Environmental Performance and the Cost of Capital: Evidence from Commercial Mortgages and REIT Bonds*

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Abstract

There is an ongoing debate about the impact of environmental performance on a firm's cost of capital, but most academic studies are hindered by methodological challenges. The real estate sector, which is at the nexus of many environmental and energy issues, offers a laboratory to address the relationship in a direct manner. Using a sample of U.S. REITs, we investigate the spreads on commercial mortgages collateralized by real assets, some of which are environmentally certified. We also study spreads on corporate debt, both at issuance and while trading in the secondary market. The results show that environmentally certified buildings command significantly lower spreads as compared to conventional, but otherwise comparable buildings. The spread difference varies between 35 and 36 basis points, depending on the specification. At the corporate level, we document that REITs with a higher fraction of environmentally certified buildings are able to issue bonds at lower spreads, after controlling for a broad set of REIT and bond characteristics. A difference-in-difference analysis of bond spreads in the secondary market corroborates this finding. The results in this paper provide some evidence that the financial market capitalizes the environmental performance of collateral into the pricing of financial products.

Keywords: Environmental performance, commercial mortgage valuation, corporate bonds, commercial real estate, real estate investment trusts (REITs)

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1 Introduction

As witnessed by the recent attention to the COP21 meetings in Paris, there is an increasing societal focus on environmental issues, most importantly the carbon externality from energy consumption, and its effects on climate change. This focus has led to global corporate action on environmental sustainability – a major aspect of the broader corporate social responsibility (CSR). While some firms, such as Unilever and Patagonia, have made CSR core to their business strategy, other firms invest in CSR just to be compliant with regulation. Such differentiation leads to important questions about the relationship between firms' environmental performance and their financial performance, the outcome of which is of interest to investors, corporations, and policy makers.

There is a significant body of academic research investigating this relationship, typically focusing on broad measures of CSR. Margolis, Elfenbein, and Walsh (2007) survey the related literature for the period over the 1972 to 2007 period and conclude that environmental performance and other elements of CSR tend to have a positive impact on financial performance. More recently, Servaes and Tamayo (2013) paint a more nuanced picture, providing evidence that such positive relationship only holds for companies with high customer awareness. Eccles, Ioannou, and Serafeim (2014) document that companies voluntarily adopting sustainability policies subsequently perform better financially, both on the stock market as well as measured by accounting metrics.

Even though there seems to be some consensus regarding the impact of environmental performance on financial performance, it is rather challenging to disentangle the mechanism by which CSR affects corporate performance. One such mechanism is that CSR or environmental performance may lead to an improved corporate image and an enhanced reputation, which could benefit companies on the

labor, goods, and capital markets (Turban and Greening 1997). Another mechanism is more direct, and relates to efficient use of resources, generating less pollution and waste, and an overall increase in organizational effectiveness (Sharfman and Fernando 2008).

While CSR may directly affect the operations of a firm, another mechanism to influence financial performance is through the cost of capital needed to finance operations. It has been argued that CSR-related investments may lead to a reduction in operational risk (An and Pivo 2015, Albuquerque, Durnev, and Koskinen 2014, Kytle and Hamilton 2005), which could result in easier access to capital or a reduced cost of capital.

The literature investigating the impact of CSR and environmental practices on the cost of debt is quite limited, with the early literature documenting no discernable effect or even higher spreads for better CSR performance. For example, D'Antonio, Johnsen, and Hutton (1997) investigate the performance of socially screened bond mutual funds, but find no relationship between CSR and yield differences on a risk-adjusted basis. Sharfman and Fernando (2008) conclude that the debt capacity for companies with a superior environmental performance is higher, but that their cost of debt is higher as well.

More recent papers contrast the early findings: Bauer and Hann (2010) document strong evidence that environmental performance is associated with reduced bond spreads. Goss and Roberts (2011) show that companies with a lower score from KLD – a CSR rating agency – have higher spreads on their bank loans. However, investments in CSR are only rewarded if the borrower has a high credit rating. Attig, Ghoul, Guedhami, and Suh (2013) find that bonds issued by firms with strong CSR performance have better credit ratings, which usually leads to better financing terms. More recently, Chava (2014) analyzes the cost of equity and bank loans for companies with and without environmental concerns. The results show that firms without these concerns pay lower interest rates,

and that investors in their stocks demand lower returns. Oikonomou, Brooks, and Pavelin (2014) document that strong CSR performance is associated with better credit ratings and lower cost of debt for firms in a broad range of industries.

While recent studies are directionally consistent in findings, questions remain about the mechanism of the documented effects. There are also some concerns about endogeneity issues that tend to hamper research in related fields: the direction of causality between environmental performance and cost of capital is hard to identify, due to potentially confounding factors. For example, firm's cost of capital may be affected by the quality of its management, which may also affect the firm's environmental considerations.

This paper addresses some of the shortcomings in the literature, investigating the effect of corporate environmental performance on the cost of debt, not just at the company level, but also at the level of individual assets and the loans financing those assets. We examine the real estate sector, which provides a unique combination of companies whose sole activity is the management of a real estate portfolio – Real Estate Investment Trusts, or REITs – and assets which are unequivocally related to the debt that underwrites the assets – corporate bonds and mortgages. We analyze the spread on bonds issued by REITs and on the mortgages that are collateralized by individual buildings, a combination of analyses that is possible for REITs only. The analysis at the individual asset level examines different assets owned by the same firm and the mortgages collateralizing those assets, implying that firm characteristics cannot explain the cross-sectional effects, reducing endogeneity concerns.

We also specifically address the issue of endogeneity in the corporate-level analysis. First, we employ a robust set of instruments in a two-stage model, using a weighted local measure of environmental certification for each REIT portfolio, as well as the lagged weights of environmental certification. In addition, we estimate a difference-in-difference

analysis on REIT corporate bond spreads after issuance. This time-series analysis allows us to investigate the effects of changes in REIT environmental performance on corporate bond spreads. The difference-in-difference approach aims to isolate the impact of a change in the share of environmentally certified buildings in a portfolio by a given firm on the change in bond spreads, eliminating any unobservable fixed effects.

In addition to the methodological advantages offered by analyzing commercial real estate, the sector plays a key role in the production – and therefore also the reduction – of greenhouse gas emissions. For instance, the Energy Information Administration (EIA) reports that buildings accounted for 41 percent of total US energy consumption in 2014.[1] Moreover, the EIA expects the energy consumption in the commercial building sector to increase by 23 percent until 2040.[2] As the regulatory response to increasing energy efficiency in the real estate sector is mostly focused on market-based solutions, for example through improving information transparency, understanding the broader financial implications of investments in the energy efficiency and environmental performance of real estate is important for investors and policy makers alike.

As a proxy for the energy and environmental efficiency of buildings, we investigate the mortgage spreads of assets that are environmentally certified by LEED or Energy Star – both are widely accepted measures of environmental building performance. Controlling for a broad set of mortgage and asset characteristics, we test how the capital market evaluates the environmental performance of collateral underlying financial products. The results show that the spreads of mortgages on environmentally certified buildings are significantly lower than those on conventional buildings, with the difference varying between 35 and 36 basis points, depending on the specification. This translates into a reduction of $210,000 to $211,000 in the annual interest payment of an

[1]Energy consumption by sector for 2014 retrieved from: `http://www.eia.gov/totalenergy/data/monthly`.

[2]EIA Annual Energy Outlook 2014. For details, please visit `http://www.eia.gov/forecasts/aeo`.

average commercial mortgage in the sample. The heterogeneity in a building's environmental performance is also reflected in mortgage spreads. A detailed analysis of buildings with different LEED labels shows that the decline in the interest expense is largest for Platinum labeled buildings, with a reduction in interest payments of some $410,000.

At the corporate level, we assess the fraction of a REIT portfolio that is environmentally certified – as measured by LEED and Energy Star certification – and then evaluate the impact on REIT corporate bond spreads. Using a two-stage least square analysis that explicitly controls for endogeneity, we document that companies with a higher share of energy efficient and environmentally certified assets have significantly lower bond spreads, even though the effect is economically quite small. A one-standard deviation increase in the share of environmentally certified buildings decreases the corporate bond spread at issuance by about 11 basis points. This translates into a difference in interest payment of $109,000 for the average corporate bond in our sample. Importantly, the difference-in-difference analysis shows a 17 basis point decline in bond spread when a REIT increases its share of environmentally certified buildings by one percent.

The results in this paper add to the academic evidence on the economic implications of environmental performance in general, and specifically for real estate. There is strong evidence that environmentally certified buildings have a higher and more stable occupancy rate, and higher marginal rents and transaction prices (Eichholtz, Kok, and Quigley 2010, 2013, Fuerst and McAllister 2011), and that REITs with a higher share of environmentally certified buildings have stronger operational performance (Eichholtz, Kok, and Yönder 2012). These effects provide evidence of the market efficiently capitalizing environmental performance. The reflection of environmental performance in the cost of capital of real estate assets and firms provides another market-based nudge for building owners and

investors adopting more energy efficient investment practices in the commercial real estate market.

The remainder of the paper is organized as follows: we first discuss the concept of "green" buildings, providing an overview of the literature concerning their financial performance. Section 3 presents and describes the data employed in the analysis and Section 4 outlines the method. Section 5 discusses the results, and the paper ends with conclusions and implications.

