overlap with that of Eichholtz et al. (2010), whose sample period is from 2004 to 2007. We experiment with Eichholtz et al.'s specifications on our transaction sample. The results are reported in the appendix. Consistent with Kok et al. (2011), our results show that in more recent years, the price premium of Energy Star rated buildings has been disappearing.

type variable to test Hypotheses 5 and 8. The general specification of the probit regressions is as follows.

Going green = *f* (*Public*, *HQ*, *Sales*, *Modified gross/net lease*, *Lease term*, *SqFt*, *Sublease*, *Branch*, *RiskMed*, *RiskHigh*, *Tenant Age*, NAICS dummies, submarket dummies, year dummies) (1)

where *Going green* is a binary variable that is defined in four different ways: (i) taking the value 1 (0) if the property is (not) an eco-certified building by LEED or Energy Star, (ii) taking the value 1 (0) if the property is (not) certified by LEED, (iii) taking the value 1 (0) if the property is (not) certified by Energy Star, and (iv) taking the value 1 (0) if the Energy Star Score of the property is (not) equal to or higher than 75.

To take advantage of the novelty of using benchmark data and lease-level data, this study revisits the pricing of office space with an emphasis on the role of green certification and environmental performance. Following the previous literature (see, for example, Eichholtz et al. 2010; Fuerst and McAllister 2011; and Wiley et al. 2010), we use a hedonic pricing model[24] to investigate the effects of environmental variables and the incremental impact of green certification (the label) on rents and sales prices. Specifically, in our log-linear specifications, the natural logarithm of the net effective rent or sales price per square foot of a building, P_i, is given by:

$$P_i = \beta_0 + \beta_1 CERT_i + \beta_2 ENV_i + \beta_3 ACC_i + \beta_4 X_i + \varepsilon_i \qquad (2)$$

where $CERT_i$ includes a vector of eco-certification indicator variables for LEED and Energy Star certification. In this study, we also include tech-certification indicator variables; that is, whether a building is Wired-certified. ENV_i is a vector of environmental variables: the natural logarithm of site EUI and the natural logarithm of unit GHG, both normalized by degree days as is commonly done in the existing literature. Locational attributes denoted ACC_i include the submarket within which the property is located, distance to nearest subway, walkscore and the natural logarithm of the number of elevators among others. Walkscore, ranging from zero (the worst) and 100 (the

[24]The underlying hypothesis of the hedonic model is that goods, in this case office buildings, are valued for their utility bearing characteristics. These characteristics in a real estate context include structural and locational attributes (see Rosen 1974; Bailey et al. 1963). We extend the list of attributes in our study to include environmental attributes associated with structural attributes in addition to tenant attributes.

best), measures the access and walkability of an address to nearby amenities, such as businesses, parks, schools, theaters, and other common destinations.[25] To further address the notion of access premium, this study adds the natural logarithm of the number of elevators into our specification. The idea is rather simple: the more elevators that an office building has, the less amount of wait time and thus travel time occupants spent within the building. In other words, while the walkscore measures the ease of access horizontally, the number of elevators is a proxy for the ease of vertical access. Finally, X_i is a vector of standard hedonic characteristics including building characteristics and tenant characteristics (for rental regressions). Building characteristics include but are not limited to building quality such as Class A or Class B, on-site amenities (e.g., whether the building has a conference facility, day care center, or court yard, restaurant, security, on-site property manager), and structural features of the building including the number of elevators, the number of floors, building age, and building size, among others. Tenant characteristics include but are not limited to tenant age, tenant risk, NAICS dummies, square feet leased, etc.

VII. Empirical Results

7.1. Probit Regression Results

The probit analysis uses rent data for Chicago, DC, and NYC. Table 2 reports the results of our tests to see whether Hypotheses 1-4 and 6-7, using Models (1) – (4) hold. Model (1) shows that non-publicly traded (private) tenants and small tenants with lower annual sales or requiring less square feet tend to occupy a green-certified building. More specifically, a tenant is more likely to occupy a building with a green label e.g., LEED-certified or Energy Star-certified building when the tenant is a private firm, has lower annual sales, signs a shorter-term lease, leases less square feet, and does not sign a sublease contract. These relationships are statistically significant at either the 1% or the 5% level. Overall, the results support Hypotheses 6-7 and are consistent with the notion that large tenants and publicly-listed tenants are less likely to occupy eco-certified space. The rationale is that these tenants have a greater need for space; the owners of large buildings which suit their needs do not necessarily need a green certification label to differentiate their building as a marketing strategy. The evidence suggests that going-green decisions can be better

[25]Pivo and Fisher (2011) found that the market values of commercial office, retail, and apartment buildings are positively related to walkscores.

understood from the landlord's perspective; that is, going green is an integral element of a landlord' property-level differentiation strategies. In contrast, the results based on Model (1) conflict with the predictions of Hypotheses 1-4. The evidence suggests that a tenant's decision to occupy a green labeled building is not driven by a tenant's legitimacy concerns nor their heterogeneous characteristics or capacities.

Models (2) and (3) in Table 2 experiment with different definitions of what the "going green" label represents. In Model (2), the binary dependent variable takes the value 1 (0) if the property is (not) certified by LEED; in Model (3), the binary *Going green* variable takes the value 1 (0) if the property is (not) certified by Energy Star. The results are similar to those reported in Model (1). The green label has a higher degree of fit with the landlord's decision to invest in green technology and certification relative to that of the tenant decision to occupy green space.

Model (4) in Table 2 differs from the previous three specifications in that the measurement of binary dependent variable is based solely on the properties' environmental performance regardless of whether the landlord undertakes the certification efforts (obtains a green label). Here, we use Energy Star's certification cutoff and set *Going green* to be 1 (0) if the property has (does not have) an Energy Star Score equal to or higher than 75. Therefore, if a tenant occupies a property that has an Energy Star Score of 80 and the landlord does not bother to eco-certify the building, the *Going Green* variable for this lease observation would have the value 1 in Model (4), but has a value 0 in Model (1) – Model (3).

The result of the probit regression in Model (4) of Table 2 yields additional insights relative to the results in Model (1) – Model (3). A tenant is more likely to occupy a high environmental performance building[26] in terms of a "simulated" Energy Star Score when a tenant signs a shorter-term lease and leases *more* square feet. These relationships are statistically significant at the 1% and the 5% level, respectively. It appears that large, sought-after tenants care more about the actual green performance of an office building rather than whether it has a green certification *per se*.

In Model (5) of Table 2 we add the contract type variable into the specification which results in a drop in the sample size from nearly 7,000 to approximately 4,000. The binary dependent

[26] To the best of our knowledge, there is no existent data source allowing one to distangle the combined environmental footprint of a permanent structure and its occupants. Thus, in this study when we discuss the environmental performance of a building, we refer to the combined performance of the permanent structure and its occupants.

variable takes the value 1 (0) if the building is certified by LEED or Energy Star.[27] The coefficient for *Modified gross/net lease* of -0.175 is statistically significant at the 1% level. The result supports Hypothesis 8 and the landlord's perspective. That is, when a landlord owns an eco-certified building, the landlord prefers a gross/full service lease to recoup his or her incremental green investment. The evidence is at odds with the tenant directly receiving cost saving benefits arising from occupying green space and Hypothesis 5, which predicts a positive coefficient for *Modified gross/net lease*.

