Decomposing the Value Effects of Sustainable Real Estate Investment: International Evidence

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Abstract

While some evidence exists on the benefits of sustainable investment for publicly traded real estate firms, little is known as to how such benefits materialize within the firm, especially on an international scale. We decompose the effects of sustainable investment on the value and performance of listed real estate investment firms across countries with and without mandatory environmental reporting on investment properties. In the US, a country without requisite reporting, we find that REITs with a more sustainable portfolio experience higher rental income, higher operating expenses, and lower interest expenses, increasing cash flows available for distribution to shareholders. These firms also carry lower systematic risk, are subject to less uninformed trading, and attract higher premiums to NAV. We find less nuanced results for real estate investment firms in the UK, which face mandatory environmental reporting. Our findings suggest that environmental reporting requirements may facilitate improvements in the environmental performance of properties and enhance transparency.

Key words: Real estate investment trusts; sustainability; energy efficiency

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Real estate investment firms around the globe increasingly commit to ever more ambitious sustainability practices.[1] Since 2010, the number of real estate investment firms agreeing to have their businesses scrutinized for the Global Real Estate Sustainability Benchmark (GRESB) has increased from 198 to 759, representing a gross asset value of US$2.8 trillion.[2] However, survey evidence suggests that the primary concern of real estate managers in relation to sustainability efforts is the impact on financial outcomes of the firm (Pivo, 2008). So, do environmentally sustainable properties offer benefits for the financial performance of the firms investing in them? If so, what are the underlying economic drivers and mechanisms?

Several features of the literature on sustainable real estate investment to date motivate our analysis. First, existing evidence mostly comes from individual properties. This evidence suggests that environmentally certified office buildings attract premiums in rent, occupancy, and asset values (Eichholtz, Kok, and Quigley, 2013, 2010; Fuerst and McAllister, 2011; Miller, Spivey, and Florance, 2008; Wiley, Benefield, and Johnson, 2008), with similar findings for multifamily rental rates (Bond and Devine, 2016).[3] By comparison, little evidence exists for the effects of investments in sustainable buildings on the performance of real estate investment firms. Given the relatively recent growth in environmental building certifications (Kok, McGraw, and Quigley, 2011), it is unclear whether the current level of diffusion is sufficient to have an economically significant impact on large investment portfolios that are predominantly comprised of conventional buildings.

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[1] The pursuit of environmentally sustainable building is often attributed to the observation that real estate is associated with more than 40% of energy consumption, and more than 80% of electricity use, the highest level of all use sectors (see http://www.eia.gov).

[2] See: https://www.gresb.com/2016/global.

[3] On the property level, there is also evidence to the following: Sustainable properties subject to lower rates of obsolescence (Kok and Jennen, 2012), and improve tenant satisfaction, leading to higher lease renewal rates (Devine and Kok, 2015). Furthermore, sustainable properties are less likely to be associated with residential mortgage delinquency (Kaza, Quercia, and Tian, 2014) and commercial mortgage default (An and Pivo, 2015). The value premium for sustainable properties on average also exceeds the marginal cost involved in constructing buildings of high environmental standards (Chegut, Eichholtz, and Kok, 2015).

To the extent that evidence on the relationship between sustainable investments and the performance of real estate investment firms exists, it is ambiguous. Ho, Rengarajan, and Lum (2013) examine the effects of sustainable investments on the operational performance in Singaporean REITs and find mixed results. Fuerst (2015) finds that international REITs with a higher GRESB ranking fail to achieve higher total stock returns than their lower-ranking peers. Eichholtz, Kok, and Yönder (2012) find that US REITs with a larger proportion of sustainable properties in their portfolio do not earn positive abnormal stock returns. [4]

Where the existing real estate literature documents a positive effect of sustainability practices on firm-level financial outcomes, the underlying mechanisms are unclear. Sah, Miller, and Ghosh (2013) find higher corporate valuations for US REITs that participate in the Energy Star program. Eichholtz, Kok, and Yönder (2012) find improvements in accounting measures of operational performance for US REITs with more sustainable properties. Fuerst (2015) finds that REITs with a higher GRESB ranking achieve higher risk-adjusted returns. Yet, these studies stop short of identifying the economic mechanisms underlying these improvements. Thus, research is unable to offer insights for managers into the amount of resources they should optimally allocate to generating "green value," or to provide guidance for investors on what might be the price of a "green conscience."

Several scholars call for improved insight into the mechanisms that drive performance differences between sustainable and conventional firms, see for instance Eccles, Ioannou, and Serafeim (2014); Margolis, Elfenbein, and Walsh (2009). We contribute to these efforts by decomposing the effects of investing in sustainable properties on the value and performance of listed real estate investment firms.