2 Environmental Performance and Real Estate Investments

It has been well documented that the commercial and residential real estate sector can play a pivotal role in the reduction of global energy consumption, given its significant footprint, and the wide array of seemingly profitable energy efficiency measures and technologies at its disposal (Enkvist, Naucler, and Rosander 2007, Kahn, Kok, and Quigley 2014). The real estate industry has responded to the societal debate and regulatory response in different ways. One particularly important development is the establishment of environmental certification programs, both at the building and at the portfolio level. Information provision about the relative performance of assets and firms, comparable to the miles-per-gallon (MPG) sticker on cars or hygiene scorecards in restaurants, may lead to increased consumer awareness, and thus increased market efficiency (Jin and Leslie 2009, Sexton and Sexton 2014).

In the U.S., the two leading certification programs at the asset level are LEED and Energy Star, which have been developed by the U.S. Green Building Council (USGBC) and the U.S. Environmental Protection Agency (EPA), respectively. As of November 2015, the U.S. real estate market counted 18,167 commercial buildings with a LEED certificate and 26,938 commercial buildings with an Energy Star label.[3]

[3]The Green Building Information Gateway provides information on the number of buildings certified under the LEED program by the USGBC: `http://www.gbig.org/search/advanced`. The number of commercial buildings labeled by the EPA is retrieved from: `http://www.energystar.gov/index.cfm?`

The environmental performance of the built environment is increasingly relevant to a substantial part of the commercial real estate market, as the diffusion of the two certification programs has spread rapidly over the past decade. At the end of 2005, less than six percent of the building stock (by square footage) in the 30 largest office markets in the U.S. had been certified under the LEED and Energy Star program, but this increased to almost 40 percent at the end of 2014 (Holtermans, Kok, and Pogue 2015). Moreover, McGraw-Hill Construction estimates that 44 percent of new construction projects in 2012 were "green" and projections suggest that this share will increase to 55 percent by 2016.[4]

Comparable to investments in CSR for a general corporation, an important and lingering question is the extent to which social and environmental benefits of real assets generate economic and financial value for investors. Indeed, a survey by Pivo (2008) shows that REIT managers give more weight to "concern for risk and return" and "opportunities to outperform" than to "moral responsibility" when they consider sustainability investments in assets. However, this early survey also shows that managers' main concern lies in the lack of information on the financial performance of environmentally certified buildings.

A growing body of literature aims to assess the economic implications of energy efficiency and environmental performance of buildings. Capitalizing on the widespread adoption of environmental certification, the literature consistently shows that certified commercial buildings generate significantly higher marginal rents and increased transaction prices as compared to conventional, but otherwise comparable buildings (Chegut, Eichholtz, and Kok 2014, Eichholtz et al. 2010, 2013, Fuerst and McAllister 2011). Importantly, these studies also find higher and more stable occupancy rates for environmentally certified buildings, which is the key yardstick for systematic risk at the

`fuseaction=labeled_buildings.locator`.

[4]McGraw-Hill Construction Green Building Outlook 2013.

asset level. For residential homes, Brounen and Kok (2011) document not just higher values for more efficient homes, but also a significantly shorter time on the market when dwellings are on sale.

Analyzing the implications of investments in environmental performance at the corporate level, Eichholtz et al. (2012) document that REITs owning a larger fraction of environmentally certified buildings display enhanced operating performance, as measured by return on assets (ROA), return on equity (ROE) and funds from operations (FFO). A four-factor model shows that REITs with larger fractions of environmentally certified space also exhibit significantly lower systematic risk (beta).

It is important to note that besides positive rent and value effects, the literature also consistently shows a negative relationship between environmental performance and risk: environmentally certified real estate assets tend to have higher and more stable occupancy rates, are easier to sell, and have lower systematic risk. A recent paper by An and Pivo (2015) reiterates these results, documenting that commercial mortgages collateralized by environmentally certified buildings have a lower default risk. This finding is particularly important for the purpose of this paper, since lower default risk may translate into a lower required risk premium, and potentially also into a lower cost of debt.

3 Data

3.1 REITs and Environmentally Certified Buildings

We identify LEED and Energy Star labeled buildings in the portfolios of REITs by matching the addresses of REIT-owned assets provided by SNL Real Estate with LEED and Energy Star data provided by the U.S. Green Building Council (USGBC) and the Environmental Protection Agency (EPA). Using GIS techniques, we transform all addresses into longitudes and latitudes, which enables us to geographically map the different datasets, identifying matching assets.

Figure 1 presents the time series of the average overall share of environmentally

certified space (by square footage) for the sample of REITs, as well as the LEED and Energy Star shares. Analogous to the green building adoption rates documented by Holtermans et al. (2015), the share of environmentally certified buildings is close to zero around 2006, but a continuing upward trend can be observed since that year. In 2014, the average share of environmentally certified buildings reached almost 5 percent of the total square footage of assets in REIT portfolios. The LEED and Energy Star shares show a comparable upward trend. In 2014, the cumulative Energy Star share slightly exceeded the cumulative LEED share and represented almost 4 percent of the total square footage of REIT assets.

– Insert Figure 1 here –

Figure 2 shows the total share of environmentally certified buildings for all REIT-owned assets in the U.S. (in square footage), measured by Core Based Statistical Area (CBSA) for the years 2006, 2010 and 2014. We observe a clear trend of an increasing share of environmental certification of REIT assets over time. The average share of environmentally certified assets in REIT portfolios in each CBSA increased from 2.7 percent in 2006 to 8.2 percent in 2014.[5] Moreover, not only the share of assets with an Energy Star or LEED certification increases over time, but the geographical coverage also increases substantially. In 2006, REITs owned environmentally certified assets in just 42 different CBSAs, this number increased to 224 CBSAs in 2014 (out of a total of 929 CBSAs in the U.S.).

As compared to the mean of 2.7 percent, the median share of environmentally certified assets by square footage was a mere 0.3 percent in 2006. This increases to a median share of 2.5 percent and 5.5 percent in 2010 and 2014, respectively. The large difference between

[5]This excludes CBSAs with a share of environmentally certified assets of zero.

the mean and median shares indicates a large variation across CBSAs. For example, in 2014, the share of environmentally certified assets across CBSAs varies from 0.02 percent to more than 93 percent. Among the CBSAs, Minneapolis-St. Paul-Bloomington, Chicago-Naperville-Elgin, and Atlanta-Sandy Springs-Roswell show the largest increase in the share of environmentally certified assets over time. This is in line with findings documented by Holtermans et al. (2015).

– Insert Figure 2 here –

3.2 REITs and Commercial Mortgages

The SNL Real Estate database is our main source of data, and contains 211 REITs for which we have complete information on individual asset holdings. SNL provides detailed financial information on the assets owned by U.S. REITs, including encumbrance data for each building in every year, provided that there is a commercial mortgage collateralized by these assets in a REIT portfolio. SNL also provides the value of the encumbrance (the principal value of the debt), the interest rate, the maturity date, a dummy variable indicating whether it is a fixed rate contract, and a cross-collateralization dummy indicating whether the debt contract is cross-collateralized by other assets. SNL also provides information on building characteristics, such as the address of the building, the asset type and the age of the building.

The mortgage spread is calculated by subtracting the Treasury rate with the same or closest maturity from the mortgage rate. Time to maturity is calculated by the difference between the year of maturity and the derived year of origination.[6] Some commercial

[6]We need the exact date of origination in order to retrieve the Treasury rate corresponding to the date of origination. SNL does not provide the date of origination for the mortgages, but since SNL reports loan data for every year, the year of origination can be derived from the first appearance of the

mortgage contracts are collateralized by multiple assets. First, we determine for each debt contract which assets are combined, by grouping the debt contracts with exactly the same contractual terms by each year.[7] We then calculate the loan to value (LTV) ratio by dividing the encumbrance value by the total book value of the buildings collateralizing the corresponding contract in the year of origination.

Panel A of Table 1 presents the descriptive statistics for REIT mortgages and the buildings underlying these contracts. Our sample covers the period from 2006 to 2014. It includes 4,553 buildings owned by 143 REITs collateralizing 3,303 REIT mortgages, 177 of which are collateralized by Energy Star or LEED-certified buildings.[8] The average spread is 300 basis points for mortgages collateralized by environmentally certified buildings and 287 basis points for those mortgages collateralized by unlabeled buildings. The average time to maturity is about six years for both samples. The average value of environmentally certified buildings is almost three times as high as the value of non-certified buildings: \$153 million and \$44 million, respectively. Environmentally certified assets have a somewhat lower LTV (51 percent) as compared to conventional assets (55 percent). Around 79 percent of the assets are financed with fixed rate mortgages. Cross-collateralization is more common among non-certified buildings: 32 percent, against 18 percent for environmentally certified buildings.

– Insert Table 1 here –

In general, high quality buildings are more likely to be certified (Eichholtz et al.

debt contract in the database. Assuming that the day and month of origination are similar to the day and month of maturity, we derive the complete date of origination by combining this information with the year of the first appearance in the database.

[7]We group the contracts collateralized by different buildings by controlling for the same interest rate, the same encumbrance, the same date of maturity and the same company.

[8]3.9 percent of the buildings in our mortgagesample are Energy Star or LEED certified. Specifically, 2.3 percent of the buildings have an Energy Star label and 2.1 percent are certified under the LEED program. These numbers are in line with the numbers reported in Figure 1.