Although the analysis in Model (5) of Table 2 is informative, it is incomplete. The reason for this is that the free cash flows to the landlord is a function of both lease contract type (modified gross/net lease vs. gross/full service lease) and net effective rent. Thus, a complete specification for examining the relationship between the going green decision and the choice of lease contract type should take net effective rent into consideration. To do so, we employ an alternative specification in which *Modified gross/net lease* is the dependent variable. As a consequence we are able to augment the specification with the inclusion of CPI-deflated net effect rent. An additional benefit for using this alternative specification is its potential to check the robustness of Model (5) in Table 2. The intuition for this is one can argue that the going green decision and the choice of lease contract type are a joint decision with no clear direction of causality. We consider three alternative definitions of going green: (i) LEED- or Energy Star-certified, (ii) LEED-certified, and (iii) Energy Star-certified. The results of the probit regressions are reported in Table 3.

The results of the probit regressions in Table 3 and those of Model 5 in Table 2, tell the same story. A modified gross/net lease contract tends to be used when the building is not eco-certified, which is consistent with Hypothesis 8. Additionally, the results in Table 3 show that a modified gross/net lease is more likely to be used when the net effective rent is high, the tenant uses the building as their headquarters, the lease term is short, and the lease is a sublease. All these relationship are statistically significant at the 1% level across three different definitions of going green. To the best of our knowledge, this is the first study documenting a positive relationship between net effective rent and the use of modified gross/net lease. This implies that owners of large office buildings with lots of amenities do not necessarily need a green certification label to

[27] We also experiment with the other three alternative definitions of *Going green*. The unreported results are qualitatively similar.

attract large tenants since these tenants are not only willing to pay higher net effective rents but also are willing to incur pay their pro-rate share of operating expenses under a modified gross/net lease contract.

Previously, the results reported in Model (1) – Model (4) in Table 2 show that although a large tenant that occupies a large space (high *SqFt*) is less likely to occupy an eco-certified building, this same tenant is more likely to occupy a high environmental performance building (a "generic green" building) having a "simulated" Energy Star Score equal to or higher than 75. We now turn our attention to whether this result would continue to hold under different criteria of environmental performance and also whether this result is robust to a different specification. In addition to the Energy Star Score, we use the site EUI and the unit GHG as alternative criteria for measuring the buildings' environmental performance and set the performance cutoff at the 75 percentile of the city,[28] similar to the Energy Star performance hurdle. We next restrict our analysis to a subset of lease data in which the sampled buildings are "green" in either of the following two senses: eco-certified versus high environmental performance but without any green certification. During this process, we discard those lease observations associated with non-comparable office buildings; e.g., office buildings that are neither green-certified nor of high environmental performance. The sample size is reduced from nearly 7,000 to 4,213–4,605 depending on the performance criteria used. The resulting binary dependent variable takes a value 1 if the tenant's lease contract is in an eco-certified building and takes a value 0 if the lease contract of a tenant is in a non-certified, yet high- environmental performance building. The probit regression results are reported in Table 4.

The evidence in Table 4 is consistent with the results in Table 2 in the sense that large brand-name tenants care more about actual green performance of a building than whether a building has a green certification *per se*. Regardless of whether environmental performance is evaluated by Energy Star Score, site EUI, or unit GHG, the coefficients of *SqFt* are negative and statistically significant at the 1% level across all three specifications. That is, a lease involving a large amount of space by a prominent tenant is more likely to correspond to a non-eco-certified, high-environmental performance building in terms of Energy Star Score, site EUI, or unit GHG, instead of an eco-certified building.

[28] By doing so, we control for degree days.

7.2. Hedonic Regression Results

Our hedonic rent regressions are based on the net effective rents of individual leases. This new data feature differentiates the current study from previous studies where the focus of the analysis is at the property level using the average asking (not actual) rent for the entire building. Table 5 reports lease-level hedonic rent regression results.

The most notable result in Table 5 is that the widely documented rent premium in the existent literature is sensitive to the type of green labels and environmental performance criteria. Consistent with the existing literature (see Eichholtz et al. 2010; Fuerst and McAllister 2011; and Wiley et al. 2010), we find that a rent premium for LEED certification, particularly at the levels of Platinum, Silver, and Certified. In contrast, there is rent *discount* for Energy Star certification. The negative coefficients are statistically significant at the 1% level across all specifications. The result is consistent with Kok et al. (2011) finding that Energy Star is in a later stage of its market diffusion, as evidenced by the speed of new adoption has been decreasing over time (see Figure 1, Kok et al. 2011). The lack of rent premium for Energy Star certified buildings is also consistent with the "gentrification effect" proposed by Chegut et al. (2014). The authors used U.K. commercial properties data and found that adding green buildings into a submarket has a positive impact on the values of *all* properties in that submarket, but it has a dampening effect on the rent and sales price premium of existing green buildings. In addition, we find that there is a positive, statistically significant relationship at the 1% level, between site EUI and net effective rent, and a negative, statistically significant relationship at the 1% level, between unit GHG and net effective rent.

Table 5 also shows that an office lease has a higher net effective rent when the tenant is a publicly-listed firm, the lease term is longer, the square feet leased is less, the lease is not a sublease, the lease is for a branch location, the tenant/firm is younger, the building is younger, and the building is designated either class A or class B. Amenities that result in higher net effective rents include having an atrium, a court yard, a bank, conference facilities, and a kitchen on the premises. In contrast, the presence of a convenience store, a dry cleaner, and/or a mailroom on the premises reduces net effective rents. Following Liu et al. (2018), we include a series of floor indicator variables in the specifications.[29] We find that net effective rent rises with the height of

[29] We exclude the floor indicator variable for floors 31 to 35 to avoid the singular matrix problem. The point estimate for this dummy variable is quite close to that of floors 26 to 30.

the leased space. Plausible reasons include views and greater productivity (see Liu et al. 2018). Net effective rent is also higher when the building has a lower walkscore and the building has more elevators. These results together suggest that vertical access is an important attribute for the tenant. In contrast to Pivo and Fisher (2011), we do not find walkscore, a proxy for horizontal access, to be valued by the tenants in our office lease data. Our result makes sense if one believes that office leasing are guided by corporate executives' preferences, that corporate executives in major metropolitans prefer corporate car service over other modes of transportation,[30] and that walking time is a small component of traveling costs for corporate executives.

