IT PAYS TO BE GREEN

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0.1 Introduction

The global debate surrounding climate change has prompted investors, policy-makers, and corporations to consider using buildings as a means to achieve sustainability. The built environment and sustainability are undoubtedly intertwined. For example, it is reported that buildings account for approximately 40 percent of the consumption of raw materials and energy, while their associated construction activity accounts for at least 30 percent of world greenhouse gas emissions (Royal Institution of Chartered Surveyors 2005). Thus, the design and operation of real estate can play an important role in energy conservation. Buildings are increasingly being touted as vehicles for achieving energy efficiency, carbon abatement, and corporate social responsibility (Waddock and Graves 1997). This shift in the perception and use of buildings is gradually moving commercial property markets to seek highly coveted "green" certifications. This paper seeks to explore the financial consequences of building "green" by empirically evaluating the impact "green" certifications have on rents commanded by commercial office properties in Manhattan, New York.

Investments in energy efficiency at the time of construction or renovation are fiscally prudent. Some benefits of building "green" include: saving current resources expended on energy, water, waste disposal and other operating costs, insuring against future energy price increases, and decreasing greenhouse gas emissions. Additionally, improved environmental quality inside of green buildings could result in higher employee productivity. There is popular discussion of the presumed health and productivity costs that are imposed by poor interior quality in commercial buildings, and thus tenants may be willing to pay a higher rent for buildings in which indoor environmental quality is better. Moreover, locating corporate activities in a "green" building may affect the corporate image of tenants since leasing space in a "green" building may send a concrete signal of corporate social responsibility. Favorable reputations may enable firms to charge premium prices (Klein and Leffler 1981), to attract a better work force (Turban and Greening 1997), and to attract investors (Milgrom and Roberts 1986). As a result, tenants may be willing to pay higher rents for green buildings. Finally, if tenants would prefer sustainable buildings, then sustainable buildings could have longer economic lives than conventional buildings. If the economic benefits of building green for commercial property are indeed reflected in tenants' willingness to pay premiums on rent for "green" spaces, this would enable investors to offset the higher initial investment required for sustainable buildings.

In the United States, there are two major programs that encourage the development of energy efficient and sustainable buildings through systems of ratings that designate and publicize exemplary buildings. The Energy Star program is jointly sponsored by two Federal agencies, the US Environmental Protection Agency, and the US Department of Energy. Energy Star began in 1992 as a voluntary labeling program designed to identify and promote energy-efficient products in order to reduce greenhouse gas emissions. The Energy Star rating was extended to commercial buildings in 1995, and the labeling program for these buildings began in 1999. Nonresidential buildings can receive an Energy Star certification if the source energy use of the building (that is, the total of all energy used in the building), as certified by a professional engineer, achieves certain specified benchmark levels. The benchmark is chosen so that the rating is awarded to the top quarter of all comparable buildings, ranked in terms of source energy efficiency. The Energy Star rating is marketed as a commitment to conservation and environmental stewardship. But it is also touted as a vehicle for reducing building costs and for demonstrating superior management skill.

The US Green Building Council (USGBC), a private nonprofit organization, has developed the LEED ("Leadership in Energy and Environmental Design") green building rating system to encourage the "adoption of sustainable green building and development practices." Since adoption in 1999, separate standards have been applied to new buildings and to existing structures. The requirements for certification of LEED buildings are substantially more complex than those for the award of an Energy Star rating. It is claimed that LEED-rated buildings have lower operating costs, increased asset values, and provide healthier and safer environments for occupants. It is also noted that the award of a LEED designation "demonstrates an owner's commitment to environmental stewardship and social responsibility." LEED ratings come in four distinct levels - Certified, Silver, Gold, and Platinum - reflecting varying degrees of energy performance between awarded buildings.

To persuade property owners, developers and investors in the global marketplace of the benefits of "green" investment, the payoff from investment needs to be identified. Prior published literature devoted to this task generally indicates a positive relationship between environmental certification and financial outcomes in the marketplace. Eichholtz et al. (2010) document significant and positive effects on market rents and selling prices following environmental certification of office buildings in the United States. Relative to a control sample of conventional office buildings, LEED or Energy Star labelled office buildings achieve rents that are about 2 percent higher, and premiums to selling prices as high as 16 percent. Other studies confirm these findings (Fuerst and McAllister, 2011a; Miller et al., 2008). Within the London commercial office market, premiums for certified buildings are approximately 19.7 percent for rental transactions and 14.7 percent for sales transactions, relative to non-certified buildings in the same location cluster (Chegut et. al., 2013).

