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Green Certification and Building Performance: *Implications for Tangibles and Intangibles*

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Buildings are a critical component in modern society—the majority of U.S. gross domestic product (GDP) is generated through service sector work in office buildings (84% of all U.S. jobs and 82% of U.S. GDP)[1] and manufacturing in industrial facilities. Income is spent in shopping malls and retail facilities, and the shift to online shopping is leading to more activity in logistical warehouse space. The pivotal role of real estate is reflected in its relative share of national energy consumption, which is up to 81% of total electricity consumption in Europe and North America and almost 40% of overall energy consumption in both continents.[2] With that, the real estate sector is a leading contributor to greenhouse gas emissions, which are an intrinsic part of energy generation from fossil fuels (in 2013, fossil fuels represented 82% of total U.S. energy consumption and 74% of European energy consumption).[3]

For tenants and occupants of investor- or corporate-owned properties, attention to energy consumption in buildings has become increasingly important. Corporate carbon footprints are measured, benchmarked, and publicized through such tools as the Carbon Disclosure Project (CDP), Dow Jones Sustainability Index (DJSI), and other measurement schemes and rankings. Buildings thus represent a tangible and important part of a firm's corporate social responsibility profile and strategy, and some tenants may desire, or even require, certain levels of sustainability. Therefore, building owners, investors, and managers may be affected by the choices they make on investments in energy and sustainability issues—both at the development stage and throughout the building's economic life.

Academic evidence on the financial implications of energy efficiency and sustainability in buildings has increased in recent years. The results of these studies are remarkably consistent: commercial office buildings with labels that attest to higher levels of energy efficiency or sustainability are typically found to have slightly higher rents, higher occupancy rates, and higher sales prices (see Eichholtz, Kok, and Quigley [2013]; Fuerst and McAllister [2009]). Such findings are corroborated for the multifamily and single-family housing market (see Kahn and Kok [2014]; Bond and Devine [2015]). Additionally, recent studies on energy efficiency and default risk have documented a negative correlation between ENERGY STAR for homes and single-family mortgage delinquency (Kaza, Quercia, and Tian [2014]) and between ENERGY STAR and LEED for commercial buildings and commercial mortgage default (An and Pivo [2015]). There are some concerns, however, about the research's shortcomings: these studies are mostly based on cross-sectional studies of the U.S. market, where results may be due to an omitted variable bias, or inability to control for building characteristics that are correlated with green building certification; most studies use data on self-reported asking rents from commercial databases such as CoStar, which may be inconsistent with achieved rent and exclude incentives such as rent-free periods; and the existing literature provides limited insight into the implications of energy efficiency and sustainability labels on less tangible, more indirect determinants of building performance, such as tenant satisfaction, service calls, and energy consumption.

This study resolves some of the shortcomings of the existing literature on the effects of "green" building certification on the performance of commercial real estate assets. Using a longitudinal, proprietary dataset that includes almost 300 properties across North America, we assess the relationship between various proxies for green building, including ENERGY STAR, LEED, and BOMA BESt, and both financial and nonfinancial outcomes. The dataset covers the 2004–2013 time period, including the boom, bust, and subsequent recovery of the North American real estate market. The nonfinancial performance measures include tenant satisfaction (gleaned from detailed tenant surveys), lease renewal rates, and resource consumption data.

The results of the analysis provide important new insight into the implications of energy and sustainability certification on the operation and performance of institutionally owned commercial real estate assets. Descriptive, nonparametric comparisons show clear differences between the average levels of tenant satisfaction for "green" and "conventional" buildings, reflected in survey scores that are 4% higher for green buildings in general and, more specifically, 10% higher for LEED buildings and 20% higher for BOMA BESt buildings. We also measure the relationship between green building certification and more tangible, financial metrics of building performance. Using data on 12,667 leases, we find that achieved rents differ by 3%–4% for the U.S. sample, and occupancy rates differ by 4% (LEED) to 10% (ENERGY STAR). Results for Canada are consistent with the U.S. results for LEED certification: certified buildings achieve higher rents and have higher occupancy rates. Importantly, the detailed data for Canada allow us to estimate the effect of green building certification on the likelihood of lease renewal and rent concessions. The results show the likelihood of lease renewal is significantly higher in BOMA BESt and LEED-certified buildings, and that rent concessions lead to a reduction in the average rent of "just" 7%, as opposed to 11% for conventional buildings.

The findings in this article not only corroborate but also add to the literature on the value of environmental amenities in the commercial real estate sector. For real estate owners, it is important to understand and appreciate the implications of more efficient, certified green buildings on metrics other than rents and prices alone—more satisfied tenants that have fewer complaints. This leads to higher lease renewal rates, higher occupancy rates, lower rent concessions, and ultimately higher cash flows and valuations. Of course, as with every study, our study has shortcomings that center around a detailed but relatively small sample and a lack of "observables" on the buildings in our sample. More work needs to be done to understand the exact determinants of increased tenant satisfaction, but this article provides a first view on the broader effects of constructing and operating better buildings and its importance for owners and tenants alike.