In addition to rent regressions, we also apply our hedonic specification to office buildings that sold. Cities in our sample of sold office buildings are expanded to include Boston, Minneapolis, Philadelphia, Portland (OR), San Francisco, and Seattle in addition to Chicago, New York, and Washington, DC that was used in our sample of office leases. The sample size is 544. Table 6 reports property-level hedonic sales price regression results. The sales price premium documented in the previous literature is sensitive to the type of green labels and environmental performance criteria. Although we find that a sales price premium exists for LEED certification at the Platinum and Gold levels, there is no sales price premium for LEED silver certification or LEED certification, Energy Star certification, nor environmental performance as proxied by site EUI and unit GHG.

To accommodate the nonolinearity of unit sales price in the number of the floors of the building, we add a squared term to the regression specifications. To the extent that the cost method of appraisal reflects the most probable selling price, unit sales price should be convex in the number of the floors of the building. The reason for this is that unit cost reaches the lowest level when the building is not too short so that the cost of land can be adequately allocated by enough squared feet, and when the building is not too tall so that a more expensive construction method is not required. As expected, Table 6 shows that the unit sales price is convex in the height of the building. The coefficient for the number of floors is negative and statistically significant at the 1% level. The coefficient for the squared term is positive and statistically significant at the 1% level.

Table 6 also shows that among amenities, controlled access leads to a higher sales price per unit, whereas having a food court or restaurant on-site reduces the sales price per unit. In addition,

[30] https://bermudalimo.com/executives-prefer-corporate-car-service/

an office buyer is willing to pay a higher per unit sales price when the building is of higher quality (designated as either class A or class B) and has an accessible location (a high walkscore). A possible reason for the positive relationship between walkscore and per unit sales price in the transaction sample, yet the lack of it between walkscore and net effective rent in the rent sample, is that the buyer of an office building has the real options of remodeling and turning the property into a different use; e.g., hotel or residential use. The values of these real options are likely to be a positive function of walkscore. On the other hand, office tenants do not have such options.

7.3 Environmental Performance Regression Results

In this subsection, we use a variant of the hedonic model to describe the variation in two environmental variables: site EUI and unit GHG. Site EUI reflects utility bills, and is often the parameter of interest from a property owner's perspective. Greenhouse gas emission, as measured by unit GHG, contributes directly to global warming. Since we are interested in whether degree days impact our environmental variables, we do not normalize site EUI and unit GHG by degree days; instead, we include degree days as an additional explanatory variable in the hedonic specification.

The results of the hedonic regressions for environmental performance using lease data are reported in Table 7.[31] The results show that LEED-certified buildings are associated with statistically significant lower site EUI and unit GHG. Higher certification levels - Platinum and Gold - are associated with improved environmental performance. We also find that Energy Star certification is associated with a reduction of site EUI and unit GHG. Overall, these results suggest that certification programs, such as LEED and Energy Star, can be effective in achieving energy efficiency and reducing carbon externalities.

The results in Table 7 also show that tenants who sublease space tend to choose office buildings that have a higher site EUI and unit GHG. Negative environmental externalities, in terms of site EUI and unit GHG, are greater for older buildings, buildings that have more elevators and buildings in mediocre locations (walkscore is lower). Some amenities, such as courtyard, bank, and restaurants appear to result in a higher site EUI and unit GHG as well.

[31] In addition to the number of floors and its squared term, we also experiment with the use of floor indicator variables. The unreported results are qualitatively similar.

Table 8 reports the results of hedonic regressions for environmental performance using sales transactions. We find that Energy Star certification is related to lower site EUI and unit GHG with the regression coefficients statistically significant at the 1% level. In contrast, there is little evidence that LEED certification is effective except at the Platinum level. We also find that unit carbon externalities per square foot are greater for smaller and taller buildings, highest quality buildings (rated Class A), and buildings that have more elevators.

VIII. Conclusion

We use newly available databases on environmental performance benchmarking and lease transactions of individual tenants, together with tenant characteristics as well as building and locational attributes, not only to disentangle actual environmental performance from green certification *per se*, but also to determine whether a "green" premium for rent and sales price exists for green label. We construct a "generic green" scoring system for buildings to conduct a horse race in which we compare the performance, rent, and price of generic green space to "branded" green space. We find that large tenants and publicly-listed tenants are less likely to occupy eco-certified or "branded green" space since these tenants have greater space requirements, and owners of large buildings with plentiful amenities and competitive advantages do not necessarily need green certification as a marketing strategy. However, we also find that large tenants care more about the *actual* environmental performance of the occupied space than the certification of the space. In addition to this, if a building owner does make an investment in green certification, the landlord will tend to use a gross/full service lease wherein most of the green savings accrue to the landlord so that she/he can recoup the incremental green capital outlays.

Our findings suggest that it is important for policy makers to incentivize landlords, particularly those owning large buildings replete with amenities, to undertake green initiatives to mitigate negative environmental externalities. We also believe that more work should be devoted to a better-aligned eco-certification program toward environmental performance given our finding that tenants appear to have the ability to distinguish actual environmental performance from eco-certification; i.e., separating the wheat from the chaff. Such efforts should prove fruitful in advancing environmental sustainability.

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Table 1: Summary of Office Lease and Benchmark Variables

This following table presents the definitions and summary statistics of the office lease variables and local benchmark variables used in our hedonic regressions.

Variable	Definition	Mean†	Std.†
Public	Binary variable that takes the value 1 (0) if the tenant is (not) a public firm	0.16	0.36
HQ	Binary variable that take the value 1 (0) if the property is (not) used as the tenant's headquarter	0.17	0.38
Sales	The natural logarithm of the tenant's annual sales in millions	4,490.45	228,069.54
Modified gross/ net lease	Binary variable that take the value 1 (0) if the lease is a modified gross or net lease (gross or full service lease)	0.43	0.50
Lease term	The natural logarithm of lease term in years	7.12	3.94
SqFt	The natural logarithm of total square feet leased by the tenant	15,803.82	40,359.32
Sublease	Binary variable that takes the value 1 (0) if the lease is (not) a sublease	0.11	0.30
Branch	Binary variable that takes the value 1 (0) if the tenant location type is (not) branch location	0.32	0.47
RiskMed	Binary variable that take the value 1 (0) if D&B Hoovers rates (does not rate) the tenant as a medium risk firm	0.09	0.28
RiskHigh	Binary variable that take the value 1 (0) if D&B Hoovers rates (does not rate) the tenant as a high risk firm	0.10	0.30
Tenant age	The natural logarithm of the age of the tenant in years	28.51	34.82
LEED	Binary variable that takes the value 1 (0) if the building is (not) certified at any of the four LEED rating levels: Certified (*LEED_CRT*), Silver (*LEED_SLV*), Gold (*LEED_GLD*), or Platinum (*LEED_PLT*)	0.27	0.44
Energy Star	Binary variable that takes the value 1 (0) if the building is (not) certified as an Energy Star building	0.48	0.50
Net effective rent	The natural logarithm of CPI-deflated net effective rent per sq. ft.	48.85	21.76
EUI	The natural logarithm of site energy use intensity that is the annual amount of the energy consumed on site, measured in thousands of British thermal units, kBTU, per sq. ft., as reflected in utility bills	81.38	37.65
GHG	The natural logarithm of annual direct and indirect greenhouse gas emissions measured in pounds per sq. ft.	18.83	9.70
Degree days	The number of degree days in a metropolitan area; degree days are measured based on 65ºF, and the data are retrieved from the National Oceanic and Atmosphere Administration's website	5,991.74	432.19
Size	The natural logarithm of building size in sq. ft.	521,888.32	520,065.67
Building age	The natural logarithm of the age of the property, measured from the year built or the year of a major refurbishment, whichever occurred more recently	27.16	27.98
Class A	Binary variable that takes the value of 1 (0) if the building is (not) a class A building	0.61	0.48
Class B	Binary variable that takes the value 1 (0) if the building is (not) a class B building	0.35	0.47
Walkscore	A value between zero and 100 that measures the access and walkability of an address to nearby amenities, such as grocery stores, parks, schools, restaurants, etc.	97.34	4.73
Elevators	The natural logarithm of the number of elevators	11.53	10.57
Wired	Binary variable that takes the value 1 (0) if the digital connectivity of the building is certified by WiredScore at the Certified level (*Wired_CRT*), at the Silver level (*Wired_SLV*), at the Gold level (*Wired_GLD*), or the Platinum level (*Wired_PLT*)	0.23	0.41