2010). Therefore, the impact of environmental certification can also capture unobservable building characteristics. SNL provides information regarding book value and building age, but to obtain a broader set of building quality characteristics, we match the SNL data with information from CoStar Property. CoStar Property collects data on building rents and transaction prices, combined with an elaborate set of building characteristics. We are able to cross-reference 2,707 buildings from the SNL sample with the CoStar database, 96 of which are Energy Star or LEED certified. For these buildings, we obtain detailed information on the amenities that are present in the building. This includes information on whether the building has been renovated, and its distance to a transit stop. In this subsample, 34 percent of certified buildings are renovated, against 16 percent for the non-certified buildings. Certified buildings are also closer to a transit stop and have a higher likelihood of including amenities.

3.3 REIT Bonds

We retrieve corporate bond data for all U.S. equity REITs from FactSet. For each REIT bond, we observe the date of origination, the issue amount, the bond yield, the date of maturity, the bond rating by Moody's and whether the bond is callable and/or convertible. Importantly, we also retrieve secondary market data for the bond yield and credit rating. Following Anderson, Mansi, and Reeb (2003), we employ the credit rating data by first ranking ratings from low to high, creating a ranking variable that has a value of one for the lowest credit rating, increasing by one for each notch increase in the credit rating. The highest possible value is 23, corresponding to an AAA+ credit rating. In our sample, the ranking variable for Moody's rating ranges from 8 (B2) to 17 (A2).

We collect constant maturity treasury rates (CMT) from the U.S. Treasury.[9] Comparable to the mortgage analysis, we calculate the spread of the REIT bonds by

[9]For further details, please visit `http://www.treasury.gov/resource-center/data-chart-center/interest-rates/`.

subtracting the Treasury rate with the same or closest time to maturity from the yield of the bond on the REIT bond's origination date, and at the end of every year subsequent to origination if we have secondary market data. We also collect financial characteristics of REITs from SNL for the year preceding the origination: total assets, firm Q, and the ratio of total debt to total assets (as well as the interest coverage ratio for the robustness checks).

Merging the SNL data with the secondary market data from FactSet, we obtain a dataset of 234 bonds issued by 44 REITs during the 2006 to 2014 period. In the panel dataset for the secondary market performance analysis, the number of bonds appearing annually varies from 172 to 218. Appendix Figure A.1 shows the annual trends in the number of REITs, the number of bonds and the number of bond originations by year.

Panel B of Table 1 presents the descriptive statistics of the REIT corporate bond sample. The average bond spread is 300 basis points, including secondary market data. When we limit the data to the year of origination only, the average spread is 194 basis points. The average time to maturity is 6.53 years and at issuance the mean time to maturity is approximately 10 years. Some two percent and 26 percent of the bonds issued are callable and convertible, respectively. The value of total assets of an average REIT in the bond sample is $9.42 billion. The mean debt ratio is 53 percent, while the average firm Q is 1.47.

We also present the descriptive statistics on the share of environmentally certified assets and firm characteristics by firm-years: about two percent of a REIT portfolio in the sample is either Energy Star or LEED certified. The share of buildings that have an Energy Star label is 1.3 percent, while the share of buildings with LEED certification is 1.1 percent. The relatively low adoption of environmental certification amongst the buildings in the REIT sample provides an indication that environmental certification still plays a rather limited role in REIT operations.

4 Methodology

4.1 REIT Commercial Mortgages

First, we use the asset level data directly, linking the presence of a label attesting to the energy efficiency or environmental performance of an individual building or a small portfolio of buildings to the mortgage collateralized by these assets. We estimate the following equation to assess the impact of the energy efficiency and environmental performance of the collateral on the mortgage spread:

$$\textit{Mortgage Spread} = f(\textit{Environmental Certification, Building, Mortgage Characteristics, Firm Characteristics}) \quad (1)$$

As building quality controls, we employ indicator variables for renovation, amenities and distance to public transport stops, as well as building size, a building vintage dummy (less than 10 years old), and the logarithm of the book value of the building.[10] In all mortgage regressions, we control for year, state, and asset type-fixed effects.

We use the LTV ratio as one of the mortgage controls. Additionally, since lenders may keep the LTV lower for riskier firms or assets, we follow Titman, Tompaidis, and Tsyplakov (2005) and employ an indicator variable for LTVs larger than 0.7. This indicator variable should capture the higher LTV choice for less risky firms or assets. We also control for time to maturity (in years) and include variables for fixed-rate mortgages and cross-collateralization.

The quality of the borrowing firm is also likely to affect the mortgage spread. We therefore explicitly control for firm characteristics. Specifically, we include firm size, debt ratio, and the market-to-book ratio.

[10] In unreported regressions, we also directly use the age of the assets but find insignificant results due to nonlinearity in the relationship. Results are available upon request.

4.2 REIT Corporate Bonds

In order to estimate the impact of energy efficiency and environmental performance on the bond spread of a REIT we indirectly employ the asset level dataset, using the results of the matching to create a portfolio-level measure of environmental performance, following Eichholtz et al. (2012). For each REIT, we calculate the dynamic portfolio share of environmentally certified assets, which is the ratio of the total square footage of certified buildings (measured by Energy Star, LEED, or both) and the total square footage of the portfolio of a REIT, thus indicating the degree to which a REIT portfolio includes environmentally efficient assets:

$$Environmental\ Certification\ Share^{g}_{i,t} = \frac{\sum_l Sqft\ of\ Certified\ Buildings^{g}_{i,l,t}}{\sum_l Sqft\ of\ Buildings_{i,l,t}} \tag{2}$$

In this equation, i stands for REIT i, t stands for year t, l stands for building l and g is the certification, which is either Energy Star, LEED, or both. In the multivariate analysis, we estimate the following equation, explaining bond spreads by energy efficiency and environmental certification characteristics, as well as bond characteristics and a set of control variables:

$$Bond\ Spread = f(Environmental\ Certification\ Share,\ Bond,\ Firm\ Characteristics) \tag{3}$$

In Equation 3, we use the portfolio share of certified buildings in order to proxy for the environmental performance of each REIT. Bond characteristics include the logarithm of the value of the bond, year to maturity, bond rating and variables indicating whether the bond is callable or convertible. One can expect that the bond spread should increase by

the total value of debt, as the bond becomes riskier if the total amount of debt increases. However, the amount of debt can also reflect the financial health of the issuer. For callable bonds, we expect a premium, reflecting the option value of the call and a discount for the convertible bonds. Higher bond ratings should also be associated with lower spreads.

Regarding the time to maturity, the literature suggests two possible outcomes (Goss and Roberts 2011): according to the "trade-off" hypothesis, there is a positive relationship between spread and time to maturity, as a bond becomes riskier due to the longer lending period, in which unforeseen events can occur. Conversely, the "credit quality" hypothesis predicts a negative relationship between time to maturity and the spread, because longer-term borrowers are likely to be less risky borrowers.

We use lagged firm characteristics in our model. For these variables, we expect that firm size, measured by the logarithm of total assets, is associated with a lower spread, since larger firms are better able to withstand negative shocks to cash flows and may be less likely to default. As a further measure of financial risk, we exploit the debt ratio, measured as total debt divided by total assets.[11] As the debt-to-asset ratio increases, firms should face higher bond spreads. We also control for firm Q, measured by the ratio of the market value of assets to the book value of assets. A higher firm Q indicates better growth opportunities, implying that the bond spread should be lower.

In estimating the regression reported in Equation 3, we use bond data both at issuance and while trading in the secondary market. The bond data analysis at issuance is cross-sectional, while the secondary market data offer a panel setting. We acknowledge that endogeneity is a concern in non-experimental, cross-sectional studies. For example, environmentally certified buildings are not randomly assigned to portfolios and building owners do not randomly invest in the environmental performance of buildings. For the OLS estimates of Equation 3 to yield consistent estimates, we must

[11] In unreported regressions, we also include the interest coverage, documenting similar results.

therefore assume that our measure of environmental performance is uncorrelated with other explanatory variables.

We use two different robustness tests to overcome the endogeneity concerns. First, using the panel dataset, we apply a difference-in-difference approach, using the first difference of the bond spread and explanatory variables in order to eliminate the effects of unobservables. Our aim is to remove any possible impact of unobservable and time-invariant firm and bond characteristics, which can potentially be correlated with the share of environmentally certified buildings. By using differences, the impact of such time-invariant characteristics are removed, allowing us to observe directly the impact of a change in the share of certified buildings of a given REIT on the change in the bond spread.

Additionally, we use a two-stage least squares estimation. In the first stage, we regress the share of environmentally certified assets of each REIT portfolio on its lagged share and a local variable measuring the fraction of environmentally certified buildings in the area where a REIT's assets in the portfolio are located, combined with the other explanatory variables that we employ in the bond spread regressions. In order to create the weighted local measure of environmentally certified buildings, we use the market share of environmentally certified commercial buildings in each of the 30 largest markets in the U.S. over time.[12] The weighted local measure of environmentally certified buildings is calculated by aggregating the sum of the "green" market shares multiplied by the ratio of the number of buildings in a REIT portfolio in that particular market. In the second stage, we regress the fitted measure of environmentally certified buildings on bond spreads and ratings. We perform the Hansen J (Hansen, Heaten, and Yaron 1996) and Kleibergen-Paap (Kleibergen and Paap 2006) tests to check the validity and identification of the

[12]See Holtermans et al. (2015) for a full list of the markets that are included.

models.

$$\textit{Environmental Certification Share} = f(\textit{Local Greenness, Bond, Firm Characteristics}) \tag{4}$$

$$\textit{Bond Spread} = g(\textit{Environmental } \widehat{\textit{Certification Share}}, \textit{Bond, Firm Characteristics}) \tag{5}$$

$$\Delta\textit{Bond Spread} = f(\Delta\textit{Environmental Certification Share}, \Delta\textit{Bond Characteristics}, \Delta\textit{Firm Characteristics}) \tag{6}$$

5 Empirical Findings

5.1 Commercial Mortgage Spreads and Environmental Certification

Table 2 provides the results of Equation 1. We regress mortgage spreads on an indicator of energy efficiency and environmental certification, and a large set of control variables. The standard errors are heteroskedasticity-robust and clustered by REIT. In Columns 3 to 6 of the table, we present the results using the sample matched with CoStar data, more extensively controlling for building quality characteristics. The models explain 51 to 55 percent of the cross-sectional variation in mortgage spreads.