DATA AND METHODS

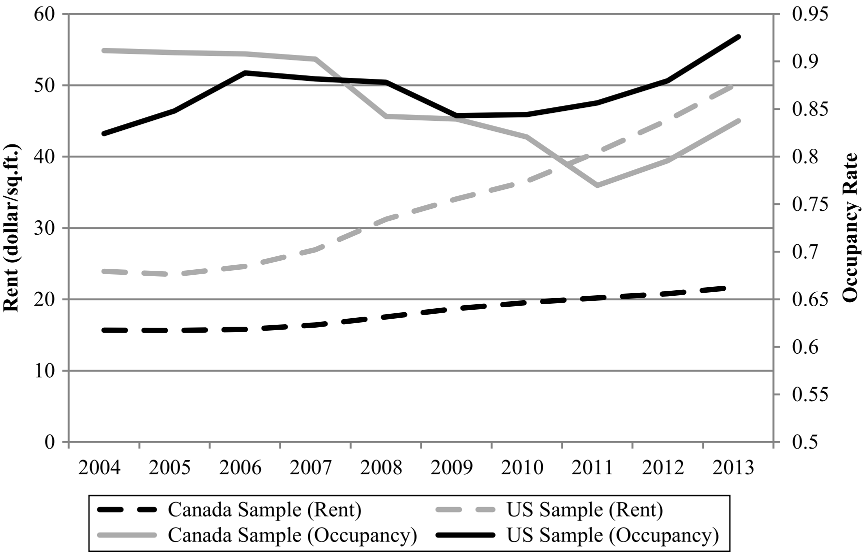
Data

The novel feature of this study is our ability to examine a set of commercial buildings across both Canada and the United States, and to do so with an unprecedented level of detail. The dataset consists of commercial office buildings managed by Bentall Kennedy, one of North America's largest real estate investment advisory and services firms. We included all buildings in operation as of January 1, 2014, with data collected on or aggregated to a monthly basis (or the most granular frequency greater than monthly) for the 10-year period covering 2004–2013. The final dataset includes 148 buildings in Canada and 143 buildings in the U.S., representing 24 million and 34 million square feet of office space, respectively. Although there is a bicoastal concentration, buildings are also situated in the midwest United States and in some Canadian prairie provinces.[4]

Rental data. The rent data are based on recurring billing files, with proprietary data on historical lease contracts available monthly for each unit in each building. Data include information on start and end date (or suspend date, if applicable), unit size, rental rate, and information on rent-free periods ("rental assistance," "rent credits," or "free rents") or tenant improvement allowances. The achieved rent is the net cash flow obtained by the landlord,

EXHIBIT 1

Rental and Occupancy Trends, 2004–2013



after adjusting for incentives and tenant improvements. Exhibit 1 highlights the average rental rate (in the local currency, left-hand axis) and the average occupancy rate (right-hand axis), for Canada and the United States. Over the 10-year period, Canadian average rental rates increased by 28% (in nominal terms) while U.S. average rental rates increased by 52%. On average, assets in both countries experienced a decrease in their occupancy rates in the crisis (from 91% to 76% in Canada; from 89% to 84% in the U.S.), but the last years of the sample show a significant rebound in occupancy rates.

Tenant satisfaction surveys. Biannual tenant-level survey data are collected in a standard form and aggregated into property-level data. This information is available for Canadian properties only, and due to limitations in matching the survey data to leases, the building average satisfaction scores are based on an equal-weighted methodology, in which each survey carries the same weight in determining the average score for the building regardless of the amount of space leased in that building.

Exhibit 2 compares tenant satisfaction in two sustainability and energy efficiency-related categories: HVAC and Recycling. Panel A, examining HVAC-related tenant survey questions, indicates that tenants in noncertified buildings are almost always less satisfied with the HVAC system performance, while tenants in LEED Core and Shell buildings are among the most satisfied. The Recycling results in Panel B are less likely to be affected by biasing features (because building age, class, etc., are unlikely to impact recycling programs), and satisfaction ratings are fairly consistent and high across the certified building categories. Non-certified buildings returned the lowest level of tenant satisfaction regarding recycling initiatives in every subcategory. Because the degree of recycling program offered is a choice of the building management, this provides some indication of the operational difference experienced between certified and noncertified buildings and the direct impact that can have on tenant satisfaction.