NumFloor	The natural logarithm of the number of floors of the building	24.48	15.22

Note: † before taking natural logarithm.

Table 2: Probit Regression Results Based on Chicago, DC, and NYC Lease Data

The following table presents probit regression results for the lease data. The sample period is from 2012 to 2017. The binary depedent variable of going green is defined in various ways through columns (1) to (5). *p*-values are in parentheses.

	(1)	(2)	(3)	(4)	(5)
Value 1	LEED or Energy Star	LEED	Energy Star	Energy Star Score ≥75	LEED or Energy Star
Value 0	All else	All else	All else	All else	All else
Intercept	1.321	2.892	1.090	-0.798	1.489
	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**
Public	-0.135	-0.195	-0.123	-0.030	-0.072
	(0.017)*	(0.002)**	(0.030)*	(0.594)	(0.365)
HQ	-0.020	-0.041	-0.020	0.002	-0.062
	(0.696)	(0.469)	(0.697)	(0.972)	(0.374)
Sales	-0.027	-0.037	-0.018	-0.004	-0.031
	(0.015)*	(0.002)**	(0.093)	(0.762)	(0.040)*
Modified gross/net lease					-0.175
					(0.002)**
Lease term	-0.121	-0.073	-0.109	-0.126	-0.183
	(0.002)**	(0.096)	(0.006)**	(0.001)**	(0.001)**
SqFt	-0.097	-0.175	-0.075	0.046	-0.077
	(0.001)**	(0.001)**	(0.001)**	(0.014)*	(0.002)**
Sublease	-0.168	-0.278	-0.117	0.021	-0.273
	(0.002)**	(0.001)**	(0.034)*	(0.712)	(0.001)**
Branch	-0.026	-0.010	-0.042	0.013	-0.104
	(0.597)	(0.856)	(0.396)	(0.795)	(0.130)
RiskMed	-0.031	-0.115	-0.031	-0.030	-0.043
	(0.601)	(0.092)	(0.605)	(0.625)	(0.511)
RiskHigh	0.022	0.051	0.025	-0.091	-0.019
	(0.687)	(0.415)	(0.646)	(0.105)	(0.803)
Tenant age	0.017	0.015	0.017	-0.026	0.038
	(0.535)	(0.606)	(0.518)	(0.325)	(0.275)
NAICS dummies	Yes	Yes	Yes	Yes	Yes
Submarket dummies	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes
Sample size	6933	6933	6933	6498	4074

Note: ** significant at the 1% level. * significant at the 5% level.

Table 3: Probit Regression Results of Lease Data: Lease Contract Type

The following table presents probit regression results for the lease data. The binary depedent variable of lease contract type takes the value 1 (0) if the lease is (not) either a modified gross contract or a net lease contract. The sample period is from 2012 to 2017. *p*-values are in parentheses.

	(1)	(2)	(3)
Value 1	Modified Gross or Net Lease	Modified Gross or Net Lease	Modified Gross or Net Lease
Value 0	All else	All else	All else
Intercept	-3.347	-3.492	-3.327
	(0.001)**	(0.001)**	(0.001)**
LEED or *Energy Star*	-0.170		
	(0.002)**		
LEED		-0.259	
		(0.001)**	
Energy Star			-0.143
			(0.009)**
Net effective rent	0.913	0.925	0.911
	(0.001)**	(0.001)**	(0.001)**
Public	-0.004	0.004	-0.006
	(0.959)	(0.964)	(0.947)
HQ	0.217	0.223	0.215
	(0.005)**	(0.004)**	(0.006)**
Sales	-0.027	-0.028	-0.028
	(0.083)	(0.074)	(0.077)
Lease term	-0.214	-0.215	-0.216
	(0.001)**	(0.001)**	(0.001)**
SqFt	-0.020	-0.012	-0.022
	(0.455)	(0.658)	(0.409)
Sublease	0.324	0.338	0.319
	(0.001)**	(0.001)**	(0.001)**
Branch	-0.081	-0.078	-0.080
	(0.278)	(0.294)	(0.281)
RiskMed	-0.157	-0.145	-0.157
	(0.082)	(0.108)	(0.082)
RiskHigh	0.046	0.050	0.047
	(0.581)	(0.552)	(0.575)
Tenant Age	-0.016	-0.014	-0.015
	(0.679)	(0.709)	(0.694)
NAICS dummies	Yes	Yes	Yes
Submarket dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Sample size	4074	4074	4074

Note: *p*-values are in parentheses. ** significant at the 1% level. * significant at the 5% level.

Table 4: Probit Regression Results of Lease Data: Certification vs. Performance

The following table presents probit regression results for the lease data. The binary depedent variable takes the value 1 if the property is cetified by LEED or Energy Star, and takes the value 0 if the property is not certified, yet producing top quartile performance in terms of Energy Star Score, site EUI, or unit GHG. The sample period is from 2012 to 2017. *p*-values are in parentheses.

	(1)	(2)	(3)
Value 1	LEED or Energy Star	LEED or Energy Star	LEED or Energy Star
Value 0	Energy Star Score ≥ 75 but not certified	Site EUI performance in the top quartile but not certified	GHG performance in the top quartile but not certified
Intercept	1.841	1.577	1.599
	(0.001)**	(0.001)**	(0.001)**
Public	-0.113	-0.150	0.021
	(0.163)	(0.123)	(0.817)
HQ	-0.036	0.022	-0.003
	(0.610)	(0.791)	(0.966)
Sales	-0.031	-0.007	-0.035
	(0.056)	(0.706)	(0.045)*
Lease term	-0.034	0.033	-0.108
	(0.561)	(0.642)	(0.081)
SqFt	-0.187	-0.184	-0.164
	(0.001)**	(0.001)**	(0.001)**
Sublease	-0.301	-0.304	-0.440
	(0.001)**	(0.003)**	(0.001)**
Branch	0.039	-0.065	-0.017
	(0.575)	(0.441)	(0.829)
RiskMed	-0.021	-0.000	0.084
	(0.807)	(0.997)	(0.359)
RiskHigh	0.062	0.118	0.071
	(0.409)	(0.182)	(0.389)
Tenant age	-0.003	-0.061	-0.024
	(0.946)	(0.190)	(0.565)
NAICS dummies	Yes	Yes	Yes
Submarket dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Sample size	4605	4213	4325

Note: *p*-values are in parentheses. ** significant at the 1% level. * significant at the 5% level.