This paper seeks to corroborate prior literature and provide analysis of the impact of environmentally sustainable building practices upon economic outcomes as measured in the marketplace. I concentrate on commercial office properties in Manhattan and investigate the relationship LEED and Energy Star ratings have on the effective rents (rents adjusted for building occupancy levels) commanded by these properties during the 2003-2016 period, relative to comparable control buildings in a similar location. My findings suggest that there is a rental premium of approximately 4% for buildings with a "green" certification.

0.2 Data

This paper uses data from 28,432 rental contracts for commercial office buildings in Manhattan between 2003 and 2016. The rental contract data was obtained from CompStak, a crowd-sourced real estate data platform. The data is cross-sectional at the contract level and contains the following information about each building: street address, transaction year, transaction quarter, construction year, renovation year, sub-market, building class, transaction size, effective rent (equal to contract rent multiplied by the occupancy rate), lease term, and free rent period. There are a total of 4,969 distinct commercial office buildings in the dataset.

LEED and Energy Star rated buildings were identified by street address on Green Building Information Gateway (GBIG). GBIG is a data platform launched by the U.S. Green Building Council to provide greater transparency of the built environment's "green" dimension. The data is cross-sectional at the rating level and contains the following information about each rating: street address, type of rating (LEED or Energy Star), subcategory of rating, and rating date. I merged the rating data from GBIG with the office building rental contracts identified in CompStak based on street address and rating date. Thus, a rating was "added" to a transaction if the rating was awarded prior to the quarter in which the rental contract transacted. I assume that a building has no rating prior to its earliest rating date. A total of 242 LEED or Energy Star ratings have been distributed to 49 distinct commercial office buildings in New York City. However, only 30 of these rated buildings had rental contracts transact between 2003 and 2016.

Image 1 depicts all 4,969 distinct commercial office buildings identified in the CompStak database projected onto a map of Manhattan. The 30 distinct buildings which received a LEED or Energy Star rating prior to at least one rental transaction appear as green circles while the remaining, unrated buildings appear as yellow circles.

Image 1: The 4,969 distinct office buildings identified in CompStak

Based upon the latitude and longitude of each rated building, I used GIS techniques to identify all other office buildings in the CompStak database within a radius of one quarter mile. In this way, I created 30 clusters of nearby office buildings. Image 2 depicts the same buildings as Image 1, but additionally shows the radius of one quarter mile surrounding each rated building. Although the original CompStak dataset included information about sub-markets, the definition of sub-market varies from the very general "Upper East Side" to the very specific "World Trade Center". These sub-markets are widely accepted Manhattan neighborhood delineations. A total of 24 distinct sub-markets exist in this dataset and include: Madison/Fifth Avenue, Grand Central, Columbus Circle,Gramercy Park/Union Square, Sixth Avenue, World Trade Center, NoHo/Greenwich Village, Financial District, Hudson Square, Midtown Eastside, Murray Hill, Penn Station, Park Avenue, City Hall Insurance, Times Square South, Times Square, SoHo, Hudson Yards, UN Plaza, Upper Eastside, Chelsea, Upper Westside, North Manhattan, and Tribeca. Location is arguably the single most important factor influencing rental price. Therefore, I did not feel it was adequate enough to only control for sub-market given the variation in location quality that exists in larger sub-markets (a building on 59th Street may rent for a very different price point than a building on 96th Street, yet they would both be within the "Upper East Side" sub-market). As a result, some of my regressions control for location using these 24 sub-markets while others control for location using the 30 one quarter mile GIS clusters.

Image 2: Quarter mile clusters surrounding each of the 30 rated buildings

Variable explanations are presented in Table 1 and summary statistics for relevant variables are presented in Table 2. Further augmentation to the data set included the creation of dummy variables reflecting the age of the building, renovation status, building height, and building class. Additionally, 2,225 observations were missing data for the dependent variable, EFF_RENT, and were dropped from the data set. Moreover, 2,894 observations were dropped due to missing information regarding the building's class. Finally, since the first green rating in my dataset occurred in quarter three of 2007, the 6,310 observations that transacted prior to this date were dropped from the data set.