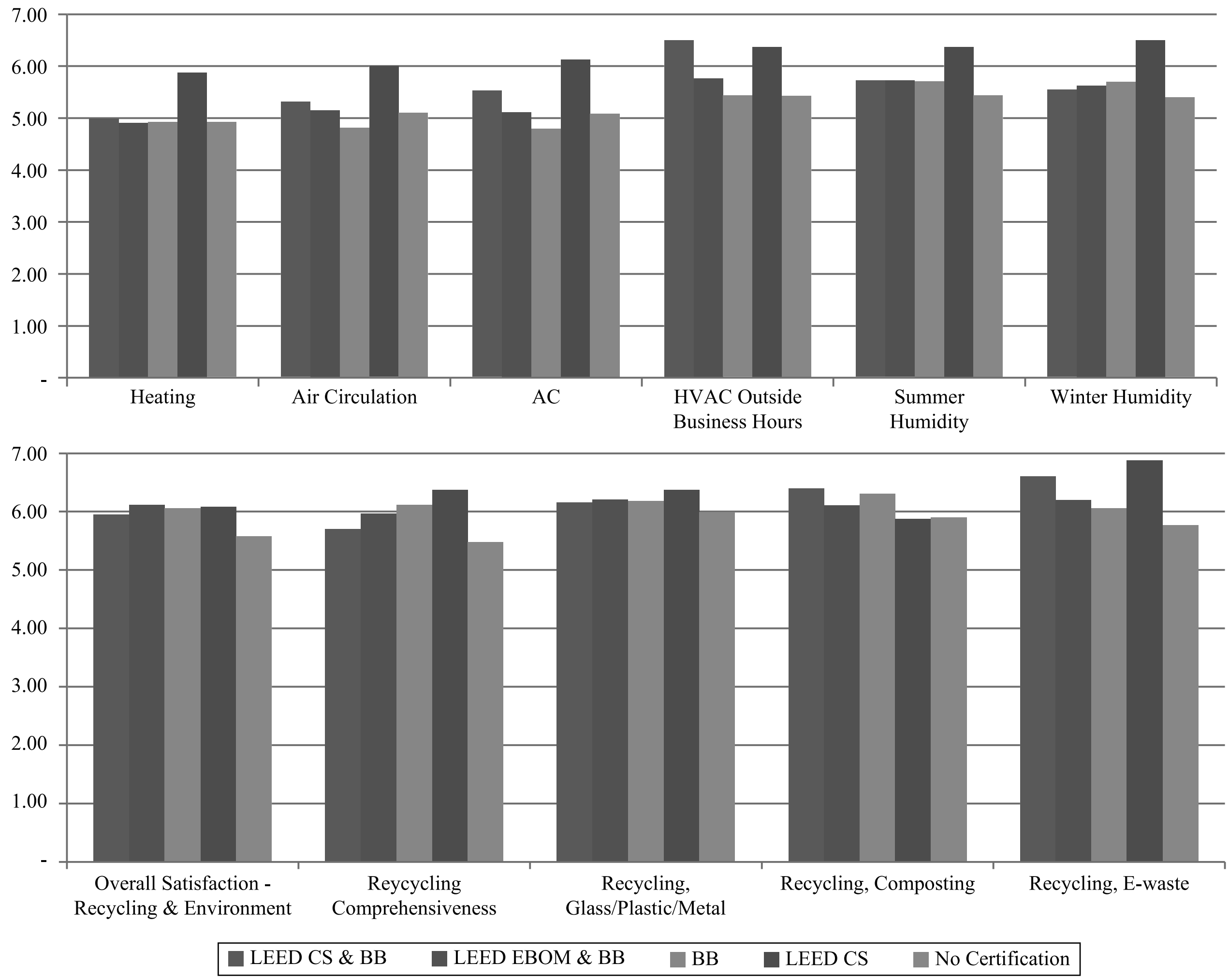
Utilities. Building-level monthly water and power usage data are available on 132 of the Canadian sample buildings, beginning as early as 2004 for approximately 30% of the buildings. Similar data collection on U.S. properties did not begin until 2009, and data are available for 62 properties only. Water data measure the cubic meters (m^3) of potable water consumed by a building each month. (This is the water used for plumbing purposes, not for power generation.) Energy data are measured in British thermal units (BTUs) and capture the total energy consumption of a building from all utility sources providing energy to operate the property. Sources of power include electricity, natural gas, steam, and chilled water.[5] Consumption comparisons across green certified buildings and conventional buildings in Canada and the United States highlight notably lower power usage of LEED Core and Shell buildings and decreased water usage by all types of Canadian certified buildings.[6]

Green certification. To assess the efficiency and sustainability credentials of individual assets, building-level certifications provided by the LEED, BOMA BESt, and ENERGY STAR programs are tracked, as are the specific certification programs pursued, the level of certification achieved, and any periods of certification lapse.

BOMA (the Building Owners and Managers Association) launched their Building Environmental Standards (BESt) in 2005 to measure the energy and environmental performance of existing buildings. The

Exhibit 2

Tenant Satisfaction Survey Outcomes



Note: For a color version of this exhibit, please visit The Journal of Portfolio Management *website at www.iijournals.com/jpm.*

program has since been fine-tuned to address new construction, existing building, and homes, and includes specialized certification specifications for office buildings and other property types. Certification is valid for a three-year period, renewable at any time.[7]

The U.S. Environmental Protection Agency (EPA) created the ENERGY STAR certification program in the early 1990s. Qualification for the certification label is achieved by operating more efficiently than standard building codes require.[8]

The U.S. Green Building Council (USGBC) developed the Leadership in Energy and Environmental Design (LEED) program in 1998 to provide a framework for measurable green building design, construction, operations, and maintenance concepts. With the exception of the Existing Buildings: Operations and Management (EBOM) program, all other certifications are determined based on design during the original development phase and last forever once granted. The EBOM certification is effective for a period of five years.[9]

Methods

Our empirical approach utilizes the standard real estate valuation framework in the form of a hedonic pricing model (Rosen [1974]). To separate the effects of green certification from confounding factors such as size, age, building quality, and location, we use a semi-log equation relating the rent per square foot (and subsequently the occupancy rate or other measures of performance, such as tenant satisfaction scores) to the observable characteristics and location of each building.

$$\log R_{ijtn} = \alpha + \sum_{h=1}^{H} \beta_h X_{ih} + \sum_{n=1}^{N} \gamma_{nt} C_{in} + \delta G_i + \varepsilon_i \quad (1)$$

In Equation (1), $\log R_{ijt}$ is the logarithm of the rent of unit j in building i at time t in geographical market n. X_{ih} is a vector of hedonic characteristic h (e.g., size, age, quality) of building i. To precisely control for the influence of location on the rent of the unit in a building, each geographic market n is an indicator variable taking the value of 1 if building i is located in market n and zero otherwise. We control for general time trends in each market by including year-quarter dummies interacted with each market—average rental levels can thus vary per quarter per market. G_i, the main variable of interest in our model, is an indicator variable taking the value of 1 when building i is certified by LEED, BOMA BESt, or ENERGY STAR and zero otherwise. The variables α, β_h, γ_{nt}, and δ are estimated coefficients; ε_i is an error term.

The term δ is thus the average premium, in percentage, estimated for a labeled building relative to those observationally similar buildings in its geographic market. Standard errors are clustered at the market level to control for spatial autocorrelation in rents and occupancy rates within that market. In a second set of estimates, we include additional terms in Equation (1), further splitting out the green indicator by the underlying attributes, such as labeling level, efficiency score, etc.