Table 5: Hedonic Regression Results of the Natural Logarithm of Net Effective Rent

The following table presents OLS regression results for the lease data. The dependent variable is the natural logarithm of net effective rent. The sample period is from 2012 to 2017. *t*-stats are in parentheses.

	(1)	(2)	(3)	(4)	(5)
Intercept	4.114 (29.88)**	4.086 (29.52)**	3.801 (26.55)**	3.765 (26.19)**	3.762 (26.28)**
LEED	0.023 (2.66)**		0.026 (2.99)**		
LEED_PLT		0.078 (3.01)**		0.086 (3.34)**	
LEED_GLD		0.018 (1.79)		0.024 (2.36)*	
LEED_SLV		0.042 (3.58)**		0.043 (3.68)**	
LEED_CRT		0.076 (3.93)**		0.080 (4.17)**	
Energy Star	-0.032 (-4.20)**	-0.037 (-4.89)**	-0.024 (-3.16)**	-0.030 (-3.88)**	
EUI			0.088 (6.90)**	0.091 (7.11)**	0.092 (7.21)**
GHG			-0.031 (-2.72)**	-0.032 (-2.90)**	-0.032 (-2.82)**
Public	0.026 (2.55)*	0.028 (2.66)**	0.025 (2.45)*	0.026 (2.56)*	0.026 (2.48)*
HQ	0.009 (0.96)	0.011 (1.17)	0.009 (0.97)	0.011 (1.18)	0.009 (0.99)
Sales	0.002 (1.06)	0.002 (0.86)	0.002 (0.97)	0.001 (0.75)	0.002 (1.03)
Lease term	0.063 (8.75)**	0.063 (8.73)**	0.065 (9.01)**	0.064 (8.97)**	0.065 (8.97)**
SqFt	-0.019 (-5.16)**	-0.019 (-5.18)**	-0.019 (-5.29)**	-0.020 (-5.30)**	-0.019 (-5.17)**
Sublease	-0.131 (-12.65)**	-0.131 (-12.54)**	-0.135 (-13.08)**	-0.135 (-13.06)**	-0.134 (-13.00)**
Branch	0.032 (3.53)**	0.033 (3.64)**	0.033 (3.63)**	0.034 (3.73)**	0.033 (3.59)**
RiskMed	0.017 (1.53)	0.017 (1.57)	0.016 (1.44)	0.016 (1.46)	0.016 (1.44)
RiskHigh	0.013 (1.30)	0.013 (1.28)	0.014 (1.36)	0.013 (1.33)	0.013 (1.33)
Tenant age	-0.018 (-3.64)**	-0.018 (-3.65)**	-0.018 (-3.74)**	-0.018 (-3.73)**	-0.018 (-3.76)**
Building age	-0.011 (-3.48)**	-0.011 (-3.20)**	-0.011 (-3.46)**	-0.010 (-3.16)**	-0.009 (-2.96)**
Class A	0.118 (6.33)**	0.114 (6.07)**	0.125 (6.70)**	0.121 (6.45)**	0.127 (6.79)**
Class B	0.079 (4.83)**	0.078 (4.78)**	0.078 (4.79)**	0.078 (4.77)**	0.077 (4.73)**
Walkscore	-0.004 (-2.91)**	-0.003 (-2.64)**	-0.003 (-2.66)**	-0.003 (-2.40)*	-0.003 (-2.58)**
Elevators	0.038 (4.74)**	0.040 (4.86)**	0.032 (3.96)**	0.033 (4.04)**	0.034 (4.23)**
Wired	-0.20 (-2.51)*		-0.18 (-2.18)*		
Wired_PLT		-0.033 (-2.78)**		-0.030 (-2.53)*	-0.027 (-2.29)*
Wired_GLD		-0.025 (-2.26)*		-0.025 (-2.26)*	-0.025 (-2.29)*
Wired_SLV		-0.003 (-0.16)		0.005 (0.31)	0.008 (0.48)
Wired_CRT		0.038 (1.04)		0.036 (0.97)	0.027 (0.74)
Floor1-5	-0.044 (-3.81)**	-0.044 (-3.84)**	-0.044 (-3.83)**	-0.045 (-3.87)**	-0.045 (-3.90)**
Floor6-10	-0.033 (-2.94)**	-0.034 (-3.02)**	-0.032 (-2.91)**	-0.033 (-2.99)**	-0.033 (-2.98)**
Floor11-15	-0.010 (-0.82)	-0.011 (-0.92)	-0.009 (-0.78)	-0.010 (-0.88)	-0.009 (0.80)
Floor16-20	0.016 (1.23)	0.015 (1.16)	0.016 (1.21)	0.015 (1.15)	0.016 (1.22)
Floor21-25	0.065 (4.63)**	0.063 (4.49)**	0.064 (4.54)**	0.062 (4.39)**	0.063 (4.49)**
Floor26-30	0.086 (5.41)**	0.084 (5.31)**	0.085 (5.41)**	0.083 (5.30)**	0.085 (5.40)**
Floor36-40	0.157 (7.54)**	0.157 (7.54)**	0.155 (7.46)**	0.155 (7.47)**	0.155 (7.45)**
Floor41-45	0.203 (6.27)**	0.199 (6.14)**	0.204 (6.31)**	0.200 (6.18)**	0.204 (6.33)**
Floor46+	0.179 (6.94)**	0.178 (6.89)**	0.181 (7.02)**	0.180 (7.00)**	0.178 (6.91)**
Atrium	0.032 (3.54)**	0.030 (3.28)**	0.036 (3.90)**	0.033 (3.62)**	0.035 (3.89)**
Court yard	0.048 (3.73)**	0.051 (3.95)**	0.046 (3.62)**	0.049 (3.82)**	0.048 (3.69)**
Bank	0.036 (4.87)**	0.038 (5.04)**	0.033 (4.49)**	0.035 (4.66)**	0.034 (4.58)**
24 hour	-0.012 (-1.62)	-0.009 (-1.27)	-0.015 (-1.98)*	-0.012 (-1.64)	-0.014 (-1.88)
Concierge	0.007 (1.03)	0.007 (1.02)	0.006 (1.01)	0.006 (0.99)	0.006 (0.88)
Controlled access	0.005 (0.44)	0.007 (0.57)	0.005 (0.44)	0.006 (0.53)	0.007 (0.62)
Conference	0.025 (2.70)**	0.025 (2.70)**	0.026 (2.85)**	0.026 (2.85)**	0.024 (2.58)**
Convenience store	-0.037 (-3.09)**	-0.033 (-2.72)**	-0.040 (-3.34)**	-0.035 (-2.92)**	-0.038 (-3.17)**
Day care	0.009 (0.31)	0.010 (0.34)	0.006 (0.19)	0.007 (0.24)	0.011 (0.36)
Food court	-0.053 (-2.07)*	-0.049 (-1.90)	-0.045 (-1.74)	-0.040 (-1.55)	-0.040 (-1.55)
Food service	0.007 (0.83)	0.008 (0.96)	0.007 (0.81)	0.008 (0.95)	0.009 (0.98)
Kitchen	0.103 (4.14)**	0.094 (3.78)**	0.109 (4.39)**	0.100 (4.03)**	0.102 (4.17)**
Restaurant	0.009 (1.28)	0.008 (1.11)	0.006 (0.85)	0.005 (0.64)	0.006 (0.84)
Dry cleaner	-0.074 (-4.44)**	-0.083 (-4.85)**	-0.073 (-4.40)**	-0.081 (-4.78)**	-0.075 (-4.47)**
Pool	0.049 (1.01)	0.057 (1.15)	0.036 (0.75)	0.046 (0.95)	0.014 (0.30)

