U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Utilizing Commercial Real Estate Owner and Investor Data to Analyze the Financial Performance of Energy Efficient, High-Performance Office Buildings

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Preface

Within the U.S. Department of Energy's (DOE) Building Technologies Office Multi-Year Program Plan, the Commercial Buildings Integration Program's mission is to accelerate voluntary adoption of significant energy performance improvements in existing and new commercial buildings. At JDM Associates, we are honored to be working with DOE to promote energy efficiency among market leaders and drive energy efficiency efforts in the commercial real estate industry. In the years leading up to the execution of this pilot research project, we conducted extensive stakeholder engagement with academic and professional real estate researchers, leading commercial real estate firms, and industry organizations. With their help, we reviewed existing studies that investigate potential connections between energy efficiency and financial performance of assets, discussed challenges that have severely limited data acquisition and sharing, and assessed potential strategies and solutions for overcoming these barriers and catalyzing more robust research in this field.

JDM's Principals helped to facilitate wide-scale energy efficiency engagement in commercial real estate under the EPA Green Lights Program in the early 1990s, and promoted energy data collection by working to recruit building owners to benchmark over 2 billion square feet of commercial real estate in ENERGY STAR® Portfolio Manager®. As energy efficiency has matured, so have our efforts. Now, JDM's focus turns beyond "what gets measured, gets managed," and we are scrutinizing deeper issues. Even though further adoption of whole-building energy benchmarking remains an imperative cornerstone to improved efficiency, our primary challenge is no longer acquiring energy data. Instead, we find ourselves attempting to meaningfully aggregate and pair energy performance information with financial metrics and market factors to understand what the data means for commercial real estate owners and investors, and leveraging research findings to inform these market actors and encourage greater adoption and investment in energy efficient technologies in the future.

This pilot project is merely the first step in an iterative process, and additional work between DOE and data providers will likely be needed to continue refining data collection and analysis methodologies. And although the findings of this report are limited in scope, we anticipate that they are a precursor to larger studies capable of determining when, where, and how energy efficiency can affect financial performance. For more details about this project and getting involved as a researcher or data provider, please contact Holly Carr through the DOE Office of Energy Efficiency and Renewable Energy. We want to thank our colleagues at DOE and our entire industry working group for their candid, practical, and ultimately helpful feedback throughout this project.

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Deborah Cloutier, Farshid Hosseini, and Andrew White of JDM Associates conducted this work and wrote the ensuing report.

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- Principal Real Estate Investors: Jennifer McConkey, Michelle Fisher, and Lance Stierman
- U.S. Department of Energy: Holly Carr and Cindy Zhu

List of Acronyms

BOMA	Building Owners and Managers Association
BTO	Building Technologies Office
DOE	U.S. Department of Energy
EERE	Energy Efficiency and Renewable Energy
EIA	Energy Information Administration
LBNL	Lawrence Berkeley National Laboratory
LEED	Leadership in Energy and Environmental Design
MSA	Metropolitan Statistical Area
MV	Market Value
NOI	Net Operating Income
NRA	Net Rentable Area
OpEx	Operating Expenses
RentConc	Rental Concessions
ROA	Return on Assets
ROE	Return on Equity
SF, SqFt	Square Foot (Feet)

Executive Summary

Evidence has shown that owning and operating energy efficient, high performance, "green" properties results in multiple benefits including lower utility bills, higher rents, improved occupancy, and greater net operating income. However, it is difficult to isolate and control moderating factors to identify the specific drivers behind improved financial performance and value to investors that results from sustainability in real estate.

The U.S. Department of Energy (DOE) is interested in facilitating deeper investigation of the correlation between energy efficiency and financial performance, reducing data acquisition and matching challenges, and developing a stronger understanding of how sustainable design and energy efficiency impact value. DOE commissioned this pilot study to test the logistical and empirical procedures required to establish a Commercial Real Estate Data Aggregation & Trends Analysis lab (Data Lab), determine the potential benefits available through the Data Lab, and contribute to the existing body of evidence in this field. The Data Lab will contain information from multiple commercial real estate owners, databases, and other sources, facilitating streamlined research into and deeper investigation of the relationship between buildings' energy and financial performance. This study was designed to replicate similar methodologies used in prior research which confirmed that actionable conclusions could be drawn from the data requested as part of the Data Lab initiative.