Coefficients for the control variables are in line with expectations and consistent across specifications. In four out of six specifications, the LTV coefficient is significantly positive; a higher level of borrowing at the individual building level increases the spread. The dummy indicating LTV ratios larger than 0.7 has a significantly negative coefficient, suggesting that less risky firms face lower spreads and that riskier firms are crowded out

at higher LTV levels. Time-to-maturity has a negative impact on the spread, supporting the "credit quality" hypothesis. Fixed-rate mortgages have significantly higher spreads. Finally, when multiple assets collateralize the mortgage contract, the spread declines, although the coefficients are insignificant. This effect is most likely due to diversification.

The building quality controls obtained from CoStar, reported in Columns 3 to 6, have negative signs in all specifications. The results indicate that mortgages collateralized with buildings of higher quality have lower spreads. The presence of more than five amenities in a building, for example, is associated with a reduction in mortgage spread of 27 to 29 basis points. Building renovation decreases mortgage spreads by about 21 basis points. Proximity to public transport has the expected sign but is not statistically significant.

Importantly, we document that if a mortgage contract is collateralized by an environmentally certified asset, the borrower faces significantly lower spreads. Columns 1 and 3 show that the overall effect of environmental certification on mortgage spreads is statistically and economically significant, and is not materially affected by the inclusion of additional variables controlling for building quality. The decrease in mortgage spread is 35 to 36 basis points. For an average commercial mortgage in our sample, this translates into an annual interest payment that is lower by about $210,000.

Columns 2 and 4 present the results of regressing mortgage spread on LEED and Energy Star indicators, and Columns 5 and 6 include only one of the indicators. The findings indicate that the documented effect is mostly determined by LEED certification. If the building collateralizing the mortgage is LEED certified, borrowers face 38 to 58 basis points lower mortgage spreads. On average, this implies lower annual mortgage interest payments of $230,000 to $323,000 for the mortgages in our sample. The results for Energy Star certification are reported in Columns 2, 4, and 6, and show certification coefficients that are negative, but statistically insignificant.

– Insert Table 2 here –

These findings suggest that mortgage lenders reflect the environmental characteristics of the certified buildings in mortgage pricing, leading to lower mortgage spreads for such buildings. Although we do not have information about the default rates of the underlying collateral, the findings are in line with the lower occupancy risk and higher income generated by environmentally certified buildings (Eichholtz et al. 2010, 2013, Fuerst and McAllister 2011), as well as recent findings on lower default risk for environmentally certified assets in a broad pool of CMBS loans (An and Pivo 2015).

To assess heterogeneity in the documented effects, we evaluate the impact of variation in certification levels on mortgage spreads. We use increasing levels of LEED certification, employing specifications that are otherwise similar to those employed previously. We first divide LEED certified buildings into two groups, by combining "Certified" and "Silver" certifications as the "low-level" dummy and "Gold" and "Platinum" certifications as the "high-level" dummy. We also separately evaluate "Gold" and "Platinum" labels. The hypothesis is that, as the level of LEED certification increases, we expect a larger reduction in mortgage spread. Results are reported in Table 3. The explanatory power of the models is comparable to previous specifications, and that also holds for the coefficients of the control variables.

In columns 1 and 2 of Table 3, we analyze mortgage spreads without the additional building quality characteristics from CoStar. We document a significantly negative relationship between LEED certification levels and mortgage spread. While mortgages on buildings with low-level certification have a spread that is 46 basis points lower, the high-level certifications reduce the mortgage spread by 59 basis points. The reduction is even larger for "Platinum" labels: we observe a 68 basis point decline in mortgage spreads for buildings with these labels. Based on the average mortgage size in the

sample, if collateral would be LEED Platinum-certified, the interest expense on that mortgage would decline by approximately $410,000 per year.

Including the complete set of building quality controls, the certification coefficients increase relative to the findings in the first two columns, and continue to point to a decline in spreads as the level of buildings' environmental performance increases. The spread discount for high-level certifications remains statistically significant at 65 basis points when including the additional building characteristics. The discount for Platinum-certified collateral slightly declines to 61 basis points and is significant at the five-percent level.

– Insert Table 3 here –

5.2 Corporate Bond Spreads and Environmental Certification

We analyze REIT corporate bond spreads by investigating the relationship between the share of environmentally certified space in REIT portfolios and bond spreads at the time of origination. In the REIT corporate bond sample, we observe 234 bond originations from 2006 to 2014. Table 4 presents the results of Equation 3. Columns 1 to 3 show the OLS regressions, while Columns 4 to 6 show the 2-stage GMM regressions, using the "regional green share" as the instrument. The results of the two different analyses are consistent with respect to the observed outcomes: the size of the coefficients, statistical significance levels and explanatory power of the models are only marginally affected.

We document that the overall portfolio share of environmentally certified buildings and the LEED share significantly lower the bond spread. A one-standard deviation increase in overall "green" share and LEED share decreases the bond spread by 8 and 9 basis points, respectively. On average, this corresponds to a decline in annual interest expense of $76,000 and $88,000, respectively. The results for the 2-stage GMM

regressions, where we explicitly control for potential endogeneity, show a slightly higher impact of portfolio greenness on bond spreads, corresponding to an 11 basis point decrease in bond spreads for a one-standard deviation increase in both the overall share of environmentally certified buildings in a REIT portfolio and the share of LEED certified buildings.[13] Even though the measure of environmental concerns is quite different, the discounts we document on the bond spreads are remarkably similar in magnitude as compared to Goss and Roberts (2011) and Chava (2014).

It should be noted that the average LEED share is 1.13 percent of the portfolio, with a standard deviation of 3.55. In order to achieve the spread reduction reported above, an average REIT will thus have to quadruple its portfolio share of green buildings. Hence, although we find a statistically significant impact of portfolio greenness on bond spreads, the economic significance is relatively small. Given the still-modest share of environmentally certified buildings on the balance sheets of REITs, this finding is in line with expectations.

– Insert Table 4 here –

The control variables show that the corporate bond rating and the convertibility option are the most important determinants of REIT bond spreads at origination, irrespective of the regression specification. For example, a one-notch increase in credit rating decreases the bond spread with 29 to 42 basis points.

Subsequently, we examine the development of REIT bond spreads in the secondary market. In Table 5, we present the results from the OLS and 2-stage GMM regressions of bond spreads measured over time, using a panel dataset on firm characteristics, bond

[13]In the two-stage least squares regressions, we reject the null hypothesis of the Kleibergen-Paap test that the model is under-identified and do not reject the null hypothesis of the Hansen J Test that the instruments are valid at the one percent significance level, indicating that our instruments are valid and are performing in line with expectations.

characteristics, and the extent to which a REIT portfolio includes LEED and Energy Star certified buildings. The standard errors are again heteroskedasticity robust and clustered by firm.

The signs of the coefficients on the control variables of the bond and firm controls are as expected. Time to maturity has a negative impact on bond spreads, supporting the "credit quality" hypothesis proposed by Goss and Roberts (2011). If the bond is callable, the spread increases significantly, reflecting the option value of the call. For convertible bonds, the spread is significantly lower. The coefficient of the rating is insignificant, although the sign of the coefficient is as expected. The coefficient of the market-to-book ratio is significantly negative. This indicates that higher future growth opportunities lower the bond spread. An 0.1 increase in the market-to-book ratio results in a 13 to 14 basis-point increase in the bond spread.

In Column 1 of Table 5, we evaluate the spread impact associated with the temporal dynamics in the share of LEED or Energy Star certified assets in REIT portfolios. We document that a one-standard deviation increase in the share of environmentally certified buildings decreases the spread by 12 basis points, slightly higher as compared to the results of the cross-sectional regressions reported in Table 4. This corresponds to a reduction of $118,000 in interest payment for the average REIT corporate bond in the sample.

In Columns 2 and 3, we investigate separately the impact of LEED and Energy Star shares. A one-standard deviation increase in the LEED share reduces the bond spread by 11 basis points. While the coefficient of the Energy Star share has the expected sign, the effect is statistically insignificant as indicated in Column 3. Columns 4 to 6 of Table 5 show the two-stage least square estimation results. We find similar results, but with a somewhat higher significance and a higher impact of the portfolio share of environmental certification of buildings on bond spreads, irrespective of how we define "greenness."

A one-standard deviation increase in the share of environmentally certified buildings decreases the bond spread by 24 basis points. A one-standard deviation increase in LEED share reduces the bond spread by 22 basis points, corresponding to an average decline in the interest expense of $223,000. Similarly, a one-standard deviation increase in the Energy Star portfolio share decreases the spread by 14 basis points.