Mail	-0.056 (-4.09)**	-0.055 (-3.96)**	-0.055 (-4.05)**	-0.054 (-3.90)**	-0.053 (-3.88)**
Mall	0.015 (0.52)	0.021 (0.68)	0.014 (0.45)	0.019 (0.61)	0.015 (0.49)
Site management	0.008 (1.27)	0.008 (1.22)	0.007 (1.14)	0.007 (1.08)	0.006 (0.84)
Security system	0.001 (0.18)	0.001 (0.10)	0.001 (0.18)	0.001 (0.10)	0.001 (0.05)
NAICS dummies	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes
Submarket dummies	Yes	Yes	Yes	Yes	Yes
Sample size	6932	6932	6932	6932	6932
Adjusted R^2	67.23%	67.34%	67.50%	67.62%	67.45%

Note: *t*-statistics are in parentheses. ** significant at the 1% level. * significant at the 5% level.

Table 6: Hedonic Regression Results of the Natural Logarithm of Unit Sales Prices

The following table presents OLS regression results for the sales data. The dependent variable is the natural logarithm of unit sales price. Cities in the sample of sold office buildings include New York, Chicago, Washington, DC, Boston, Minneapolis, Philadelphia, Portland (OR), San Francisco, and Seattle. The sample period is from 2012 to 2017. *t*-stats are in parentheses.

	(1)	(2)	(3)	(4)	(5)
Intercept	6.786 (6.70)**	6.698 (6.56)**	6.701 (6.54)**	6.567 (6.35)**	6.258 (6.03)**
LEED	0.130 (2.47)*		0.133 (2.51)*		
LEED_PLT		0.264 (2.21)*		0.275 (2.29)*	
LEED_GLD		0.128 (2.05)*		0.133 (2.12)*	
LEED_SLV		0.059 (0.69)		0.058 (0.68)	
LEED_CRT		0.236 (1.53)		0.240 (1.55)	
Energy Star	0.075 (1.41)	0.073 (1.36)	0.082 (1.51)	0.081 (1.49)	
EUI			0.035 (0.57)	0.036 (0.59)	0.004 (0.06)
GHG			-0.006 (-0.10)	0.004 (0.07)	0.002 (0.04)
Size	-0.100 (-1.31)	-0.100 (-1.31)	-0.094 (-1.22)	-0.091 (-1.17)	-0.072 (-0.91)
Site area	-0.003 (-0.05)	-0.004 (-0.05)	-0.009 (-0.13)	-0.011 (-0.16)	-0.001 (-0.01)
Building age	-0.019 (-0.97)	-0.016 (-0.81)	-0.019 (-0.95)	-0.015 (-0.78)	-0.027 (-1.38)
Class A	0.535 (5.49)**	0.524 (5.31)**	0.530 (5.41)**	0.515 (5.18)**	0.559 (5.63)**
Class B	0.298 (3.61)**	0.296 (3.54)**	0.294 (3.53)**	0.289 (3.45)**	0.290 (3.43)**
Walkscore	0.016 (2.15)*	0.017 (2.28)*	0.016 (2.13)*	0.017 (2.27)*	0.016 (2.17)*
Elevators	0.111 (1.69)	0.115 (1.73)	0.108 (1.60)	0.109 (1.60)	0.113 (1.65)
Wired	-0.055 (-1.03)		-0.056 (-1.03)		
Wired_PLT		-0.048 (-0.54)		-0.053 (-0.59)	-0.017 (-0.19)
Wired_GLD		-0.104 (-1.36)		-0.107 (-1.39)	-0.078 (-1.01)
Wired_SLV		0.017 (0.19)		0.023 (0.25)	0.033 (0.36)
Wired_CRT		-0.107 (-0.49)		-0.086 (-0.39)	-0.082 (-0.37)
NumFloor	-1.029 (-3.72)**	-1.043 (-3.76)**	-1.058 (-3.78)**	-1.085 (-3.85)**	-0.936 (-3.33)**
$NumFloor^2$	0.166 (3.62)**	0.169 (3.67)**	0.171 (3.66)**	0.176 (3.75)**	0.151 (3.22)**
Atrium	0.036 (0.60)	0.027 (0.44)	0.036 (0.60)	0.025 (0.41)	0.028 (0.46)
Court yard	-0.016 (-0.20)	-0.006 (-0.07)	-0.016 (-0.19)	-0.005 (-0.06)	-0.018 (-0.21)
Bank	0.044 (0.85)	0.048 (0.92)	0.043 (0.83)	0.047 (0.90)	0.057 (1.09)
24 hour	-0.009 (-0.17)	-0.012 (-0.24)	-0.008 (-0.15)	-0.011 (-0.22)	-0.011 (-0.22)
Concierge	0.043 (0.82)	0.037 (0.70)	0.045 (0.85)	0.038 (0.73)	0.046 (0.87)
Controlled access	0.212 (3.17)**	0.218 (3.22)**	0.213 (3.17)**	0.220 (3.25)**	0.221 (3.26)**
Conference	-0.072 (-1.11)	-0.076 (-1.16)	-0.073 (-1.12)	-0.079 (-1.19)	-0.072 (-1.09)
Convenience store	-0.075 (-0.85)	-0.073 (-0.82)	-0.073 (-0.82)	-0.070 (-0.78)	-0.081 (-0.90)
Day care	0.184 (1.17)	0.180 (1.13)	0.194 (1.22)	0.190 (1.19)	0.208 (1.29)
Food court	-0.221 (-1.84)	-0.247 (-2.02)*	-0.225 (-1.84)	-0.249 (-2.01)*	-0.243 (-1.96)
Food service	-0.041 (-0.74)	-0.037 (-0.64)	-0.041 (-0.73)	-0.035 (-0.61)	-0.046 (-0.81)
Kitchen	-0.136 (-0.62)	-0.129 (-0.59)	-0.129 (-0.58)	-0.123 (-0.55)	-0.101 (-0.45)
Restaurant	-0.098 (-1.96)*	-0.102 (-2.02)*	-0.102 (-2.03)*	-0.107 (-2.11)*	-0.093 (-1.83)
Dry cleaner	0.072 (0.62)	0.072 (0.61)	0.071 (0.60)	0.070 (0.59)	0.077 (0.65)
Pool	-0.624 (-1.39)	-0.567 (-1.24)	-0.632 (-1.40)	-0.578 (-1.27)	-0.596 (-1.30)
Mail	-0.102 (-1.12)	-0.082 (-0.88)	-0.101 (-1.11)	-0.080 (-0.87)	-0.100 (-1.08)
Mall	0.015 (0.05)	0.032 (0.10)	-0.002 (-0.01)	0.017 (0.05)	0.051 (0.15)
Site management	-0.065 (-1.43)	-0.060 (-1.31)	-0.063 (-1.38)	-0.057 (-1.24)	-0.068 (-1.47)
Security system	-0.031 (-0.56)	-0.031 (-0.56)	-0.031 (-0.57)	-0.031 (-0.57)	-0.023 (-0.42)
Year dummies	Yes	Yes	Yes	Yes	Yes
Submarket dummies	Yes	Yes	Yes	Yes	Yes
Sample size	544	544	544	544	544
Adjusted R^2	55.65%	55.43%	55.50%	55.30%	54.39%