We collected commercial office portfolio data from one institutional owner and conducted correlation and multiple linear regression analyses to test the impact of LEED or ENERGY STAR® certification status on several financial variables. Our correlation analysis showed that "green" properties had higher occupancy, higher market value, net operating income (NOI) and rent per square foot, and lower operating expenses and rent concessions per square foot; results akin to the existing body of research. Additionally, the regression analysis showed that green properties experience a 28.8% increase in NOI per square foot, and a 17.6% reduction in operating expenses per square foot when compared to non-green properties. These statistically significant findings indicate that green-certified properties exhibit improved financial performance when compared to non-green properties and that meaningful insights can be drawn from the data proposed for collection in the Data Lab.

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Introduction

The residential and commercial buildings in the U.S. comprise approximately 40% of the nation's total energy consumption (EIA 2016) and are thus a high priority for focusing energy efficiency efforts. High performance buildings use less energy and other resources as compared to average buildings (Pivo and Fisher 2010), can improve occupant health and productivity (Miller, et al. 2009), and lower operational and ownership risks (Pivo and An 2015). Investors and owners of commercial real estate have increasingly placed importance on these benefits due to a general understanding that investments in energy efficiency reduce operating costs and enhance net operating income (NOI) (Devine and Kok 2015). Recent research has also provided examples of higher rent, occupancy rates, and sales prices for office buildings with green certifications (Eichholtz, Kok and Quigley 2013, Devine and Kok 2015).

However, stakeholders engaged for a scoping study investigating the role of energy efficiency in commercial mortgage underwriting noted that these benefits are difficult to observe within their individual portfolios (Mathew, et al. 2016). The question remains—to what extent do other factors maximize profitability of an asset? Possibilities include increased tenant renewals, increased occupancy, shortened vacancy periods, higher rental rates and lower rental concessions. These and other key metrics are being explored by the commercial real estate industry, yet additional data and large scale analysis are needed to generate empirical evidence that clearly demonstrates the value of energy efficiency in commercial real estate and incentivize further investment to improve efficiency and building technologies.

Commercial real estate researchers have lacked sufficient historical data to analyze the link between energy efficiency and financial performance due to the proprietary nature of the information. Academics also have difficulty replicating results and methodologies of prior studies because they do not have access to asset-level data and are required to expend significant time and expense matching records and scrubbing data for each new analysis. In 2016 the U.S. Department of Energy (DOE) teamed with industry partners to develop new resources and tools to catalyze further research on the relationship between sustainability, building performance, and financial benefits. Stakeholders helped to define a Commercial Real Estate Data Aggregation & Trends Analysis lab (Data Lab) designed to allow for large-scale investigation of asset-level trends. The Data Lab will improve access to key data sources, aggregate information from a variety of commercial real estate organizations, and provide robust protocols for maintaining data security and confidentiality.

As a precursor to the Data Lab, DOE commissioned a pilot research study intended to help DOE and other stakeholders gain experience and understanding with the data collection process, begin developing a taxonomy of asset-level data, provide proof of concept for generating portfolio and asset-level insights from the data, and to conduct similar analysis to that of previous studies (e.g., Devine and Kok 2015), thereby contributing to the existing body of evidence. The study was designed to test for expected financial benefits of energy efficient and high performance properties by comparing and analyzing the impacts of green certification on indicators of financial performance such as Market Value, NOI, Operating Expenses, Rental Concessions, Rental Income, and Occupancy. In addition to the logistical objectives noted above, the intention of this study was to begin identifying trends at a high level that could lead to new asset-level insights and lessons for applying these findings to real estate decision-making, corroborate existing research conducted on other portfolios of office properties, and provide the foundation for future studies that endeavor to answer questions identified by industry stakeholders and researchers. The lessons learned from challenges experienced during this pilot study in gathering data and developing consistent taxonomy and definitions will be essential to successfully launching the Data Lab. DOE is committed to continuing its plans to apply the lessons learned from this study by establishing a platform for stakeholders to minimize data constraints and address key research questions, such as:

- Can energy efficiency be definitively linked to asset value?
- How does sustainability or energy performance affect absorption or leasing velocity, and tenant renewal rates?
- To what extent are income and property value influenced by the level of green certification?
- Do sustainability or energy efficiency influence asset value differently across gradients of asset class and size?