Dependent Variable	
log(EFF_RENT)	Log of effective rent per square foot
Explanatory Variables	
LEED	=1 if LEED rated at time of transaction
E_STAR	=1 if Energy Star rated at time of transaction
GREEN	= 1 if LEED or Energy Star rated at time of transaction
TRANSACT_SIZE	Square footage of rental area
REN	=1 building was renovated prior to time of transaction
AGE010	=1 if the building is 0 to 10 years old
AGE1120	=1 if the building is 11 to 20 years old
AGE2130	=1 if the building is 21 to 30 years old
AGE3140	=1 if the building is 31 to 40 years old
AGE40	=1 if the building is over 40 years old
AGE_UNKNOWN	=1 if the building age is unknown
LOW_RISE	=1 if the building is less than 21 storeys tall
MID_RISE	=1 if the building is between 21 and 35 storeys tall
HIGH_RISE	=1 if the building age is greater than 35 storeys tall
RISE_UNKNOWN	=1 if the building height is unknown
CLASS_A	=1 if the building is considered to be a Class A office space
CLASS_B	=1 if the building is considered to be a Class B office space
CLASS_C	=1 if the building is considered to be a Class C office space
FREE_RENT	Months of free rent granted by the lease
LEASE_MONTHS	Length of lease in months
YR_QTR	Vector of 38 time dummies reflecting the quarter and year in which the rental contract transacted
LOC	Vector of either 24 or 30 location dummies reflecting the sub-markets or 0.25 square mile GIS clusters, respectively

Table 1: Variable Explanations

The shortcomings of this data primarily resided in crucial data, such as effective rent and building class, missing from observations. Less crucial missing data, such as building age and height, were able to be dealt with by the introduction of AGE_UNKNOWN and RISE_UNKNOWN variables. However, there was no appropriate way to estimate effective rent or building class. As a result, observations missing either of these dimensions had to be dropped from the dataset. Additionally, the dataset did not include information regarding building amenities, a characteristic that other papers found to be significant in explaining variation in rental prices. Furthermore, it is possible that not all rental transactions or ratings were reported. If true, and this omission is not randomly distributed throughout the dataset, the analysis could be unknowingly skewed. As a general comment, commercial real estate data is incredibly fragmented due to the industry's minimal adoption of technology, asymmetric sharing of information, and extreme lengths of time between transactions (a commercial office building may only transact once every twenty years).

Variable	Obs	Mean	Std. Dev.	Min	Max
EFF_RENT	17,003	68.01	133.41	1	6696
log(EFF_RENT)	17,003	3.96	.56	0	8.81
LEED	17,003	.03	.17	0	1
E_STAR	17,003	.02	.15	0	1
GREEN	17,003	.03	.18	0	1
TRANSACT_SIZE	17,003	17,320.11	48,358.59	7	1,869,752
REN	17,003	.58	.49	0	1
AGE010	17,003	.01	.10	0	1
AGE1120	17,003	.03	.17	0	1
AGE2130	17,003	.03	.18	0	1
AGE3140	17,003	.09	.29	0	1
AGE40	17,003	.83	.38	0	1
AGE_UNKNOWN	17,003	.01	.09	0	1
LOW_RISE	17,003	.33	.47	0	1
MID_RISE	17,003	.31	.46	0	1
HIGH_RISE	17,003	.32	.47	0	1
RISE_UNKNOWN	17,003	.05	.22	0	1
CLASS_A	17,003	.53	.50	0	1
CLASS_B	17,003	.39	.49	0	1
CLASS_C	17,003	.07	.26	0	1
FREE_RENT	17,003	3.43	3.75	0	50
LEASE_MONTHS	17,003	90.51	56.11	12	2256

Table 2: Summary Statistics

0.3 Methods and Results

To investigate how "green" certification influences the effective rent of commercial office buildings, the sample of "green" rated office buildings and the control sample consisting of nearby, non-rated, office buildings are used to estimate a semi-log equation relating office rents per square foot to the hedonic characteristics of the buildings, location, and transacting date of each building. As such, the regression equation we wish to estimate is:

$$log(EFF\_RENT) = \alpha + \delta * G + \beta * X + \gamma * LOC + \eta * YR\_QTR + \epsilon$$

This regression equation was estimated using robust linear regression. I chose to run a robust regression because of the likely presence of outliers and heteroskedasticity in the dataset. Least squares estimates for regression models are highly sensitive to outliers. An outlier that results from non-normal measurement error or some other violation of standard ordinary least squares assumptions compromises the validity of the regression results if a non-robust regression technique is used. Given the nature of measurement error in commercial real estate data, I opted to move forth assuming the presence of outliers.