Note: *t*-statistics are in parentheses. ** significant at the 1% level. * significant at the 5% level.

Table 7: Environmental Performance Regression Results of Lease Data

The following table presents OLS regression results for the lease data. The dependent variable is the natural logarithm of site EUI or unit GHG. The sample period is from 2012 to 2017. *t*-stats are in parentheses.

	Log(Site EUI)	Log(Greenhouse Gas Emissions)
Intercept	-37.255 (-2.31)*	61.310 (3.39)**
LEED_PLT	-0.131 (-3.74)**	-0.097 (-2.47)**
LEED_GLD	-0.084 (-5.99)**	-0.043 (-2.75)**
LEED_SLV	-0.035 (-2.16)*	-0.022 (-1.21)
LEED_CRT	-0.046 (-1.74)	-0.007 (-0.22)
Energy Star	-0.127 (-12.22)**	-0.113 (-9.77)**
Degree days	4.722 (2.53)*	-6.554 (-3.13)**
Size	0.059 (4.17)**	-0.164 (-10.37)**
Public	0.004 (0.28)	-0.017 (-1.08)
HQ	-0.003 (-0.23)	-0.000 (-0.00)
Sales	0.002 (0.77)	0.001 (0.29)
Lease term	-0.022 (-2.28)*	-0.014 (-1.29)
SqFt	0.003 (0.64)	0.012 (2.13)*
Sublease	0.057 (4.06)**	0.059 (3.72)**
Branch	-0.006 (-0.51)	-0.002 (-0.17)
RiskMed	0.012 (0.79)	0.008 (0.47)
RiskHigh	-0.015 (-1.05)	-0.020 (-1.28)
Tenant age	0.007 (1.00)	0.009 (1.20)
Building age	0.008 (1.92)	0.022 (4.48)**
Class A	-0.053 (-2.02)*	0.158 (5.42)**
Class B	0.022 (0.98)	0.111 (4.39)**
Walkscore	-0.004 (-2.44)*	-0.006 (-3.07)**
Elevators	0.035 (1.92)	0.236 (11.04)**
Wired_PLT	-0.040 (-2.41)*	0.017 (0.92)
Wired_GLD	-0.004 (-0.28)	-0.002 (-0.13)
Wired_SLV	-0.099 (-4.45)**	-0.060 (-2.38)*
Wired_CRT	0.103 (2.04)*	0.120 (2.12)*
NumFloor	0.045 (0.50)	0.050 (0.49)
NumFloor^2	-0.007 (-0.51)	-0.009 (-0.57)
Atrium	-0.016 (-1.25)	0.049 (3.45)**
Court yard	0.048 (2.71)**	0.082 (4.13)**
Bank	0.047 (4.63)**	0.043 (3.79)**
24 hour	0.026 (2.53)*	-0.004 (-0.39)
Concierge	-0.000 (-0.03)	-0.007 (-0.70)
Controlled access	0.024 (1.52)	0.053 (3.03)**
Conference	-0.013 (-1.02)	-0.005 (-0.33)
Convenience store	0.027 (1.63)	0.025 (1.35)
Day care	0.027 (0.65)	0.006 (0.13)
Food court	-0.094 (-2.65)**	0.068 (1.72)
Food service	-0.015 (-1.26)	-0.008 (-0.59)
Kitchen	-0.069 (-2.03)*	-0.034 (-0.88)
Restaurant	0.043 (4.36)**	0.039 (3.55)**
Dry cleaner	-0.012 (-0.50)	0.014 (0.52)
Pool	0.171 (2.55)*	0.084 (1.12)
Mail	-0.014 (-0.73)	-0.030 (-1.43)
Mall	0.003 (0.06)	-0.037 (-0.80)
Site management	0.016 (1.79)	0.028 (2.74)**
Security system	-0.003 (-0.31)	-0.014 (-1.20)
NAICS dummies	Yes	Yes
Year dummies	Yes	Yes
Submarket dummies	Yes	Yes
Sample size	6931	6931
Adjusted R^2	23.82%	36.65%

Note: *t*-statistics are in parentheses. ** significant at the 1% level. * significant at the 5% level.

Table 8: Environmental Performance Regression Results of Sales Data

The following table presents OLS regression results for the sales data. The dependent variable is the natural logarithm of site EUI or unit GHG. The sample period is from 2012 to 2017. *t*-stats are in parentheses.