– Insert Table 5 here –

5.3 Robustness Checks

In order to further establish causality between the share of environmentally certified buildings in a REIT portfolio and corporate bond spreads, we analyze the effect of greenness on bond spreads using a robustness check that exploits a difference-in-difference approach. We use the first difference by year in the bond spread and control variables to remove the impact of time-invariant observable and unobservable characteristics.

The results of this robustness check are presented in Table 6. Most importantly, in all specifications, the coefficients on the environmental performance measures have negative signs, and the effects are larger as compared to previous specifications. For example, a one-percent increase in the overall share of environmentally certified buildings in a portfolio significantly lowers the spread of a REIT corporate bond by 17 basis points. While the coefficient of change in LEED share is insignificant, the coefficient of change in the Energy Star share is now significantly negative. A one-percent change in the Energy Star share leads to a 17 basis point decline in the bond spread in the secondary market.

– Insert Table 6 here –

Irrespective of the specification (OLS, 2SLS, difference-in-difference), we document that the extent of environmental certification in the portfolios of REITs is significantly associated with the spreads on corporate bonds, even though the effect is economically quite small. Our results also provide evidence that environmental certification (or the effects thereof) are recognized somewhat more strongly in the secondary markets as compared to the pricing effects at the time of origination.

It has been argued that environmental performance does not just affect the cost of a firm's debt, but also its debt capacity (Sharfman and Fernando 2008). This may give rise to a potential endogeneity issue, since the higher debt capacity may also affect spreads. As a robustness analysis, we therefore investigate whether an increasing share of environmentally certified buildings in the portfolio of a REIT is associated with a higher debt capacity. By examining the LTV ratios of mortgages collateralized by environmentally certified and non-certified buildings, and the debt ratios of REITs with high and low portfolio shares of environmentally certified buildings, we are able to investigate this hypothesis in more detail.

– Insert Table 7 here –

Panel A of Table 7 presents the results of a simple non-parametric comparison and a mean-difference test for the sample of mortgages. We compare the LTV for mortgages collateralized by environmentally certified and non-certified buildings. The simple t-tests do not show significantly higher LTVs for mortgages with environmentally certified collateral. In fact, we actually observe somewhat lower LTVs for mortgages with environmentally certified collateral.

In Panel B, we compare the overall debt-to-asset ratios and outstanding bond values for the sample of REIT corporate bonds. We group REITs into three categories based

on their overall share of environmentally certified buildings. First, we analyze the REITs that do not invest in environmentally certified buildings at all. For the remainder of the sample, we classify the REITs that have a share of environmentally certified buildings in their portfolio below the median as the "low portfolio share" group and REITs with a share above the median as the "high-portfolio share" group. We then calculate the average debt-to-asset ratio and corporate bond value for each group and perform a mean-difference test between the non-certified share and high-certified share groups.

The results of these simple non-parametric comparisons show no observable, significant differences in the average debt-to-asset ratio between these groups. Bond values are lower when using Energy Star as the environmental certification, and higher – albeit insignificantly – for LEED. Summarizing, we conclude that the debt capacity is not significantly different for REITs with a higher fraction of environmentally certified buildings.

6 Conclusion and Discussion

The environmental performance of private firms can significantly affect the environment, and the extent to which firms incorporate corporate social responsibility (CSR) in their business strategy and operations may thus have implications for society. There is an ongoing debate about the financial outcomes of CSR considerations, mostly focusing on operating measures of profitability. But beyond affecting operational performance, the CSR credentials of a firm may also influence its ability to raise capital, and the price of that capital (Chava 2014).

This paper is among the first to investigate the impact of direct measures of corporate social responsibility – energy efficiency and environmental performance – on firms' cost of capital. In addition to analyzing cost of capital at the corporate level, we also address the financing cost of individual assets owned by firms. We focus on the real estate sector, which allows us to take this unique two-pronged perspective, given the explicit

link between real assets and the mortgages that collateralize such assets.

This dual approach also enables addressing some of the concerns about endogeneity that are common in the literature regarding the financial effects of corporate social responsibility. At the asset level, we control for a large number of observable characteristics that may be correlated with environmental performance. At the corporate level, we apply a two-stage GMM method, instrumenting our unique measure of CSR performance by an exogenous indicator. In addition, we exploit the time-variation in both corporate bond pricing and CSR performance, using secondary market data and our real estate-specific measure of corporate environmental performance.

Evaluating the mortgage spreads of environmentally certified buildings owned by REITs, we document that commercial mortgages on assets certified by Energy Star and LEED have significantly lower spreads as compared to non-certified assets. This effect is economically significant; if the collateral is environmentally certified, the mortgage spread declines by 35 to 36 basis points. At the point of means, the interest expense for a mortgage in our sample decreases with some $200,000.

We also evaluate different levels of environmental certification. While both the coefficients on "low-level" and "high-level" LEED certifications are significant, we observe larger spread discounts as the certification levels increase. The difference in spread is 61 to 68 basis points for the highest performing, Platinum-labeled LEED buildings, translating into a reduction in the annual interest payments for the average mortgage in our sample of $410,000.

Analyzing corporate bond spreads, we document that firms with a more environmentally efficient portfolio, measured by both Energy Star and LEED certification, have significantly lower bond spreads. Regarding the impact of certification on the cost of debt at bond issuance, we find that a one-standard deviation

increase in the LEED portfolio share decreases the spread by about 11 to 22 basis points, which translates into a $111,000 to $223,000 reduction in the interest payment for an average REIT bond. In the secondary market, if the share of environmentally certified buildings increases by one-standard deviation, the bond spread declines by 24 basis points. A simple robustness test shows that the results are not influenced by debt capacity differences between REITs that exhibit different levels of environmental performance, or by the use of a difference-in-difference analysis. These findings provide an indication that portfolio greenness reduces the cost of debt for REITs, possibly reflecting the lower risk and higher income associated with environmentally certified buildings. Although the effects are statistically significant, the economic significance at the portfolio level is quite small, which is in line with findings for general corporates (Goss and Roberts 2011) and in line with our expectations, given the limited share of environmentally certified buildings in the portfolio of the average of U.S. REIT.

The findings in this paper have some implications for REITs, investors, and policy makers. The commercial real estate sector is responsible for 46 percent of total U.S. energy consumption and emits 981 million metric tons of carbon dioxide per annum. This environmental externality is currently addressed through regulatory responses that mostly focus on increasing market efficiency through enhanced transparency. More than ten major U.S. cities, including Boston, New York, Washington D.C., as well as the state of California, have enacted regulation mandating the disclosure of commercial building energy performance. In addition, voluntary "green" certification schemes have diffused rapidly in the marketplace. If the capital market is efficient in pricing environmental performance, it will also be able to price environmental underperformance. This may have implications for the cost of capital of inefficient assets, and for their market values, providing an incentive for investors and REITs to develop investment strategies addressing the energy efficiency and environmental

performance of buildings. This effect would provide a partial, market-based solution to an otherwise daunting policy challenge, perhaps slowly reducing the negative environmental impact of the capital building stock.

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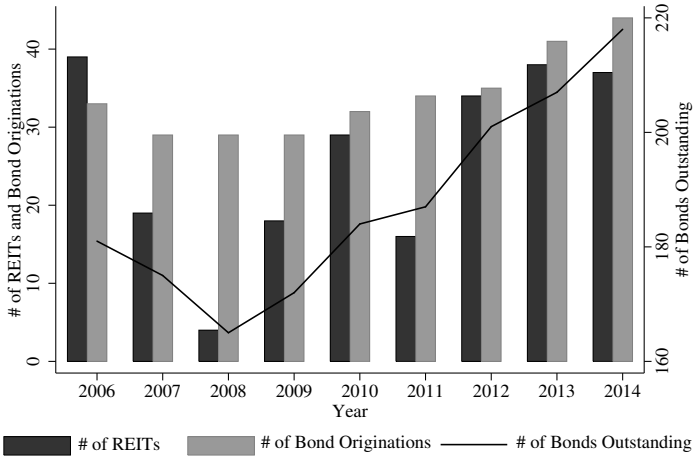
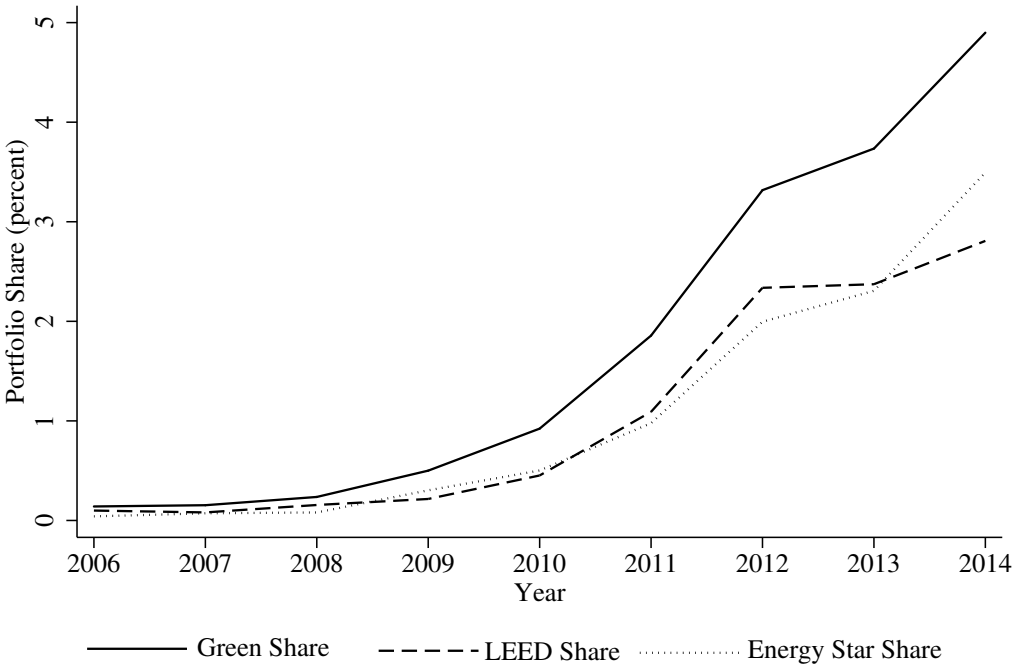
Appendix

Figure A.1: The Number of REIT Bonds at Origination and in the Secondary Market (2006-2014)



The figure shows the number of REITs and the number of corporate bond originations by REITs in the sample by year. The black line represents the number of outstanding REIT corporate bonds in the secondary market over time.