Given the substantial differences in how U.S. and Canadian properties are tracked and managed, as well as differences in the available types of data relating to the properties, the Canadian and U.S. property portfolios are evaluated separately. It is also important to note that the information on the labeled buildings in our sample is limited to observable characteristics, such as age and size. We do not have information on construction costs, quality of building management, and the presence of valuable attributes that are correlated with green building certification. For example, we cannot control for the possibility that some developers choose to systematically bundle green attributes with other amenities, such as more valuable appliances or a higher-quality finishing. We assume that such unobservables are not systematically correlated with green labels. Otherwise, we would overestimate the effects of green labels on office rents and occupancy rates.

To estimate the impact of green building certification on the likelihood of lease renewal, we estimate the following equation:

$$\Pr\,(Renewal_{ijt}) = (X_i, L_j, G_i, C_{nt}) \qquad (2)$$

where $\Pr(Renewal_{ijt})$ is a binary variable that is 1 if a lease is renewed and otherwise zero. This variable is a function of building characteristics X_i, lease characteristics L_j, and time-varying neighborhood effects C_{nt}. Again, G_i is the main variable of interest in our model and is an indicator variable taking the value of 1 when building i is certified by LEED, BOMA BESt, or ENERGY STAR and zero otherwise. This analysis is estimated using a probit model—this means that the coefficients cannot be interpreted in the same manner as a regular ordinary least squares (OLS) regression but rather as marginal effects.

RESULTS

Tangibles: Rents

Exhibit 3 presents estimates of Equation (1), based on achieved rents per square foot for each lease in each unit. We report results for all coefficients, except for the district-time effects and building characteristics (including building class, age, renovation, building size, and building height).[10] In the set of Canadian results (Columns 1–3), we also include fixed effects for the parent company (or ultimate owner) of each property, to control for the fact that owner identity may influence both the likelihood of green certification adoption and rental levels. The models explain about half of the variation in rents per square foot, based on a large sample of 236,000 quarterly observations.

The results provide some evidence on the features determining rental rates.[11] Larger buildings receive higher rates—doubling building size increases rents by about 8%. Class A and B buildings receive higher rates than Class C buildings (the baseline), by 9% and 10%, respectively. Older buildings achieve lower rents, although the relationship is nonlinear. Throughout the regressions models, a higher Walk Score also leads to higher rental rates, with a one-point increase in the Walk Score leading to a 1.2% increase in rents for the Canadian assets in the sample.

EXHIBIT 3

Green Ratings and Rents per Square Foot, 2008–2013

	Canada			United States		
	(1)	(2)	(3)	(4)	(5)	(6)
Unit Size	–0.052***	–0.052***	–0.052***	–0.041***	–0.041***	–0.041***
(Leasable Area, in logs)	[0.001]	[0.001]	[0.001]	[0.002]	[0.002]	[0.002]
Building in ClikFIX	0.311***	0.315***	0.312***			
(1 = yes)	[0.014]	[0.014]	[0.014]			
Rent-Free Dummy	–0.097***	–0.110***	–0.110***			
(1 = yes)	[0.002]	[0.002]	[0.002]			
Walk Score	0.012***	0.012***	0.012***	0.004***	0.004***	0.003***
(in logs)	[0.002]	[0.002]	[0.002]	[0.000]	[0.000]	[0.000]
Downtown				0.345***	0.340***	0.343***
(1 = yes)				[0.011]	[0.011]	[0.011]
LEED Certified	0.102***	0.175***		0.037***		
(1 = yes)	[0.009]	[0.005]		[0.009]		
BOMA Certified	–0.012***	–0.013***				
(1 = yes)	[0.002]	[0.002]				
LEED & BOMA Certified	0.094***					
(1 = yes)	[0.010]					
Rent-Free Dummy*Green Certified		0.040***	0.039***			
(1 = yes for both)		[0.004]	[0.004]			
ENERGY STAR Certified					0.027***	0.013
(1 = yes)					[0.008]	[0.008]
LEED Core & Shell			0.153***			0.140***
(1 = yes)			[0.010]			[0.020]
LEED for Existing Buildings			0.181***			0.019**
(1 = yes)			[0.006]			[0.010]
BOMA Level 1			–0.005			
(1 = yes)			[0.003]			
BOMA Level 2			–0.021***			
(1 = yes)			[0.003]			
BOMA Level 3			–0.005			
(1 = yes			[0.003]			
Constant	1.779***	1.772***	1.780***	2.470***	2.455***	2.474***
	[0.028]	[0.028]	[0.028]	[0.046]	[0.046]	[0.046]
Building Characteristic Controls	Yes	Yes	Yes	Yes	Yes	Yes
District or MSA-Time-Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Parent-Company Controls	Yes	Yes	Yes	No	No	No
Operator-Fixed Effects	No	No	No	Yes	Yes	Yes
N	235,994	235,994	235,994	88,743	88,743	88,743
R^2	0.489	0.489	0.489	0.340	0.340	0.341
Adj. R^2	0.486	0.486	0.486	0.323	0.323	0.324

*Notes: Building Characteristic Controls include Building Class (A, B, or C), Age and Age^2, Renovation, Building Height (High Rise and Mid Rise), and Building Size (natural log of Gross Leasable Area). ClikFIX is a tenant service request call management system. Standard errors are shown in brackets. Significance at the 0.10, 0.05, and 0.01 levels are indicated by *, **, and ***, respectively.*

Importantly, Column 1 presents the impact of LEED or BOMA BESt certification. LEED certification alone results in a 10.2% premium.[12] This premium is mirrored in properties that have both certifications (9.4%), however, "BOMA BESt only" results are quite small (1.2%) and negative.