	Log (Site EUI)	Log(Greenhouse Gas Emissions)
Intercept	-10.457 (-0.91)	19.093 (1.69)
LEED_PLT	-0.264 (-2.02)*	-0.322 (-2.49)*
LEED_GLD	-0.131 (-1.90)	-0.042 (-0.61)
LEED_SLV	0.020 (0.21)	0.078 (0.84)
LEED_CRT	-0.127 (-0.74)	0.007 (0.04)
Energy Star	-0.213 (-3.60)**	-0.159 (-2.73)**
Degree days	0.002 (1.16)	-0.003 (-1.37)
Size	-0.214 (-2.53)*	-0.266 (-3.19)**
Site area	0.186 (2.53)*	0.135 (1.80)
Building age	-0.017 (-0.79)	0.004 (0.21)
Class A	0.207 (1.91)	0.236 (2.21)*
Class B	0.168 (1.83)	0.106 (1.17)
Walkscore	0.001 (0.13)	-0.008 (-1.01)
Elevators	0.117 (1.60)	0.292 (4.06)**
Wired_PLT	0.132 (1.34)	0.100 (1.02)
Wired_GLD	0.064 (0.75)	0.037 (0.44)
Wired_SLV	-0.127 (-1.27)	-0.164 (-1.66)
Wired_CRT	-0.524 (-2.20)*	-0.591 (-2.51)*
NumFloor	1.038 (3.39)**	0.871 (2.89)**
$NumFloor^2$	-0.154 (-3.03)**	-0.156 (-3.10)**
Atrium	0.030 (0.45)	0.104 (1.59)
Court yard	-0.017 (-0.19)	0.084 (0.92)
Bank	0.022 (0.39)	-0.001 (-0.02)
24 hour	-0.027 (-0.48)	0.030 (0.55)
Concierge	-0.045 (-0.78)	0.040 (0.71)
Controlled access	-0.061 (-0.82)	-0.110 (-1.49)
Conference	0.054 (0.75)	0.121 (1.70)
Convenience store	-0.061 (-0.62)	-0.101 (-1.04)
Day care	-0.239 (-1.31)	-0.090 (-0.52)
Food court	0.087 (0.65)	-0.269 (-2.03)*
Food service	-0.034 (-0.54)	-0.094 (-1.52)
Kitchen	-0.200 (-0.82)	0.144 (0.60)
Restaurant	0.149 (2.69)**	0.115 (2.10)*
Dry cleaner	0.043 (0.33)	0.052 (0.40)
Pool	0.269 (0.54)	0.413 (0.84)
Mail	-0.038 (-0.37)	-0.028 (-0.28)
Mall	0.419 (1.16)	-0.250 (-0.70)
Site management	-0.068 (-1.35)	-0.060 (-1.21)
Security system	0.014 (0.23)	0.038 (0.64)
Year dummies	Yes	Yes
Submarket dummies	Yes	Yes
Sample size	544	544
Adjusted R^2	24.44%	55.12%

Note: *t*-statistics are in parentheses. ** significant at the 1% level. * significant at the 5% level.

Appendix

A.1 Comparison with Sale Transactions in Eichholtz et al (2010)

In this section of the paper, we attempt to replicate the sales transactions in Table 3 but not the rent transactions in Table 1 or Table 2 in Eichholtz et al (2010) to provide readers with a comparison benchmark. However, we do NOT replicate the rent transactions in either Table 1 or Table 2 since our rental sample is based on individual lease transactions whereas Eichholtz et al (2010) use property-level rental data e.g., the entire building is treated as if it was rented to a single tenant. Several reasons exist why the results from our replication of their Table 3 are not directly comparable to their findings. For one, our 2012 to 2017 sample period does not overlap the 2004 to 2007 sample period of Eichholtz et al. (2010). Besides this, our sample of comparable buildings are buildings used for energy benchmarking purposes and are thus analogous to unbranded "generic" green buildings. In contrast to this, the comparable buildings in the EKQ study are non-green buildings.

Given these differences, it is not surprising neither the green rating per se or the LEED certification is statistically significant in Table A1 of our study compared to Table 3 in EQK. In other words, there is no incremental value to having a branded green label e.g., having LEED or Energy Star certification. Although the Energy Star certification is initially statistically significant in column 2, once age variables are added in column 2A, the Energy Star coefficient is not longer signficant. The latter result is consistent with Kok et al (2011) who show that in more recent years, the price premium of Energy Star rated buildings has been disappearing. Besides this, we find that there is an age discount which is decreasing and monotonic whereas in EKQ, prices increase with the age of the building which is counter-intuitive. Table A1 also shows that LEED buildings tend to be newer buildings. Similar to the intercepts in EQK, our intercepts associated with various model specifications are very similar to theirs although our adjusted R-squareds are higher. Similarly, employment growth is insignificant in both our results and those in Table 3 of EKQ.

Table A1: Hedonic Regression Results of the Natural Logarithm of Unit Sales Prices

The following table presents the Eichholtz et al. (2010) specification associated with Table 3 of their study on our transaction sample. The regression results for Office Sale Prices and Green Ratings for our 2012 to 2017 sample period is later than that of Eichholtz et al. (EKQ) (2010) whose sample period is from 2004 to 2007. In addition to this, our sample of comparable buildings are buildings used for energy benchmarking purposes and are thus analogous to unbranded "generic" green buildings. In contrast to this, the comparable buildings in the EKQ study are non-green buildings.

	(1)	(2)	(2A)	(3)	(4)	(5)
Intercept	5.824 (17.37)**	5.842 (17.48)**	5.835 (17.71)**	5.823 (17.67)**	5.732 (16.91)**	5.731 (16.92)**
Green rating	0.033 (0.66)			0.017 (0.34)	0.034 (0.66)	
LEED		0.107 (2.02)*	0.065 (1.24)			
Energy Star		0.008 (0.16)	0.006 (0.12)			
Size (millions of sq. ft.)	-0.167 (0.33)	-0.231 (-0.45)	-0.074 (-0.15)	-0.024 (-0.05)	0.168 (0.30)	0.212 (0.39)
Class A	0.514 (5.45)**	0.481 (5.06)**	0.432 (4.49)**	0.450 (4.71)**	0.489 (4.97)**	0.496 (5.07)**
Class B	0.258 (3.10)**	0.252 (3.03)**	0.243 (2.96)**	0.246 (3.00)**	0.276 (3.33)**	0.278 (3.36)**
Employment growth	-0.049 (-0.85)	-0.042 (-0.73)	-0.017 (-0.31)	-0.020 (-0.36)	0.001 (0.02)	0.001 (0.02)
Age < 10 years			0.426 (3.49)**	0.452 (3.75)**	0.336 (2.62)**	0.349 (2.76)**
Age 10-20 years			0.272 (2.58)**	0.289 (2.75)**	0.246 (2.28)*	0.255 (2.38)*
Age 20-30 years			0.187 (2.36)*	0.194 (2.44)*	0.154 (1.88)	0.159 (1.95)
Age 30-40 years			-0.028 (-0.43)	-0.027 (-0.40)	-0.026 (-0.38)	-0.021 (-0.31)
Renovated			0.043 (0.88)	0.048 (0.97)	0.051 (1.01)	0.055 (1.10)
Stories: high					-0.080 (-0.94)	-0.073 (-0.87)
Stories: intermediate					-0.083 (-1.37)	-0.077 (-1.29)
Amenity dummies	No	No	No	No	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Submarket dummies	Yes	Yes	Yes	Yes	Yes	Yes
Sample size	544	544	544	544	544	544
Adjusted R^2	51.46%	51.80%	53.39%	53.33%	54.06%	54.12%

Note: Following Eichholtz et al., building size is in millions of sq. ft., and no natural logarithm is taken. Employment growth rates in percentages in the year before the transaction date are from the Bureau of Labor Statistics. A building with greater than 20 stories (greater than 10 stories but no more than 20 stories) is defined as a tall (intermediate) building. *Green rating* takes the value one if the building is either certified by LEED or Energy Star. *t*-statistics are in parentheses. ** significant at the 1% level. * significant at the 5% level.