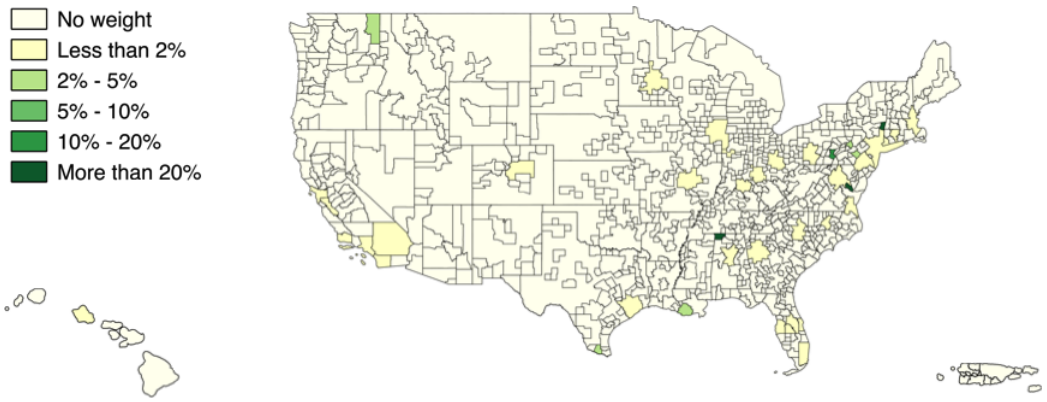
Figure 1: Portfolio Weights of Environmental Certification over Time (2006-2014)



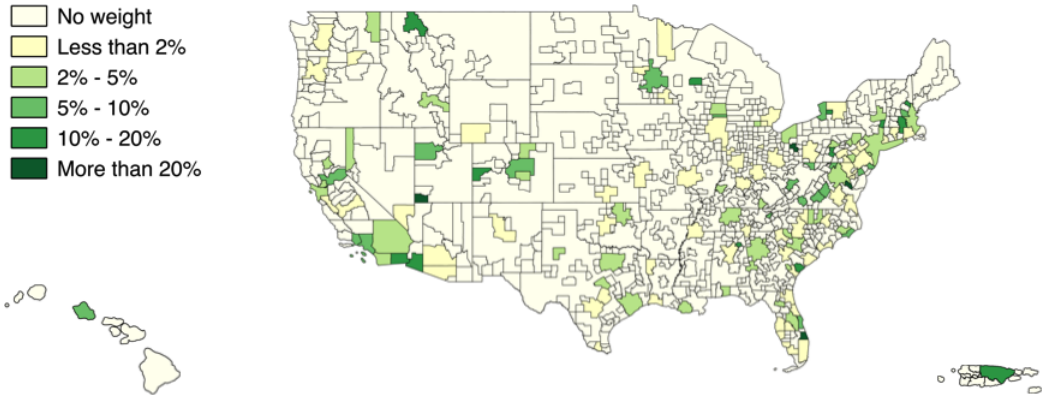
The figure displays the average share of environmentally certified buildings in REIT portfolios over time. The solid line depicts the share of buildings in REIT portfolios with an Energy Star label, LEED certification or both. The dashed and dotted lines represent the share of buildings in REIT portfolios that are certified under the LEED or Energy Star program, respectively.

Figure 2: Environmental Certification of REIT-Owned Assets by CBSA (2006, 2010, 2014)

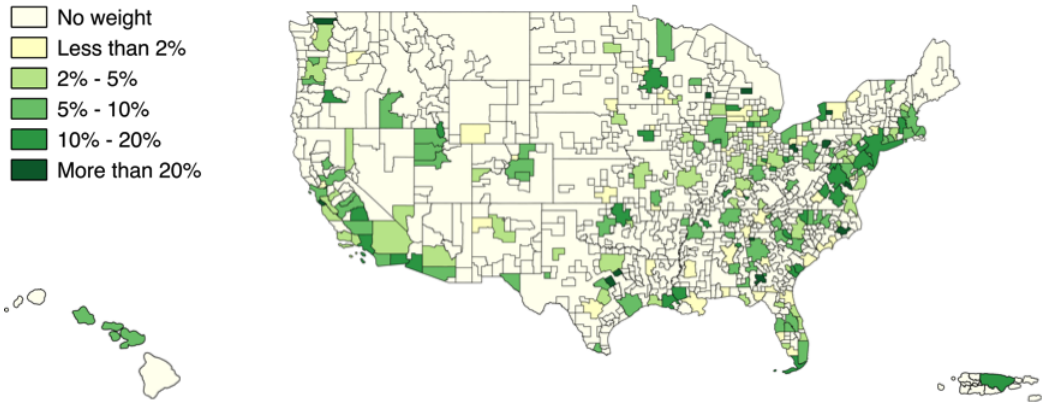
Panel A – Share of Environmentally Certified Buildings in 2006 (sq. ft.)



Panel B – Share of Environmentally Certified Buildings in 2010 (sq. ft.)



Panel C – Share of Environmentally Certified Buildings in 2014 (sq. ft.)



The share of environmentally certified buildings is calculated by Core Based Statistical Area (CBSA) and based on the total of square footage of certified buildings relative to the total square footage of assets owned by REITs in the CBSA. Hawaii, Puerto Rico and the U.S. Virgin Islands are enlarged for visibility. The state of Alaska is included in the estimation as well, but since the share of environmentally certified buildings in Alaska and its corresponding CBSA, Anchorage, is consistently zero, it is omitted from the figure.

Table 1: Descriptive Statistics
(2006-2014)

Panel A – Commercial Mortgages and Collateral Assets						
VARIABLES	Mean	Std. Dev.	Obs.	Mean	Std. Dev.	Obs.
	Non-Certified Collateral			Env. Certified Collateral		
Building Characteristics						
LEED Label (1=yes)	-	-	-	0.54	0.50	177
Energy Star Label (1=yes)	-	-	-	0.58	0.49	177
Renovated (1=yes)	0.16	0.37	2,611	0.34	0.48	96
Amenities (1=yes)	0.33	0.47	2,611	0.42	0.50	96
Transit Stop (1=yes)	0.23	0.42	2,611	0.46	0.50	96
Asset Book Value (in $ million)	44.12	96.50	4,376	152.76	253.92	177
Less Than 10 Years Old (1=yes)	0.29	0.45	4,376	0.24	0.43	177
Mortgage Characteristics						
Mortgage Spread (in bps)	287.41	179.73	4,376	300.50	157.18	177
Encumbrance (in $ million)	59.12	90.67	4,376	108.76	166.82	177
LTV (fraction)	0.55	0.24	4,376	0.51	0.26	177
Time-to-Maturity (in years)	6.26	4.92	4,376	6.11	3.84	177
Cross-Collateralization (1=yes)	0.32	0.47	4,376	0.18	0.39	177
Fixed Rate (1=yes)	0.79	0.41	4,376	0.81	0.39	177
Firm Characteristics						
Total Assets (in $ billion)	3.82	0.61	4,376	7.83	9.05	177
Firm Q	1.26	0.28	4,376	1.25	0.26	177
Debt Ratio	0.54	0.15	4,376	0.54	0.10	177
Panel B – Corporate Bonds						
	All Bonds					
Firm Characteristics						
Green Share (in percent)	1.99	4.64	1,690			
LEED Share (in percent)	1.13	3.55	1,690			
Energy Star Share (in percent)	1.30	3.17	1,690			
Total Assets (in $ billion)	9.42	7.81	1,690			
Firm Q	1.47	0.34	1,690			
Debt Ratio	0.53	0.10	1,690			
Bond Characteristics						
Bond Spread (in bps)	299.84	399.82	1,690			
Moody's Rating	14.31	1.10	1,690			
Debt Value (in $ million)	99.37	9.21	1,690			
Time-to-Maturity (in years)	6.53	4.81	1,690			
Callable (1=yes)	0.26	0.44	1,690			
Convertible (1=yes)	0.02	0.13	1,690			

Table 1 shows the descriptive statistics for REIT mortgage data in Panel A and corporate bond data in Panel B. In Panel A, LEED/Energy Star labels show whether a building is LEED/Energy Star certified. Mortgage characteristics include LTV, year to maturity, indicator variables for fixed rate mortgages and whether there is any other asset collateralizing the mortgage. Asset book value and age are also included. The descriptive statistics of mortgage and building characteristics are by building and the descriptive statistics of green share and firm characteristics are by firm-years. In Panel B, LEED (Energy Star) share is the ratio of total square feet of LEED (Energy Star) certified assets to the total square feet of the REIT portfolio in year *t*. Bond characteristics include the debt value, year to maturity and an indicator variable for callable bonds. In both panels, firm characteristics cover the logarithm of total assets, debt-to-asset ratio and firm Q calculated as the ratio of market value of assets to book value of assets. All of the financial controls are observed at year t-1. The descriptive statistics of bond characteristics are by bond issue and the descriptive statistics of green share and firm characteristics are by firm-years.