Regression results are presented in Table 3. G is the set of "green" characteristics for a given transaction. In regressions (1),(3),(4), and (6), G contains only the variable GREEN. In regressions (2) and (5), G contains the variables LEED and E_STAR. X is the set of hedonic characteristics of the transacting building. In regressions (1), (2), (4), and (5), the hedonic characteristics in X include: TRANSACT_SIZE, REN, AGE010, AGE1120, AGE2130, AGE3140, AGE_UNKNOWN, MID_RISE, HIGH_RISE, RISE_UNKNOWN, FREE_RENT, and LEASE_MONTHS. In regressions (3) and (6), X is modified to also include CLASS_A and CLASS_B. To control for location effects, I include a set of location dummy variables. In regressions (1),(2), and (3), LOC contains a dummy for each of the 24 Manhattan sub-markets. These 24 dummy variables are exhaustive and mutually exclusive. In regression (4),(5) and (6), LOC contains a dummy for each of the 30 one quarter mile GIS clusters. These GIS dummies are not exhaustive nor mutually exclusive - many buildings appear in more than one cluster while some buildings do not appear in any. Finally, I include a set of time dummies, YR_QTR, to control for the year and quarter in which the rental transaction occurred. α, δ, β, γ, and η are estimated coefficients, and ϵ is an error term. The coefficient on G, δ, can be interpreted as the effective rent percentage premium paid for buildings with a "green" certification. Column (1) shows that a commercial office building with a "green" rating (that is, LEED *or* Energy Star) rents for a 3.9 percent premium on average. This coefficient is statistically significant at the 95% level. The sign and strength of this finding suggests that, relative to similar office buildings in a given sub-market, tenants are willing to pay more for "green" buildings. The direction, magnitude and significance of this coefficient corroborates that of prior literature.

Dependent Variable: log(EFF_RENT)						
	(1)	(2)	(3)	(4)	(5)	(6)
GREEN	0.039**		0.016	0.0480**		0.032*
	(0.018)		(0.018)	(0.019)		(0.019)
LEED		-0.018			-0.001	
		(0.026)			(0.027)	
E_STAR		0.056**			0.056*	
		(0.029)			(0.030)	
TRANSACT_SIZE	-0.000***	-0.000***	-0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
REN	0.032***	0.032***	0.023***	0.042***	0.041***	0.034***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
AGE010	0.414***	0.413***	0.368***	0.424***	0.423***	0.372***
	(0.028)	(0.028)	(0.028)	(0.029)	(0.029)	(0.030)
AGE1120	0.221***	0.221***	0.190***	0.195***	0.195***	0.167***
	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.023)
AGE2130	0.153***	0.154***	0.112***	0.154***	0.155***	0.116***
	(0.023)	(0.023)	(0.023)	(0.024)	(0.025)	(0.025)
AGE3140	0.063***	0.062***	0.038***	0.026*	0.025*	-0.005
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
AGE_UNKNOWN	-0.073	-0.074	-0.078	-0.096	-0.096	-0.116*
	(0.060)	(0.060)	(0.060)	(0.061)	(0.061)	(0.062)
MID_RISE	0.086***	0.086***	0.037***	0.063***	0.064***	0.008
	(0.011)	(0.011)	(0.012)	(.010)	(.010)	(.012)
HIGH_RISE	0.179***	0.180***	0.109***	0.163***	0.164***	0.083***
	(0.012)	(0.012)	(0.013)	(0.012)	(0.012)	(0.013)
RISE_UNKNOWN	0.171***	0.170***	0.180***	0.194***	0.194***	0.196***
	(0.030)	(0.029)	(0.029)	(0.032)	(0.032)	(0.032)
FREE_RENT	-0.030***	-0.030***	-0.031***	-0.031***	-0.031***	-0.032***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
LEASE_MONTHS	0.003***	0.003***	0.003***	0.003***	0.003***	0.003 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
CLASS_A			0.156***			0.108***
			(0.023)			(0.024)
CLASS_B			0.023			-0.041**
			(0.020)			(0.021)
constant	3.672***	3.468***	3.458***	3.732***	3.732***	3.750***
	(0.115)	(0.115)	(0.042)	(0.042)	(0.042)	(0.045)
Sub-Market Location Dummies	Y	Y	Y	N	N	N
GIS Cluster Location Dummies	N	N	N	Y	Y	Y
R-squared	0.328	0.328	0.287	0.287	0.287	0.294
Number of Observations	17,003	17,003	17,003	17,003	17,003	17,003

Table 3: Robust Regression Results

Robust standard errors in parentheses below respective coefficient. *, ** and *** represent statistical significance at the 90%, 95%, and 99% confidence level. Storeys medium and high are relative to low-storey buildings, age factors are relative to buildings older than 40 years in age, and building classes are relative to Class C buildings.