[4] The ambiguity in the evidence for the effect of sustainable properties on the corporate performance of the REITs that own them mirrors the broader literature on the relationships between corporate social responsibility and financial performance (Margolis, Elfenbein, and Walsh, 2009). Dam and Scholtens (2015) conclude that the "social performance of firms seems to be valued differently, depending upon the perspective taken" (page 104).

Listed real estate investment firms offer a useful opportunity for this decomposition. For one, we observe value and performance on the individual asset (property portfolio) level as well as the aggregate corporate level. Specifically, we observe property-level cash flows, driven by rents and operating costs, and corporate-level cash flows, which account for the costs of managing and financing the portfolio. Therefore, we are able to separate the effects of sustainable investment on the individual components of corporate cash flows. Further, real estate assets actively trade in a secondary market, allowing us to observe the market value of the assets and compare it to the market value of the firm's equity. [5] With real estate firms, we are thus able to decompose any valuation effects into a component driven by cash flows and potential changes in risk, which should be reflected in the market value of the assets, and a "halo" effect of corporate sustainability that only affects the market value of the firm's equity. Our first contribution is to isolate these different empirical effects of sustainability practices on firm-level financial outcomes.

Corporate environmental sustainability goals may be motivated bottom-up, by increased demand from the real estate investment industry, or top-down, through environmental regulation imposed by governments. Different approaches to achieving sustainability may have significant implications for the empirical links between sustainability practices and firm value and performance. For instance, if voluntary sustainability certifications convey information about the environmental performance of properties, then the value of this signal may be reduced when a baseline level of public disclosure is mandatory and thus easily available. However, existing research is often limited to a single country-market and lacks comparisons that could address this question. Our second contribution is to compare the empirical links between sustainability practices and firm value and performance in the US and the UK.

[5] Market-based measures of value and performance are of particular importance because they are a better reflection of shareholder wealth (Mackey, Mackey, and Barney, 2007).

We focus on these two countries because they differ significantly in the institutional environment for sustainability reporting of investment property. While the UK requires a baseline level of environmental performance disclosure for investment property, no such requisite reporting exists in the US. Therefore, we are able to draw a direct comparison between the value and performance effects of voluntary corporate sustainability practices (in the US) and the effects of those practices in the presence of a minimum required level of engagement (in the UK).

We begin our analysis by outlining a conceptual framework that systematically links sustainability practices to property performance and firm value. We then compile a data set of listed equity REITs and property companies in the US and the UK, including information on portfolio composition. We hand-collect data on the environmental certification of commercial properties in the US and the UK from the three leading certification programs. We match this information to the firms' property holdings to calculate the share of each firm's portfolio that corresponds to environmentally sustainable buildings relative to conventional buildings, and track the evolution of this metric through time. We relate this panel of *Green Share* data to the panel of property portfolio-level and corporate-level financial outcomes.

We find that US REITs with a larger *Green Share* achieve higher rental revenue, holding assets, liabilities, and unobservable firm and time effects constant. We also find that these firms experience higher operating expenses, likely because green buildings tend to feature sophisticated technology and utilize more electricity in exchange for greater ambient control. On balance, we find that the rental revenue premium compensates for the increase in operating expenses, resulting in stable net operating income. On the corporate expense level, we find lower interest expenses associated with investment in more sustainable properties. Overall, we find that "green" US REITs have higher levels of funds available for distribution to shareholders.

On the capital markets side, we find that US REITs with a larger share of sustainable properties in their portfolio have lower systematic risk, suggesting that "green" portfolios are more resilient to variation in stock market returns. We also find that these firms have higher equity market valuations relative to net asset value. Our finding implies that these valuation gains go beyond any improvements in the market value of the underlying properties based on higher cash flows or lower risk, hence we interpret them as gains from corporate reputation effects. We also find that US REITs with a larger *Green Share* have lower stock turnover. Our finding suggests that sustainability certifications convey information about the environmental performance of properties, improving transparency and thus reducing uninformed trading.

In the UK, where a baseline level of environmental performance reporting is mandatory, we find that listed property companies benefit from having a larger *Green Share* in terms of improved net operating income and earnings measures, but the findings are less nuanced than in the US. This difference in our findings on the cash flow side suggests that mandatory environmental disclosure may gradually improve the environmental quality of investment property in the UK, reducing the marginal performance benefits from properties that carry additional voluntary certifications.

We also find that UK firms with a larger *Green Share* experience improved market valuation outcomes relative to net asset value, suggesting benefits in terms of corporate reputation. However, our findings suggest no changes in systematic risk or liquidity in the UK sample. With regards to liquidity, we interpret this contrast in our findings as evidence that the compulsory environmental disclosure for investment property in the UK produces a baseline level of information that improves transparency in the market. This baseline level of information may attenuate the marginal signaling benefits that are obtained through additional voluntary sustainability labels and that reduce uninformed trading in the US sample.