Data Methodology

Data Source

The data analyzed in this study consists of commercial office properties owned by Principal Real Estate Investors (Principal), the dedicated real estate investment group within Principal Global Investors. The dataset included 131 properties throughout the U.S. with an aggregate area of 25 million square feet. The data was broken down into three main categories: Building Information, Leasing Information, and Financial Information. The specific fields provided by Principal are identified in Table 1, below.

Building Information	Leasing Information	Financial Information
Location: - Building Zip Code - MSA	Monthly occupancy/vacancy rate	Rental rates per lease, per property
Gross floor area	Absorption rates	Net operating income
Rentable square footage	Rent concessions	Annual operating expenses
Utility consumption	Tenant retention/renewal rate	Utility expenses
Green certifications, level and year(s) certified under: - LEED - ENERGY STAR - BOMA 360 - Other	Leasing velocity	Property value: - Year end, at minimum - Date of other valuations

Table 1. Data Fields and Definitions – Data fields collected for the purposes of this analysis, and definitions for lesser known terms. Green certifications were cross-checked using ENERGY STAR's Registry of Certified Buildings and the United States Green Building Council's (USGBC) Green Building Information Gateway (GBIG) databases. Variables such as occupancy, rent, market value, NOI, and expenses were double-checked with Principal to confirm accuracy.

Data Field	Definition
Leasing Velocity	The rate of lease turnover, as measured by the length of time a space is unoccupied between leases.
Tenant Retention/Renewal Rate	The percentage of tenants that elect to extend a lease or sign a new lease within a building at the end of the initial lease.
Rent Concessions	Differences between the rent asked by a landlord and the rent received from tenants, most often in the form of free rent.
Absorption Rates	The rate at which a new building becomes leased and occupied.

Data Cleaning, Preparation, and Classification

Prior to conducting analysis, variables were adjusted to control for building size by dividing NOI, rent, rental concessions, operating expenses, and market value by gross floor area. Average monthly occupancy among the various suites within each building was aggregated and a weighted average of occupied floor area was calculated to determine the property's average annual occupancy.

Additionally, certain values were missing for a small portion of the properties in the dataset. For buildings with missing values for rent per SF, the average value of the variable within the dataset was used. For properties where gross floor area was not available, a proxy was calculated by dividing their Net Rentable Area (NRA) by 0.87, the average ratio of NRA to gross floor area within the dataset.

Properties were classified as Green if they showed an ENERGY STAR score of 75 or higher, or if they had achieved LEED Certification. Any property which had neither an ENERGY STAR score of 75 nor a LEED Certification was classified as Non-Green. Seven properties in the dataset had an ENERGY STAR score of 75, but were not listed as having achieved ENERGY STAR Certification. These seven properties were classified as Green due to the data provider's internal reporting process, which requires eligible properties to pursue ENERGY STAR Certification. Table 2 provides a descriptive comparison of the Green and Non-Green properties.

	Number of Buildings	Gross SF	Market Value	NOI	Operating Expenses	Utility Expenses	Rental Concessions	Average Occupancy
Non-Green	40%	38%	46%	42%	39%	41%	42%	79%
Green	60%	62%	54%	58%	61%	59%	58%	89%

Table 2. Descriptive comparison of Green and Non-Green properties within the dataset.

Data Analysis

Our conceptual model, depicted in Figure 1, proposed that various financial variables are dependent variables driven by the two controlled building types: Green and Non-Green. Two types of Inferential data analysis were conducted to test this conceptual model and identify potential correlations between green certification status of the properties, and the six following variables:

- Market Value
- Net Operating Income (NOI)
- Operating Expenses
- Rental Income
- Rental Concessions
- Occupancy

First, we conducted a correlation analysis to identify directionality and significance of the correlations. We then tested the data to identify the threshold of meaningful relationships, remove outliers, and develop subsets for the correlation analysis. Properties were only included in the analysis if they met the criteria below. Each subset contained at least 60 properties.