Column 2 is a variation of Column 1, with the addition of a control variable that captures the impact of certification on leasing concessions. The "Rent-Free Dummy*Green Certified" indicates that when a building is certified but also offering rent concessions, those concessions are decreased by 4%. This amount can be netted against the Rent-Free Dummy result, indicating that if a building is offering rent concessions, the rental rates are 11% lower, but if it is certified and offering concessions, the rent is only 7% lower (11% minus 4%). This is a notable finding, indicating that green certification can provide greater stability to a building's operations.

The last column of results for Canada, Column 3, breaks out the certification programs by type. These results mirror those in the first two columns, indicating that there is not one particular certification subprogram or level that is affecting the results.

Exhibit 3, Columns 4–6, present a similar analysis for the U.S. properties, based on Equation (1). Some of the control variables are managed in a different way, due to differences in the data and various property management firms used in the United States. Instead of controlling for ClikFIX (ClikFIX is a tenant service request call management system—the system is not used in the United States part of the portfolio), controls are included for the two building operators that manage at least 5% of the sample buildings.[13] Additionally, due to the availability of data, controls have been included for substantial renovations, high-rise, and mid-rise buildings, and control for rent-free periods has been omitted. Higher-quality buildings, located downtown, with higher Walk Scores, command higher rents. Age is again negatively related to building rents.

Our prime interest is in the variables indicating green certification. The results indicate a 3.7% and 2.7% premium for rental rates in LEED- and ENERGY STAR-certified buildings, respectively. These results (documented in Columns 4 and 5) are statistically strong and mirror the results found in other research on green-certified office buildings in the United States (see Eichholtz, Kok, and Quigley [2010, 2013]). Additionally, Column 6 indicates that the largest premium is associated with LEED Core and Shell certifications (14%). It should be noted that when all programs are considered together in Column 6, the strength and magnitude of the ENERGY STAR rent premium decrease, while the LEED premiums largely persist, indicating the LEED effect on rent may be "overshadowing" the ENERGY STAR effect.

Tangibles: Occupancy Rates

We then estimate Equation (1) with the occupancy rate as the dependent variable and again a large set of variables explain its variation. These control variables are omitted from Exhibit 4 due to space constraints (available upon request), but the coefficients are in line with expectations. Column 1 of Panel A indicates that, in the Canadian sample, LEED certification results in an 8.5% increase in the occupancy rate, with BOMA BESt indicating a negligible and statistically insignificant result. Column 2 adds the control for buildings with both certification programs, with results indicating that having both certifications is related to an 18.7% increase in the occupancy rate. As before, the BOMA BESt coefficient is uninformative, and the LEED coefficient should be interpreted with caution, as it represents three build-

EXHIBIT 4

Green Ratings and Occupancy Rates, 2008–2013

	(1)	(2)	(3)
A. Canada			
LEED Certified	0.085***	–0.009	
(1 = yes)	[0.019]	[0.026]	
BOMA Certified	0.007	–0.015	
(1 = yes)	[0.012]	[0.013]	
LEED & BOMA Certified		0.187***	
(1 = yes)		[0.035]	
LEED Core & Shell			0.080***
(1 = yes)			[0.020]
LEED for Existing Buildings			0.152**
(1 = yes)			[0.070]
BOMA Level 1			–0.078***
(1 = yes)			[0.026]
BOMA Level 2			0.015
(1 = yes)			[0.015]
BOMA Level 3			0.044***
(1 = yes)			[0.015]
Constant	–0.566***	–0.575***	–0.521***
	[0.090]	[0.089]	[0.091]
Building Characteristic Controls	Yes	Yes	Yes
CSA-Time-Fixed Effects	Yes	Yes	Yes
Parent-Company Controls	Yes	Yes	Yes
N	5,130	5,130	5,130
R^2	0.456	0.460	0.459
Adj. R^2	0.319	0.323	0.321
B. United States			
LEED Certified	0.040***		
(1 = yes)	[0.010]		
ENERGY STAR Certified		0.095***	0.092***
(1 = yes)		[0.009]	[0.009]
LEED Core & Shell			0.056***
(1 = yes)			[0.017]
LEED for Existing Buildings			0.017
(1 = yes)			[0.011]
Constant	1.496***	1.517***	1.523***
	[0.055]	[0.055]	[0.055]
Building Characteristic Controls	Yes	Yes	Yes
MSA-Time-Fixed Effects	Yes	Yes	Yes
N	6,854	6,854	6,854
R^2	0.422	0.434	0.436
Adj. R^2	0.162	0.180	0.181

*Notes: Building Characteristic Controls include Building Class (A, B or C), Age and Age^2, Building Size (natural log of Gross Leasable Area) and Walk Score (in logs). Standard errors are in brackets. Significance at the 0.10, 0.05, and 0.01 levels are indicated by *, **, and *** respectively.*

ings only. Last, Column 3 examines the impact of the different certification program levels and types. Strong improvement in the occupancy rate is observed for both types of LEED certified buildings and for BOMA BESt Level 3. As with prior results, these findings support the stability of certified buildings, indicating that LEED and BOMA BESt Level 3 buildings have notably higher occupancy rates.

Exhibit 4, Panel B, indicates that, in the U.S. sample, occupancy rates are 4% and 9.5% higher for LEED- and ENERGY STAR-certified buildings, respectively (Columns 1 and 2). Column 3 confirms that each program is associated with occupancy rate premiums, with the largest related to ENERGY STAR certification. Even though the sample exploited in this study is significantly smaller than samples employed in previous studies on green buildings and financial performance, the results are strikingly similar (Eichholtz, Kok, and Quigley [2010, 2013]).