Table 2: Environmental Certification and Mortgage Spreads
OLS Regressions
(2006-2014)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Environmental Certification	-0.345***		-0.363***			
(1=yes)	[0.110]		[0.131]			
LEED		-0.376***		-0.436***	-0.584***	
(1=yes)		[0.137]		[0.158]	[0.158]	
Energy Star		-0.156		-0.043		-0.202
(1=yes)		[0.156]		[0.172]		[0.205]
Renovated			-0.214**	-0.217**	-0.214**	-0.213**
(1=yes)			[0.088]	[0.088]	[0.089]	[0.091]
Amenities			-0.280***	-0.281***	-0.274***	-0.293***
(1=yes)			[0.103]	[0.103]	[0.104]	[0.107]
Transit Stop			-0.003	0.000	-0.004	-0.010
(1=yes)			[0.093]	[0.093]	[0.095]	[0.097]
log(Asset Book Value)	-0.214***	-0.213***	-0.178***	-0.177***	-0.171***	-0.183***
	[0.043]	[0.043]	[0.054]	[0.055]	[0.054]	[0.056]
Less Than 10 Years Old	-0.148**	-0.146**	-0.165**	-0.163**	-0.179**	-0.163*
(1=yes)	[0.072]	[0.072]	[0.082]	[0.081]	[0.081]	[0.084]
LTV	0.430	0.429	0.551*	0.553*	0.561*	0.545*
(fraction)	[0.284]	[0.285]	[0.309]	[0.309]	[0.310]	[0.315]
LTV Dummy	-0.304**	-0.305**	-0.323**	-0.324**	-0.330**	-0.317**
(LTV≥0.7)	[0.141]	[0.141]	[0.153]	[0.153]	[0.153]	[0.155]
Time-to-Maturity	-0.129***	-0.129***	-0.134***	-0.134***	-0.133***	-0.133***
(in years)	[0.012]	[0.012]	[0.014]	[0.014]	[0.014]	[0.014]
Cross-Collateralization	-0.290*	-0.291*	-0.225	-0.224	-0.230	-0.241
(1=yes)	[0.160]	[0.160]	[0.163]	[0.163]	[0.162]	[0.164]
Fixed Rate	1.630***	1.632***	1.745***	1.748***	1.740***	1.746***
(1=yes)	[0.162]	[0.162]	[0.179]	[0.179]	[0.178]	[0.180]
log(Firm Size)	-0.033	-0.034	-0.013	-0.014	-0.017	-0.015
(lagged, t-1)	[0.055]	[0.055]	[0.060]	[0.060]	[0.061]	[0.061]
Market-to-Book	-0.050	-0.048	0.050	0.056	0.025	0.067
(lagged, t-1)	[0.180]	[0.180]	[0.206]	[0.206]	[0.209]	[0.215]
Debt Ratio	0.338	0.340	0.501	0.502	0.503	0.497
(lagged, t-1)	[0.382]	[0.384]	[0.403]	[0.404]	[0.401]	[0.411]
Constant	3.108***	3.114***	2.110**	2.097**	2.125**	2.181**
	[0.819]	[0.820]	[0.859]	[0.860]	[0.879]	[0.884]
Year-Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
State-Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Asset Type-Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,553	4,553	2,707	2,707	2,660	2,645
R-squared	0.513	0.513	0.545	0.545	0.549	0.548

The table presents the results of the regressions of mortgage spread on the LEED/Energy Star indicator, mortgage and building characteristics. The LEED (Energy Star) dummy indicates whether an asset collateralizing a mortgage is LEED (Energy Star) certified. Mortgage and building characteristics include the LTV ratio calculated as the ratio of encumbrance to the total book value of assets collateralizing a mortgage, the logarithm of asset book value, year to maturity and variables indicating whether the mortgage is a fixed-rate mortgage and whether there is any other asset collateralizing the mortgage. The regressions also include building quality characteristics in Columns 3 to 6. All regressions include asset type dummies, year dummies and location dummies by state. Heteroskedasticity-robust and REIT-clustered standard errors are in brackets. *, **, and *** indicate significance at the 10, 5, and 1 percent level, respectively.

Table 3: LEED Certification Levels and Mortgage Spreads
OLS Regressions
(2006-2014)

VARIABLES	(1)	(2)	(3)	(4)
Low-Level LEED	-0.460**	-0.460**	-0.539***	-0.539***
(1=yes)	[0.219]	[0.219]	[0.200]	[0.200]
High-Level LEED	-0.585***		-0.650***	
(1=yes)	[0.199]		[0.242]	
Gold		-0.572**		-0.658**
(1=yes)		[0.220]		[0.283]
Platinum		-0.681***		-0.611**
(1=yes)		[0.242]		[0.305]
Renovated			-0.213**	-0.214**
(1=yes)			[0.089]	[0.090]
Amenities			-0.275***	-0.275***
(1=yes)			[0.104]	[0.104]
Transit Stop			-0.004	-0.004
(1=yes)			[0.095]	[0.095]
log(Asset Book Value)	-0.208***	-0.208***	-0.171***	-0.170***
	[0.043]	[0.043]	[0.054]	[0.054]
Less Than 10 Years Old	-0.154**	-0.154**	-0.179**	-0.179**
(1=yes)	[0.071]	[0.071]	[0.081]	[0.081]
LTV	0.451	0.452	0.563*	0.563*
(fraction)	[0.285]	[0.285]	[0.311]	[0.311]
LTV Dummy	-0.312**	-0.312**	-0.332**	-0.332**
(LTV≥0.7)	[0.142]	[0.142]	[0.154]	[0.154]
Time-to-Maturity	-0.128***	-0.128***	-0.133***	-0.133***
(in years)	[0.012]	[0.012]	[0.014]	[0.014]
Cross-Collateralization	-0.289*	-0.289*	-0.231	-0.231
(1=yes)	[0.158]	[0.158]	[0.162]	[0.162]
Fixed Rate	1.629***	1.629***	1.739***	1.739***
(1=yes)	[0.160]	[0.160]	[0.178]	[0.179]
log(Firm Size)	-0.035	-0.035	-0.017	-0.017
(lagged, t-1)	[0.056]	[0.056]	[0.061]	[0.061]
Market-to-Book	-0.070	-0.070	0.025	0.025
(lagged, t-1)	[0.182]	[0.182]	[0.209]	[0.209]
Debt Ratio	0.337	0.337	0.503	0.503
(lagged, t-1)	[0.381]	[0.381]	[0.401]	[0.401]
Constant	3.090***	3.091***	2.130**	2.129**
	[0.832]	[0.832]	[0.881]	[0.880]
Year-Fixed Effects	Yes	Yes	Yes	Yes
State-Fixed Effects	Yes	Yes	Yes	Yes
Asset Type-Fixed Effects	Yes	Yes	Yes	Yes
Observations	4,450	4,450	2,660	2,660
R-squared	0.517	0.517	0.549	0.549

Table 3 shows the relationship between LEED certification levels and mortgage spread. The low-level LEED dummy includes Certified and Silver LEED labels. The high-level LEED dummy includes Gold and Platinum LEED labels. Gold and Platinum dummies indicate Gold and Platinum LEED labels, respectively. All regressions include asset type dummies, year dummies and location dummies by state. Heteroskedasticity-robust and REIT-clustered standard errors are in brackets. *, **, and *** indicate significance at the 10, 5, and 1 percent level, respectively.