- Market Value per Square Foot (SF) < \$400
  - Properties with market value greater than \$400 per square foot lie greater than three standard deviations from the mean.
- Rent Concessions > \$0 / SF and < \$3 / SF
  - In order to be eligible for this analysis, properties were required to provide rent concessions (i.e., > \$0/SF), but remain within three standard deviations from the mean (i.e., < \$3/SF).
- Monthly Rent < \$6 / SF
  - Properties with rental income greater than \$6 per SF are outside three standard deviations from the mean.
- Occupancy > 50%
  - In order to be eligible for analysis, and representative of normal energy use and property operations, a minimum of 50% occupancy is required.

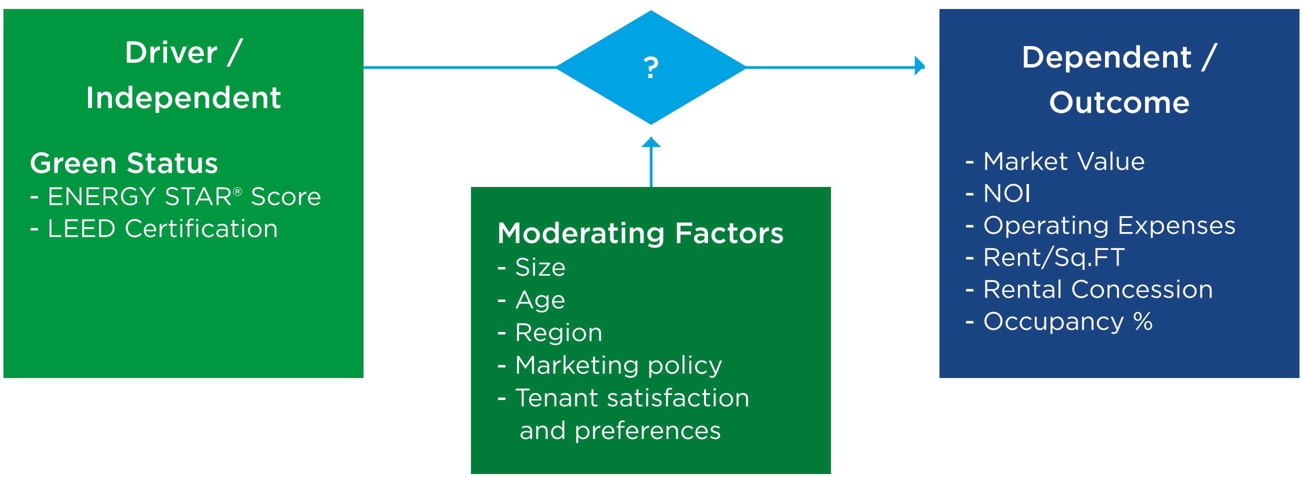


Figure 1. Conceptual Model – Analysis was conducted in accordance with the following model to test for and identify potential correlations between green certified properties and financial performance metrics. Note that due to sample size, it was not feasible to incorporate controls for age, region, marketing policy, and tenant satisfaction.

Next, we conducted multiple linear regression analyses to determine the magnitude and significance of the impact of Green certification on Market Value, NOI, Operating Expenses, Rental Concessions, and Rental Income, when controlling for building size. The model below represents the formula applied for this analysis:

$$Variable\ per\ SqFt = \alpha + \beta_1\ Size + \beta_2\ Green + \varepsilon$$

Regression analysis was also conducted for building Occupancy, using the following formula:

$$\%\ OCC = \alpha + \beta_1\ Size + \beta_2\ Green + \varepsilon$$

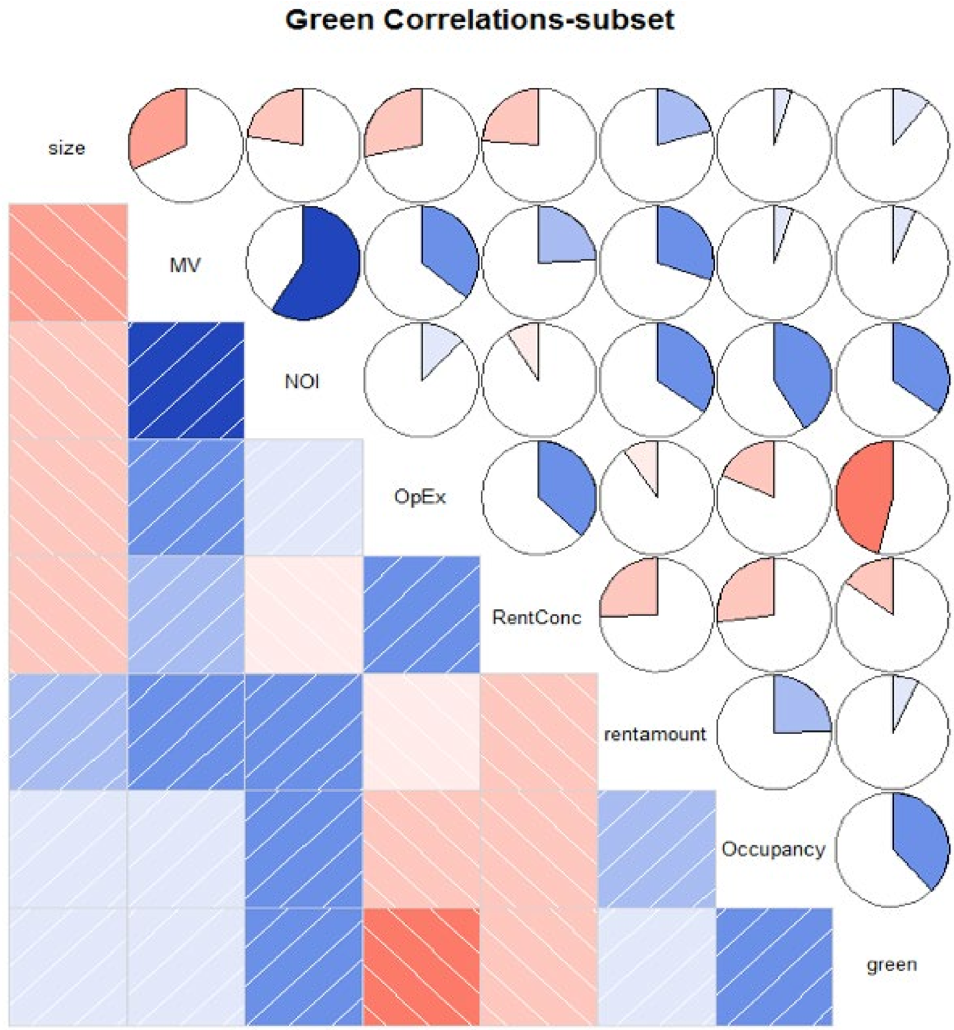
Results

Correlation Analysis

Figure 2 shows the results of the correlation analysis, which can be interpreted by selecting two variables of interest and identifying their intersecting circle or square within the graphic. Blue indicates a positive correlation, and pink indicates a negative correlation. Shading and highlighted area within the circles and squares indicate a greater correlation coefficient. The far-right column and bottom row of the figure represent the same information and indicate that Green buildings have:

- Higher Market Value/SF
- Higher NOI/SF
- Higher Occupancy
- Higher Rent/SF
- Lower Operating Expenses/SF
- Lower Rent Concessions/SF[1]

[1] For properties where rental concessions exist, green properties have lower concessions.



	size	MV	NOI	OpEx	RentConc	rentamount	Occupancy	green
size	1.00000000	-0.31721108	-0.2252281	-0.28086896	-0.2365398	0.20678598	0.04815143	0.11149470
MV	-0.31721108	1.00000000	0.5932143	0.35501204	0.2401367	0.29996307	0.05382050	0.06515287
NOI	-0.22522813	0.59321428	1.0000000	0.12913576	-0.0961901	0.34376040	0.41134280	0.34595921
OpEx	-0.28086896	0.35501204	0.1291358	1.00000000	0.3675138	-0.09927469	-0.18714266	-0.46329192
RentConc	-0.23653977	0.24013671	-0.0961901	0.36751383	1.0000000	-0.25500678	-0.26969525	-0.15297631
rentamount	0.20678598	0.29996307	0.3437604	-0.09927469	-0.2550068	1.00000000	0.24772584	0.07377364
Occupancy	0.04815143	0.05382050	0.4113428	-0.18714266	-0.2696953	0.24772584	1.00000000	0.37727331
green	0.11149470	0.06515287	0.3459592	-0.46329192	-0.1529763	0.07377364	0.37727331	1.00000000

Figure 2. Correlation Analysis – Results of correlation analysis for a subset of properties designed to remove outliers. The subset also did not include 17 properties for which Green/Non-Green status could not be determined. The far-right column and bottom row represent the correlation between Green status and the variables being analyzed. Coefficients of correlation are included in the table above.