Intangibles: Likelihood of Lease Renewal

We estimate Equation (2) as presented on page 5, to study the impact of green building certification on the likelihood of lease renewal for each of the leases in our Canada sample. For each year, all leases that are eligible for renewal are observed. If the lease was renewed, the value is 1; if it was not, the value is zero. Exhibit 5 captures the impact of building features on the probability that a lease will be renewed. We cannot directly interpret the value of these coefficients, but we can interpret the sign and statistical strength of the coefficients. In addition to the listed explanatory variables, controls are used for district (city and downtown/suburban) and time (yearly) fixed effects.

Some interesting results can be observed for the control variables (see Column 1). First, "Unit Size" indicates that the larger the unit, the greater the likelihood that the lease will be renewed (not surprising, given the effort to move a large firm). Second, the longer the length of the preceding lease, the less likely the lease is to be renewed. However, the size of that impact, while consistent, is quite small.

Column 2 indicates that both LEED and BOMA BESt certification lead to an increased probability of lease renewal. Although the LEED coefficient is not statistically significant, the BOMA BESt coefficient is, indicating a positive relationship between lease renewal and green certification. The BOMA BESt result in Column 2 can be interpreted as a 3.4% marginal increase in the likelihood of lease renewal over the likelihood of renewal in a comparable, noncertified building. Column 3 adds the group for buildings with both certifications, and while the coefficient on that is not as expected, the BOMA BESt loading retains its strong statistical strength, sign, and marginal impact. For LEED-certified buildings, the effect is about zero (0.502 minus 0.508). Last, Column 4 breaks down the certification programs into sub-schemes. The results indicate the greatest added probability of lease renewal for the BOMA BESt Level 2 and 3 properties. These two categories exhibit marginal increases in the likelihood of lease renewal of 2.1% and 5.6%, respectively. Insufficient data are available to control for BOMA BESt Level 4. Results are quite strong for LEED Core & Shell, but the number of buildings with such certification is quite small and a full cycle of lease renewal information is not yet achieved during the period of this study.

The results presented in Exhibit 5 are the first in the literature to investigate the impact of green building certification on lease renewal propensity, or "stickiness," of tenancy. The evidence suggests that BOMA BESt certification results in more instances of lease renewal. This increases a building's stability by limiting added re-leasing costs, both in terms of broker commissions and new tenant buildout and by limiting the landlord's exposure to periods of higher vacancy and expense carry.

Intangibles: Tenant Satisfaction Scores

We then explore the impact of building features on tenant satisfaction scores. As a reminder, these data are only available for the Canadian sample. The dependent variable is based on the 2012 responses to the "overall, how satisfied are you…" question in the tenant surveys. Only 2012 data are used for this analysis, as it is the only year for which surveys were completed in LEED-certified buildings. Each observation is the building average score based on all available tenant responses.

Column 1, Exhibit 6, provides a baseline scenario, in which we observe the significant (and consistent) impact of building age: a one-year increase in building age is related to a 0.02-point decrease in tenant satisfaction (based on a response scale of 1–7, with 7 being the highest score, or most satisfied tenant). This result,

EXHIBIT 5
Green Ratings and the Likelihood of Lease Renewal

	(1)	(2)	(3)	(4)
Class A	0.222**	0.146	0.140	0.111
(1 = yes)	[0.089]	[0.107]	[0.107]	[0.108]
Class B	0.060	0.039	0.036	0.026
(1 = yes)	[0.082]	[0.102]	[0.102]	[0.102]
Building Size	–0.042	0.025	0.024	0.038
(Gross Leasable Area, in logs)	[0.033]	[0.025]	[0.025]	[0.025]
Unit Size	0.085***	0.086***	0.087***	0.084***
(Leasable Area, in logs)	[0.013]	[0.013]	[0.013]	[0.013]
Building Age	–0.009**	–0.009**	–0.009**	–0.009**
(in years)	[0.004]	[0.004]	[0.004]	[0.004]
Building Age^2	0.000*	0.000**	0.000**	0.000**
(in years)	[0.000]	[0.000]	[0.000]	[0.000]
Walk Score	–0.134***	–0.044	–0.042	–0.047
(in logs)	[0.046]	[0.041]	[0.041]	[0.041]
Length of Preceding Lease	–0.002***	–0.003***	–0.003***	–0.003***
(in months)	[0.001]	[0.001]	[0.001]	[0.001]
LEED Certified		0.059	0.502**	
(1 = yes)		[0.087]	[0.247]	
BOMA Certified		0.111***	0.124***	
(1 = yes)		[0.038]	[0.038]	
LEED & BOMA Certified			–0.508*	
(1 = yes)			[0.260]	
LEED Core & Shell				0.826**
(1 = yes)				[0.327]
LEED for Existing Buildings				–0.033
(1 = yes)				[0.092]
BOMA Level 1				0.068
(1 = yes)				[0.051]
BOMA Level 2				0.184***
(1 = yes		–0.905*		[0.050]
BOMA Level 3		[0.549]		0.106**
(1 = yes)		Yes		[0.051]
Constant	0.223	Yes	–0.926*	–1.064*
	[0.633]	10,448	[0.550]	[0.553]
District-Fixed Effects	Yes	821.58	Yes	Yes
Time-Fixed Effects	Yes	0.0684	Yes	Yes
N	10,448		10,448	10,448
Chi^2	811.23		826.12	832.16
Pseudo R^2	0.0676		0.0688	0.0693

*Notes: Results estimated through a probit model, using 2004–2013 data on Canada only. Standard errors are in brackets. Significance at the 0.10, 0.05, and 0.01 levels are indicated by *, **, and *** respectively.*

indicating that tenants are less satisfied in older buildings, is consistent and statistically strong across all models in the table.