Table 4: Environmental Certification and Corporate Bond Spreads at Origination
OLS and 2-Stage GMM Regressions
(2006-2014)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	OLS			2-Stage GMM		
Green Share	-1.599*			-2.017**		
(in percent)	[0.892]			[0.989]		
LEED Share		-2.150**			-2.398**	
(in percent)		[0.973]			[1.097]	
Energy Star Share			-1.542			-1.792
(in percent)			[1.358]			[1.523]
log(Firm Size)	-0.066	-0.062	-0.071	-0.051	-0.062	-0.081
(lagged, t-1)	[0.134]	[0.134]	[0.136]	[0.165]	[0.163]	[0.171]
Market-to-Book	-0.346	-0.350	-0.324	-0.158	-0.184	-0.197
(lagged, t-1)	[0.233]	[0.232]	[0.233]	[0.287]	[0.280]	[0.299]
Debt Ratio	0.615	0.621	0.559	0.262	0.208	0.513
(lagged, t-1)	[0.481]	[0.477]	[0.488]	[0.730]	[0.738]	[0.711]
Moody's Rating	-0.292***	-0.297***	-0.282***	-0.416***	-0.410***	-0.357**
(8 to 17)	[0.072]	[0.072]	[0.074]	[0.145]	[0.143]	[0.139]
log(Bond Value Issued)	-0.129	-0.124	-0.128	-0.057	-0.045	-0.079
(in $ million)	[0.156]	[0.155]	[0.155]	[0.121]	[0.121]	[0.122]
Time-to-Maturity	-0.019	-0.019	-0.018	-0.006	-0.005	-0.010
(in years)	[0.027]	[0.027]	[0.027]	[0.020]	[0.020]	[0.021]
Callable	0.120	0.122	0.106	0.128	0.128	0.090
(1=yes)	[0.149]	[0.148]	[0.149]	[0.130]	[0.129]	[0.129]
Convertible	-2.207***	-2.196***	-2.210***	-3.018***	-3.030***	-2.939***
(1=yes)	[0.567]	[0.568]	[0.566]	[0.708]	[0.705]	[0.710]
Constant	7.380***	7.350***	7.300***	8.837***	8.878***	8.555***
	[1.818]	[1.810]	[1.830]	[1.526]	[1.526]	[1.578]
Year-Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Asset Type-Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	234	234	234	182	182	182
R-squared	0.772	0.773	0.771	0.762	0.763	0.756
Hansen J (prob.)	-	-	-	0.986	0.768	0.289
Kleibergen-Paap (prob.)	-	-	-	0.000	0.000	0.008

The table represents the OLS and 2-stage GMM regressions of bond spread on LEED/Energy Star share, bond characteristics and firm characteristics at bond origination. LEED (Energy Star) share is the ratio of total square feet of LEED (Energy Star) certified buildings to the total square feet of the portfolio in year t. Bond characteristics include the logarithm of debt value, year to maturity, Moody's rating and dummies indicating whether the bond is callable and convertible. Firm characteristics cover the logarithm of total assets, debt-to-asset ratio and firm Q calculated as the ratio of market value of assets to book value of assets. All financial controls are observed at year t-1. The regressions include asset type and year dummies. In the first stage of the last three regressions, we regress LEED (Energy Star) share on the lagged LEED (Energy Star) share, a local greenness measure and the explanatory variables from the second stage regressions. Hansen J and Kleibergen-Paap test probabilities for over-identification and under-identification are reported in the table. Heteroskedasticity-robust and firm-clustered standard errors are in brackets. *, **, and *** indicate significance at the 10, 5, and 1 percent level, respectively.

Table 5: Environmental Certification and Corporate Bond Spreads on Secondary Market
OLS Panel and 2-Stage GMM Regressions
(2006-2014)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Panel Data - OLS			2-Stage GMM		
Green Share	-2.558***			-4.249***		
(in percent)	[0.949]			[1.071]		
LEED Share		-3.143***			-5.089***	
(in percent)		[1.001]			[1.190]	
Energy Star Share			-2.057			-3.433**
(in percent)			[1.323]			[1.658]
log(Firm Size)	-0.156	-0.152	-0.166	0.391*	0.247	0.629**
(lagged, t-1)	[0.191]	[0.194]	[0.196]	[0.218]	[0.191]	[0.275]
Market-to-Book	-1.356***	-1.331***	-1.346***	-0.215	-0.389	-0.024
(lagged, t-1)	[0.440]	[0.436]	[0.442]	[0.322]	[0.291]	[0.375]
Debt Ratio	1.726*	1.670*	1.663*	-2.404***	-2.122***	-2.930***
(lagged, t-1)	[0.952]	[0.941]	[0.963]	[0.783]	[0.763]	[0.824]
Moody's Rating	-0.116	-0.118	-0.100	-0.737***	-0.617***	-0.727***
(8 to 17)	[0.120]	[0.122]	[0.121]	[0.176]	[0.153]	[0.196]
log(Bond Value Issued)	-0.540**	-0.529**	-0.529**	-0.319*	-0.291	-0.343*
(in $ million)	[0.238]	[0.234]	[0.224]	[0.193]	[0.190]	[0.197]
Time-to-Maturity	-0.070*	-0.070*	-0.071*	-0.064**	-0.037	-0.098***
(in years)	[0.037]	[0.037]	[0.037]	[0.029]	[0.026]	[0.036]
Callable	0.714***	0.716***	0.695***	0.440***	0.411***	0.444***
(1=yes)	[0.183]	[0.182]	[0.179]	[0.099]	[0.097]	[0.103]
Convertible	-3.649***	-3.648***	-3.622***	-3.361***	-3.601***	-2.955***
(1=yes)	[0.529]	[0.531]	[0.538]	[0.984]	[0.981]	[1.011]
Constant	10.372***	10.242***	10.232***	9.957***	10.180***	6.292**
	[2.921]	[2.910]	[2.883]	[2.290]	[2.187]	[2.489]
Year-Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Asset Type-Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,690	1,690	1,690	707	705	707
R-squared	0.740	0.740	0.739	0.807	0.808	0.800
Hansen J (prob.)	-	-	-	0.550	0.865	0.0276
Kleibergen-Paap (prob.)	-	-	-	0.000	0.000	0.000

The table presents the OLS and 2-stage GMM regressions of bond spread on LEED/Energy Star share, bond characteristics and firm characteristics for the secondary market sample. LEED (Energy Star) share is the ratio of total square feet of LEED (Energy Star) certified buildings to the total square feet of the portfolio in year *t*. Bond characteristics include the logarithm of debt value, year to maturity, Moody's rating and dummies indicating whether the bond is callable and convertible. Firm characteristics include the logarithm of total assets, debt-to-asset ratio and firm Q calculated as the ratio of market value of assets to book value of assets. All financial controls are observed at year *t-1*. The regressions include asset type dummies and year dummies. In the first stage of the last three regressions, we regress the LEED (Energy Star) share on the lagged LEED (Energy Star) share, local greenness measure and the explanatory variables from the second stage regressions. Hansen J and Kleibergen-Paap test probabilities for over-identification and under-identification are reported in the table. Heteroskedasticity-robust and firm-clustered standard errors are in brackets. *, **, and *** indicate significance at the 10, 5, and 1 percent level, respectively.

Table 6: Environmental Certification and Corporate Bond Spreads
Difference-in-Difference Regressions
(2007-2014)

VARIABLES	(1) ΔBond Spread	(2) ΔBond Spread	(3) ΔBond Spread
ΔGreen Share	-16.737***		
	[5.795]		
ΔLEED Share		-11.378	
		[9.359]	
ΔEnergy Star Share			-17.194***
			[6.194]
Δlog(Firm Size)	6.258***	6.123***	6.176***
(lagged, t-1)	[1.629]	[1.633]	[1.614]
ΔMarket-to-Book	1.003	0.925	0.971
(lagged, t-1)	[1.572]	[1.573]	[1.572]
ΔDebt Ratio	11.027**	11.085**	11.270**
(lagged, t-1)	[5.289]	[5.277]	[5.266]
ΔMoody's Rating	-1.411	-1.332	-1.365
(8 to 17)	[1.473]	[1.467]	[1.471]
Observations	1,344	1,344	1,344
R-squared	0.051	0.049	0.051

The table presents the difference-in-difference regression of bond spread on LEED/Energy Star share, bond characteristics and firm characteristics. LEED (Energy Star) share is the ratio of total square feet of LEED (Energy Star) certified assets to the total square feet of the portfolio in year t. Firm characteristics cover the logarithm of total assets, debt-to-asset ratio and firm Q calculated as the ratio of market value of assets to book value of assets. All of the financial controls are observed at year t-1 and first-differenced. Among bond characteristics, we also use the first difference of a bond's rating. Heteroskedasticity-robust and firm-clustered standard errors are in brackets. *, **, and *** indicate significance at the 10, 5, and 1 percent level, respectively.

Table 7: Debt Capacity Analysis

Panel A – Commercial Mortgages			
	Loan-to-Value		
	Certified	None	Certified-None *(t-stat)*
Env. Certified	0.51 (N=177)	0.55 (N=4,376)	-0.04 *(2.03)***
LEED	0.49 (N=96)	0.55 (N=4,457)	-0.06 *(2.10)***
Energy Star	0.52 (N=103)	0.55 (N=4,450)	-0.03 *(1.18)*

Panel B – Corporate Bonds at Issuance				
	Debt Ratio			
	High Portfolio Share	Low Portfolio Share	None	High-None *(t-stat)*
Env. Certified	0.51 (N=70)	0.51 (N=75)	0.52 (N=89)	-0.00 *(0.23)*
LEED	0.50 (N=62)	0.53 (N=63)	0.51 (N=109)	-0.01 *(0.74)*
Energy Star	0.51 (N=52)	0.54 (N=61)	0.50 (N=121)	0.01 *(0.96)*
	Bond Value ($ million)			
	High Portfolio Share	Low Portfolio Share	None	High-None *(t-stat)*
Env. Certified	98.64 (N=70)	98.69 (N=75)	100.00 (N=89)	-1.36 *(0.55)*
LEED	100.40 (N=62)	100.00 (N=63)	98.20 (N=109)	1.83 *(0.71)*
Energy Star	96.25 (N=52)	100.03 (N=61)	100.00 (N=121)	-3.75 *(1.43)*

The table presents univariate analysis on debt capacity. Specifically, the mean-diiference tests are performed to compare environmental certification sample with the rest of the sample. For the commercial mortgage sample, mean difference test is performed for the LTV ratio calculated as the ratio of encumbrance to the total book value of assets collateralizing a mortgage. Mean difference tests are also shown for the debt-to-asset ratio and the bond value for the corporate bond analysis at issuance.