Linear Regression Analysis

Results from the linear regression analysis are indicated in Table 3[2]. These results were controlled for size, and represent the anticipated changes for each variable if a property converted from Non-Green to Green. Results of the linear regression analysis corroborated the correlation analysis. However, due to limitations in sample size, not all findings were statistically significant.

Market Value Per SF

Coefficients	Estimate	Std. Error	t Value	Pr(<|t|)	Confidence
Intercept	169.6	29.2	5.809	0.0000000763	100 %
Size	0.00000134	0.00002836	0.047	0.962	
Green	36.7	16.67	2.201	0.03	95%
	Residual standard error	**Multiple R2**	**Adjusted R^2**	**F-Statistic**	**P-Value**
Regression Model	79.94 on 99 degrees of freedom	0.04673	0.02747	2.426 on 2 and 99 degrees of freedom	0.09359

Data set: Market Value Per SF <= $400

Net Operating Income Per SF

Coefficients	Estimate	Std. Error	t Value	Pr(<|t|)	Confidence
Intercept	6.76	2.679	2.524	0.0143	95%
Size	-0.000004328	0.000001801	-2.403	0.0194	95%
Green	3.845	1.430	2.689	0.0093	99%
	Residual standard error	**Multiple R2**	**Adjusted R^2**	**F-Statistic**	**P-Value**
Regression Model	4.682 on 59 degrees of freedom	0.1971	0.1699	7.243 on 2 and 59 degrees of freedom	0.001539

Data set: Market Value Per SF <= $400

2 Linear Regression Results – Results of linear regression analysis for a subset of properties designed to remove outliers. Outlier controls are indicated below each table, where appropriate. The impact and statistical significance are indicated by the coefficients for the regression formula, and the formulas' associated P-values.

Rent Per SF

Coefficients	Estimate	Std. Error	t Value	Pr(<|t|)	Confidence
Intercept	2.05	0.32	6.414	0.0000	100%
Size	0.000	0.000	1.533	0.129	
Green	0.12	0.18	0.654	0.514	
	Residual standard error	**Multiple R2**	**Adjusted R^2**	**F-Statistic**	**P-Value**
Regression Model	0.8361 on 96 degrees of freedom	0.02798	0.007728	1.382 on 2 and 96 degrees of freedom	0.2561

Data set: MV <=$400 and Rent <= $6 per SF

Rent Concessions Per SF

Coefficients	Estimate	Std. Error	t Value	Pr(<|t|)	Confidence
Intercept	1.915	0.8791	2.179	0.0312	95%
Size	-0.000001227	0.0000009560	-1.1283	0.2018	
Green	-0.1482	0.5150	-0.288	0.7740	
	Residual standard error	**Multiple R2**	**Adjusted R^2**	**F-Statistic**	**P-Value**
Regression Model	2.883 on 128 degrees of freedom	0.01344	-0.001975	0.8718 on 2 and 128 degrees of freedom	0.4206

Data set: MV <=$400 & 0 < Rental concession <=3

Occupancy

Coefficients	Estimate	Std. Error	t Value	Pr(<|t|)	Confidence
Intercept	0.7628	0.06956	10.965	7.27 x10-16	99.9%
Size	0.00000002896	0.00000004678	0.619	0.5382	
Green	0.06233	0.03713	1.679	0.0985	
	Residual standard error	Multiple R2	Adjusted R^2	F-Statistic	P-Value
Regression Model	0.1216 on 59 degrees of freedom	0.0487	0.01645	1.51 on 2 and 59 degrees of freedom	0.2293

Data set: MV <= 400 & RentConc < 3 & RentConc > 0 & Rent amount < 6 & Occupancy > 0.5

Operating Expense Per SF

Coefficients	Estimate	Std. Error	t Value	Pr(<|t|)	Confidence
Intercept	15.09	2.326	6.487	0.0000000199	99.9%
Size	-0.000004383	1.564	-2.803	0.00684	99%
Green	-2.266	1.241	-1.825	0.07299	90%
	Residual standard error	Multiple R2	Adjusted R^2	F-Statistic	P-Value
Regression Model	4.065 on 59 degrees of freedom	0.148	0.1191	5.123 on 2 and 59 degrees of freedom	0.008885