Column 2 examines the impact of any green certification program on tenant satisfaction, and indicates a statistically strong 1/3-point increase in satisfaction for certified buildings over their noncertified counterparts—with an average score of 5.73 for noncertified buildings, satisfaction scores are higher, on average, by about 6%. Column 3 separately examines the impact of LEED and BOMA BESt certification, and while both return an approximate 1/3-point increase in satisfaction, only BOMA BESt's results are statistically significant. Last, Column 4 examines the different programs and levels, and while all programs return a "satisfaction premium," only the BOMA BESt categories provide statistically strong results. Additionally, the BOMA BESt Levels 3 and 4 results return a 0.48-point premium as compared with the 0.20 premium for BOMA BESt Levels 1 & 2, indicating that tenants in higher-performing BOMA BESt buildings are more satisfied than those in lower performing (but still certified) buildings.

Exhibit 6

Green Ratings and Tenant Satisfaction

	(1)	(2)	(3)	(4)
Building Size	0.079**	0.057	0.052	0.037
(Gross Leasable Area, in logs)	[0.037]	[0.036]	[0.036]	[0.037]
Building Age	–0.021***	–0.022***	–0.022***	–0.020***
(in years)	[0.006]	[0.006]	[0.006]	[0.006]
Building Age^2	0.000***	0.000***	0.000***	0.000**
(in years)	[0.000]	[0.000]	[0.000]	[0.000]
Green Certified		0.333***		
(1 = yes)		[0.068]		
LEED Certified			0.312	
(1 = yes)			[0.200]	
BOMA Certified			0.309***	
(1 = yes)			[0.070]	
LEED Core & Shell				0.240
(1 = yes)				[0.265]
LEED for Existing Buildings				0.212
(1 = yes)				[0.305]
BOMA Level 1/2				0.202**
(1 = yes)				[0.084]
BOMA Level 3/4				0.476***
(1 = yes				[0.101]
Constant	5.203***	5.382***	5.452***	5.598***
	[0.451]	[0.438]	[0.440]	[0.447]
CSA-Time-Fixed Effects	Yes	Yes	Yes	Yes
Parent-Company Controls	Yes	Yes	Yes	Yes
N	352	352	352	352
R^2	0.053	0.114	0.117	0.130
Adj. R^2	0.0447	0.104	0.104	0.113

*Notes: Analysis based on the Canada sample. Standard errors are shown in brackets. Significance at the 0.10, 0.05, and 0.01 levels are indicated by *, **, and *** respectively.*

Intangibles: Utility Consumption

The last part of the analysis examines the energy and water consumption for buildings in Canada (Exhibit 7, Panel A) and the United States (Exhibit 7, Panel B). These models all control for city and time fixed effects. Power consumption represents the total monthly energy used from all sources, converted into BTUs, and then scaled by square footage and by degree days.[14] Water consumption represents the liters used per square foot of gross leasable area. Although many of the aforementioned control variables are included in this analysis, only the variables of interest in results are reported to conserve space.[15] Canadian results indicate higher utility usage in larger, older, and more occupied buildings and decreased utility usage in ClikFIX buildings.[16] Additionally, in line with expectations, data centers prove to use much more power than an average building, with the presence of a datacenter increasing energy consumption by 200%.

Panel A, Column 1, of Exhibit 7 indicates that certified buildings use slightly more power than their noncertified counterparts. One explanation may be that newer buildings use and house more energy-centric technology. Also, higher people density in certified buildings may explain this finding. Breaking the result down into certification categories, Column 2 indicates that LEED Existing Buildings use notably less power, by about 28%, than their noncertified peers. Turning to the Canadian water consumption results, Column 3 indicates that BOMA BESt properties use less water and this is reinforced by Column 4's results.

The U.S. results (Panel B) indicate that renovated buildings use consistently less power and water. LEED-certified properties utilize 14% less power, on average, with LEED Core & Shell properties using significantly less power (Columns 1–3). Water consumption findings (Columns 4–6) are statistically insignificant for LEED-certified properties. However, ENERGY STAR properties use more power than the average

EXHIBIT 7

Green Ratings and Utility Consumption

Panel A: Canada Sample

	Energy Consumption (BTU/sq.ft./degree day)		Water Consumption (liter/sq.ft.)	
	(1)	(2)	(3)	(4)
LEED Certified	0.044		0.225	
(1 = yes)	[0.032]		[0.349]	
BOMA Certified	0.077***		–0.824***	
(1 = yes)	[0.021]		[0.233]	
LEED Core & Shell		0.091***		0.357
(1 = yes)		[0.034]		[0.369]
LEED for Existing Buildings		–0.277***		–1.527
(1 = yes)		[0.100]		[1.111]
BOMA Level 1/2		0.115***		–1.117***
(1 = yes)		[0.024]		[0.258]
BOMA Level 3/4		0.033		–0.433
(1 = yes)		[0.025]		[0.273]
Building Characteristic Controls				
City–Time Fixed Effects	Yes	Yes	Yes	Yes
N	3,921	3,921	3,955	3,955
R^2	0.905	0.906	0.580	0.581
Adj. R^2	0.880	0.881	0.472	0.473

Panel B: U.S. Sample

	Energy Consumption (BTU/sq.ft./degree day)			Water Consumption (liter/sq.ft.)		
	(1)	(2)	(3)	(4)	(5)	(6)
LEED Certified	–0.143***			0.087		
(1 = yes)	[0.054]			[0.088]		
ENERGY STAR Certified		0.258***	0.296***		–0.307***	–0.321***
(1 = yes)		[0.043]	[0.043]		[0.067]	[0.068]
LEED Core & Shell			–0.580***			0.194
(1 = yes)			[0.089]			[0.152]
LEED for Existing Buildings			–0.078			0.109
(1 = yes)			[0.055]			[0.090]
Building Characteristic Controls						
MSA-Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Operator-Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
N	1,789	1,789	1,789	1,850	1,850	1,850
R^2	0.839	0.843	0.849	0.733	0.737	0.738
Adj. R^2	0.743	0.750	0.758	0.561	0.568	0.569

*Notes: Building Characteristic Controls include Building Class (A, B, or C), Age and Age^2, Renovation, Building Size (natural log of Gross Leasable Area), Building Height (High Rise and Mid Rise), Occupancy Rate and Occupancy Rate^2, and Walk Score (in logs). Standard errors are shown in brackets. Significance at the 0.10, 0.05, and 0.01 levels are indicated by *, **, and *** respectively.*

building when looking at the consumption data (versus the attributed ENERGY STAR score, which was not incorporated in the study), but they use notably less water.