In column (2), G is modified to include both LEED and E_STAR so as to estimate the effect these awards individually have on the effective rent commanded by office buildings. The estimated coefficient for the LEED rating indicates a discount of 1.8 percent for commercial effective rents, but this coefficient is statistically insignificant. The Energy Star rating is associated with premium rents of 5.6 percent and is statistically significant at the 95% level. Interestingly, these findings suggest that tenants may value an Energy Star rating over a LEED rating. This contradicts prior literature and my own hypothesis given that requirements for LEED certification are more stringent than that of Energy Star. However, one study does note "that the attributes of sustainability rated in the LEED certification process have a substantial effect on the effective rents commanded by office buildings" (Eichholtz et. al. 2013). Thus, a possible explanation for my results could be that LEED rated buildings in my sample consisted primarily of sustainability attributes not valued by the buildings' respective tenants. Column (3) shows that once building class is factored into the hedonic regression, green certification is no longer statistically significant. Building class, while an important industry categorization, is a subjective determinant of building quality. Classification standards "vary by market" and are often referred to as "an art rather than a science"(Golden 2013). A potential explanation of the sudden insignificance of "green" certifications could be attributed to the fact that the high quality infrastructure of Class A buildings overshadows the added benefits of "green" certification.

In column (4) we see statistically significant rental premiums of 4.8 percent for certified buildings. This regression, while similar to column (1)'s regression, now controls for location by using GIS clusters of one quarter mile as opposed to sub-market delineations. As a result, the buildings are being compared to more "like" buildings with regards to location and the resulting importance of obtaining a "green" certification increases when measured by rental rate premiums. Column (5) again distinguishes between the LEED and Energy Star ratings. Similar to column (2), buildings with an Energy Star rating achieved a rental premium of 5.6 percent on average. This coefficient is significant at the 90% level. Interestingly, the estimated coefficient for the LEED rating indicates a statistically insignificant rental discount of only 0.1 percent. Finally, column (6) shows a positive, statistically significant coefficient for G when building class is included in the hedonic regression and location is controlled for using GIS clustering. The coefficient indicates that premiums of 3.2% are paid for "green" certified buildings, even when infrastructure quality is controlled for via building class.

0.4 Conclusion

Growing global concern about climate change is increasingly affecting the preferences of consumers and investors. In addition, international, national and local governmental institutions are expanding the scope of environmental regulation affecting commercial real estate assets. Similar to other product markets, a voluntary environmental certification system for new buildings and renovations has emerged in most real estate markets. Despite the publicity and promotion, the voluntarily certified sector is minuscule in terms of the current total commercial real estate stock (as evident by there being only 49 distinct buildings with a LEED or Energy Star rating in all of Manhattan). However, it is likely that "green" certification of commercial buildings will become progressively more important.

The idea that "green" certified buildings should obtain a rental price premium is *a priori*. It is expected that investors' holding costs should be lower due to attractiveness to tenants associated with business performance, image, fiscal incentives, corporate social responsibility, and lower running costs. This can lead to a rental premium and/or lower vacancy rates. The results of the empirical analysis confirm these expectations. The hedonic regressions suggest that there is a rental premium of approximately 4% for "green" certification.

It is important to note that there are a number of caveats attached to the interpretation of this and similar empirical studies of price differentials in commercial real estate. First, the controls for inherent heterogeneity between certified and non-certified buildings are bound to be imperfect even when applying a comprehensive set of variables in the hedonic model. For example, it is possible that the "green" certification process is only one element of additional investment to create a market-leading building. To control for all unique facets of a building is virtually impossible in the framework of a hedonic model. Second, it could be the case that intangible preferences play a role in determining the value of real estate. Why is it that comparable buildings across the street from one another rent for different prices? Is it because of the building's architecture, the view, the way that sun light filters through the windows, or some other obscure feature that is not easily quantifiable? Finally, these empirical studies provide a cross-sectional snapshot of price differentials for a specific sample in a specific time period. It is expected that price differentials for certified buildings should vary over time and between buildings. Although the results of this paper are in line with the findings of the majority of studies on rental premiums of certified buildings, this is a study of a niche market with relatively small sample sizes. As the quantity, detail and accuracy of data is likely to improve over time, future research will be able to address a number of more specific issues such as the individual contributions of tenant image benefits, higher productivity, or lower operating costs to the "green" premium.

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