Data set: MV <= 400 & RentConc < 3 & RentConc > 0 & Rent amount < 6 & Occupancy > 0.5

Table 3. Linear Regression Results – Results of linear regression analysis for a subset of properties designed to remove outliers. Outlier controls are indicated below each table, where appropriate. The impact and statistical significance are indicated by the coefficients for the regression formula, and the formulas' associated P-values.

Discussion

The correlation analysis conducted on this dataset reveals several trends which indicate that green and energy efficient buildings exhibit stronger financial performance than their non-green counterparts; findings that have been observed in numerous other studies (DOE 2015). Further, by conducting the linear regression analysis, we were able to estimate the potential impact of converting a Non-Green property into a Green property within this dataset. A breakdown of these impacts is shown in Table 4. Please note that although we identified correlations between green buildings and financial performance, this analysis was not designed to distinguish causation or the underlying source of the improved performance.

Variable	Change from Non-Green Average	Statistically Significant?
Market Value	8.4%	No
NOI	28.8%	Yes
Rent	4.3%	No
Rental Concessions	-6.9%	No
Occupancy	6.2%	No
Operating Expense	-17.6%	Yes

Table 4. Impacts of Converting from Non-Green to Green – Based upon the results of the linear regression analysis described above, this table reflects the potential impacts on asset-level financial performance if converting a Non-Green property to a Green property. Unfortunately, not all results were statistically significant, due to sample limitations within the data set.

A projected market value increase of 8.4%, was consistent with the findings of numerous studies of the U.S. market for LEED and ENERGY STAR properties (DOE 2015). However, future analysis of the return on equity (ROE), and return on assets (ROA) for these properties is needed to more effectively test this result and map the finding to studies of other institutional investors. Additionally, the small sample size for this study indicates limited statistical significance for this correlation, and additional data and controls would be beneficial for confirming the relationship.

The observed reduction in rental concessions was an intriguing result, as it could have ripple effects on the other variables. Lower rental concessions naturally yield a higher effective rent, which impacts NOI, and, when NOI is used to calculate the market value of the property, a potential incremental increase in asset value. Further, rental concessions may hold the key to several other sustainability insights that have not been fully explored yet. For example, if tenant utility costs remain low in an energy efficient building, or its profitability increases through improved worker productivity, a tenant is therefore more capable to pay owners' asking rent. The stability in tenant operations and a potential desire to renew their leases would therefore translate into a more stable stream of income for the owner, reducing income lost to vacant space, broker fees, and marketing efforts, all of which would contribute to improved profitability for the asset.

Similarly, lower operating expenses —which showed a very strong relationship to green status in this analysis— also have an impact on asset value. Taking the anticipated market value increase within Principal's portfolio and dividing it by the projected reduction in operating expenses, we found a ratio of approximately $16.17/SF in potential benefit for LEED and ENERGY STAR properties. A similar ratio was determined in research conducted by Eichholtz et al, which found that a $1/SF reduction in energy costs was associated with, on average, a $13/SF increase in sales price (2011).

The anticipated occupancy increase of 6.2% for a Green building within the Principal portfolio was lower than the observed increase of 10-18% of some studies (Wiley, Benefield and Johnson 2008) (Eichholtz, Kok and Quigley 2010), but fell within the 3-8% range of occupancy premiums identified by others (Fuerst and McAllister 2009). One possible explanation for the lower premium than that identified by Wiley and Eichholtz is the markets in which this sample of buildings are located. Over 50% of the buildings in this dataset are located in the Los Angeles, Portland, San Francisco, and Seattle metropolitan areas, which are renowned for being early adopters and promoters of green building (CBRE 2015). As such, it is possible that tenant expectations in these markets dictate energy efficiency and green building practices, thus minimizing the potential to ask higher rents for green buildings. Further, offices in central business districts of major markets are typically expected to maintain occupancy well above national averages, which could also have mitigated the potential occupancy premium.