SUMMARY AND IMPLICATIONS

Understanding the implications of energy policy and the rise of voluntary green labeling schemes on the performance of the commercial real estate sector is important, given the large environmental externality imposed by the sector and the disconcerting fact that there seems to be a negative correlation between building vintage and building energy consumption (Kahn et al. [2014]). Although there is a growing body of evidence on the financial outcomes of green building certification, most of these studies are based on the same database, potentially suffering from systematically biased data. Additionally, not much is known outside of the commercial office sector in the U.S., and most focus has been on standard financial metrics, such as rents and prices.

This article adds to the literature on the implications of more efficient building construction with respect to the performance of these durable assets in the marketplace. Using a proprietary dataset of one of the largest building managers in North America, we investigate tangible and intangible building performance measures and their relationship with energy efficiency and sustainability certification.

The findings are interesting and important for real estate occupants, owners, and policy makers: besides confirming rental and occupancy differences between green and conventional buildings, we document significantly higher levels of tenant satisfaction, increased probability of lease renewals, and decreased tenant rent concessions for certified buildings. These results hold fairly constant across the Canadian and U.S. samples and are among the first to provide insight into the nonfinancial implications of constructing and adopting more sustainable space. Although results on green premiums have been widely documented, these findings help understand the value drivers, which clearly stem from more "sticky" tenants that appear to be more satisfied in green buildings than in conventional buildings.

The results for resource consumption and green building certification are less robust, but evidence indicates that buildings certified under operation-focused programs (LEED EBOM and BOMA BESt) do experience decreased utility usage. These findings imply that more research is needed on actual consumption outcomes of operating green buildings. Building codes and construction labels do not necessarily guarantee efficient operation or use by building occupants.

The benefits uncovered through this analysis carry significant income and value implications, which are relevant for the appraisal/valuation community. Although it can be difficult to measure the financial impact of improved tenant satisfaction, what can be measured are the financial impacts of the added building stability through a more satisfied tenant base. Decreased rent concessions allow for greater capture of rent, while decreased power and water usage leads to lower expenses— for both landlord and tenants. Additionally, the relationship between better-off tenants, higher re-leasing probability, and higher occupancy rates is clear, and all three relative improvements lead to a more stable rent roll and less costly building operations. Therefore, both the cost savings and the decreased variability of the building's operations and turnover should lead to higher value for more efficient, green buildings. In an efficient market, these findings will increasingly be reflected in choices and underwriting decisions made by real estate investors and lenders, further reinforcing the effects of building quality on building value, the first effects of which are already observable in the marketplace.

ENDNOTES

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[1]Bureau of Labor Statistics, Employment, Hours, and Earnings from the Current Employment Statistics survey (National): http://data.bls.gov/cgi-bin/surveymost?ce.

[2]See http://www.eia.gov/totalenergy/data/browser/xls.cfm?tbl=T02.01&freq=m and http://www.eia.gov/totalenergy/data/browser/xls.cfm?tbl=T02.01&freq=m.

[3]See U.S. Energy Information Administration, Monthly Energy Review, June 2015: http://www.eia.gov/beta/MER/index.cfm?tbl=T01.03#/?f=A&start=2013&end=2014&charted=1-2-3-5-12. See also, Eurogas, Statistical Report 2014: http://www.eurogas.org/uploads/media/Eurogas_Statistical_Report_2014.pdf.

[4]Summary statistics of the sample are available upon request.

[5]Chilled water is a renewable energy source found in buildings next to deep-water bodies, such as the Great Lakes. Lake cooling is a technology where cold water is drawn from the lake and used as a heat sink, most commonly to cool air. This process is highly energy efficient, using approximately one-tenth the energy needed to cool air through traditional methods.

[6]Graphic comparisons of water and power usage are suppressed but are available upon request.

[7]For more information, see http://www.bomabest.com/wp-content/uploads/BBEER-2014-Full-Report.pdf.

[8]For more information, see www.energystar.gov.

[9]For more information, see www.usgbc.org/leed.

[10]Walk Score measures "walkability" on a scale from 0 to 100, based on walking routes to destinations such as grocery stores, schools, parks, restaurants, and retail. The average

Walk Score for green-certified buildings is about 63, as compared with a 47 Walk Score for noncertified buildings.

[11]These results are suppressed to conserve space but are available upon request.

[12]The number of LEED-certified buildings is quite small in the Canada sample. In an alternative specification, we suppress LEED-certified buildings, due to the limited number of LEED-only certified buildings. This set of results is not reported but available upon request. Similar results are documented once all LEED-certified buildings (including those also certified under BOMA BESt) are removed from the samples.

[13]Results are omitted from the table due to confidentiality concerns. ClikFIX is a tenant service request call management system.

[14]Degree days are calculated based on temperature measurement at the weather station nearest to each building (matched by GIS), where degree days measure the difference between the average temperature on a given day and 18 degrees Celsius (65F).

[15]Full regression results tables are available upon request.

[16]Building management plays an important role in determining the operating performance of commercial office buildings (Kahn, Kok, and Quigley [2014]).

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