As observed in other studies, green properties in this dataset achieved higher rent income per square foot than non-green properties. Further, the estimated 4.3% increase in rental income for this portfolio was similar to the 3.5% and 7.9% premiums identified for ENERGY STAR and LEED properties, respectively, during analysis of over 21,000 properties (Eichholtz, Kok and Quigley 2011).

One of the strongest correlations identified in this analysis was the relationship between NOI and Green buildings. Other research has also identified a positive correlation between NOI and energy efficient properties (Pivo and Fisher 2010), but not at the scale of the increase observed within this dataset. In the context of this analysis, it is conceivable that the potential impact of green status on NOI consists of aggregated benefits generated in part by other individual variables. I.e., Increasing occupancy, reducing operating expenses, lowering rental concessions, and improving rental income, are all components that affect NOI, and have combined to produce a cascading effect that yields higher NOI for green properties.

Conclusion and Next Steps

Additional data is needed to more clearly define the links between sustainability and financial performance, provide additional controls for moderating factors, and improve the quality of these findings. This analysis was conducted for only one subset of a single owner's portfolio. Utilizing data from a single source inherently incorporates biases based upon a specific investment strategy due to a relatively homogeneous set of buildings in specific markets. This bias might mask some of the potential impacts of sustainability and energy efficiency on Rent, NOI, Market Value and other variables, and can only be mitigated by generating a larger, more diverse dataset with assets from additional markets, building classes, and sizes.

With an understanding of the potential impact of additional research, DOE continues to identify a robust research agenda and explore opportunities, like the Commercial Real Estate Data Aggregation and Trend Analysis Lab (Data lab) housed at LBNL. With the framework and proposed protocols established, DOE now seeks commercial real estate data that can be analyzed by approved researchers. For this lab to succeed, it will be critical for DOE to establish consistent, common data fields, data taxonomy, and definitions for calculating variables such as NOI, rent, and rental concessions. To move the body of sustainable real estate research forward significantly, DOE will continue to seek out opportunities to aggregate lease-level information from data providers and explore how this more granular information can be best utilized by approved researchers.

Bibliography

CBRE. 2015. National Green Building Adoption Index 2015. Annual Market Analysis, CBRE.

Devine, Avis, and Nils Kok. 2015. "Green Certification and Building Performance: Implications for Tangibles and Intangibles." The Journal of Portfolio Management.

DOE, U.S. Department of Energy. 2015. "Energy Efficiency & Financial Performance: A Review of Studies in the Market." Better Buildings Solution Center. December. Accessed October 28, 2016. https://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/Energy%20Efficiency%20and%20Financial%20Performance_12_2015.pdf.

EIA, Energy Information Administration. 2016. Frequetly Asked Questions. April 6. http://www.eia.gov/tools/faqs/faq.cfm?id=86&t=1.

Eichholtz, Piet, Nils Kok, and John M Quigley. 2013. "The Economics of Green Building." Review of Economics and Statistics.

Eichholtz, Piet, Nils Kok, and John M Quigley. 2011. "The Economics of Green Building." Institute of Business and Economic Research.

Eichholtz, Piet, Nils Kok, and John Quigley. 2010. "Doing Well by Doing Good? Green Office Buildings." American Economic Review.

Fuerst, Franz, and Patrick McAllister. 2009. "An Investigation of the Effect of Eco-Labeling on Office Occupancy." The Journal of Sustainable Real Estate.

Mathew, Paul, Nancy Wallace, Elena Alschuler, and Leonard Kolstad. 2016. "Commercial mortgages: An underutilized channel for scaling energy efficiency investments?" ACEEE.

Miller, Norman G, Dave Pogue, Quiana D Gough, and Susan M Davis. 2009. "Green Buildings and Productivity." Journal of Sustainable Real Estate .

Pivo, Gary, and Jeffrey Fisher. 2010. "Income, Value and Returns in Socially Responsible Office Properties." Journal of Real Estate Research.

Pivo, Gary, and Xudong An. 2015. "Default Risk of Securitized Commercial Mortgages: Do Sustainability Property Features Matter?" RERI Research Conference. Chicago: Real Estate Research Institute (RERI).

Wiley, Jonathan A., Justin D. Benefield, and Ken H Johnson. 2008. "Green Design and the Market for Commercial Office Space." Journal of Real Estate Finance and Economics.

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