In conclusion, we clarify, conceptually and in the data, the relative value and performance effects of sustainability practices on the property-level, the operating and financing level of the firm, as well as the corporate level from the shareholder's point of view. Further, the existing literature mostly focuses on individual countries. We compare the value and performance effects of environmental certification practices in different international markets with market-led versus regulation-driven approaches to achieving sustainability in the built environment.

1 Conceptual background on sustainability and REIT value

Our empirical work is based on the fundamental dividend-discount relationship of corporate valuation.[6] The dividend discount model defines firm value V at time t as the present value of future dividends D_t, discounted at a rate r:

$$V_t = \int_t^T D_t e^{-rt} dt \tag{1}$$

Table 1 shows a standard REIT income statement. According to this statement, the corporate cash flow available for distribution to shareholders, C_t, is the cash flow obtained from the properties owned and operated by the REIT, Y_t, minus any interest expense, I_t, and minus corporate level overheads, G_t:

$$C_t = Y_t - I_t - G_t \tag{2}$$

[Table 1 about here.]

[6] Capozza and Seguin (1999) use this relationship in a similar way to motivate empirical tests.

If REITs pay out 100% of cash flows available for distribution, then, following (1), firm value becomes:

$$V_t = \int_t^T (Y_t - I_t - G_t)_t e^{-rt} dt \tag{3}$$

Assuming constant rates of growth in property cash flows, g^y, and corporate overheads, g^g, (3) may be simplified, in perpetuity, to the following expression:

$$V_t = \frac{Y_t}{r - g^y} - \frac{I_t}{r} - \frac{G_t}{r - g^g} \tag{4}$$

The REIT regulation requires qualifying firms to pay out at least 90% of taxable corporate income as dividends, and many REITs regularly pay out significantly more than the mandatory minimum (Boudry, 2011; Hardin and Hill, 2008; Wang, Erickson, and Gau, 1993). This pay-out policy results in a close correlation between REIT dividends and cash flows available for distribution. Therefore, the valuation of REITs is closely related to the present value of future corporate cash flows. If a corporate policy to invest in sustainable properties affects REIT firm value, then it must do so via one or more of the valuation components identified above.

1.1 Cash flow effects

A corporate policy of investing in sustainable properties may affect the numerator of the dividend (cash flow) discount valuation through a number of different economic channels. Here, we outline our hypotheses in relation to those channels. Several of our hypotheses are the first attempts to examine such questions. However, where possible, each hypothesis is rooted in the relevant existing literature.

Property level cash flows: Property level cash flows are a function of rental revenues and operating expenses. Research on the individual building level suggests that prop-

erties with sustainability certifications achieve higher rental rates (Bond and Devine, 2016; Eichholtz, Kok, and Quigley, 2013, 2010; Fuerst and McAllister, 2011; Kahn and Kok, 2014; Miller, Spivey, and Florance, 2008; Wiley, Benefield, and Johnson, 2008). As a result, we expect that these rental value benefits carry over to the portfolio level so that REITs with a larger proportion of sustainable properties in their portfolio realize higher rental revenues.

In terms of operating expenses, a major goal of sustainable building is to decrease resource usage, reducing energy-related operating costs (Kats, 2003; Newsham, Mancini, and Birt, 2009; Scofield, 2009, 2013). However, Fullbrook, Jackson, and Finlay (2006) and Kats (2010) find a positive relationship between environmental certification and energy use, particularly in technologically sophisticated "smart buildings". On the other hand, Devine and Kok (2015) argue that sustainable buildings may be associated with lower tenant incentives and re-leasing costs over time. To our knowledge, we are the first to test whether REITs with a larger share of sustainable properties realize higher or lower operating expenses.

Net Operating Income (NOI): NOI, the bottom-line property level cash flow measure, is a function of both, rental income and operating expenses. The balance of these items may increase or decrease with a larger share of sustainable properties. Therefore, the net effect on portfolio-level NOI is an empirical question.

General and Administrative (G&A) expenses: After net operating income, corporate level cash flows are a function of corporate level overheads. Devine and Kok (2015) find that environmentally certified properties are associated with higher tenant satisfaction, thus possibly requiring less intense asset management. REITs with a larger share of sustainable properties may therefore incur lower G&A or management expenses. To the best of our knowledge, we are the first to explore this possible effect of sustainable investment on corporate management expenses.

Interest expensee: Interest expenses also affect corporate-level cash flows. Eichholtz, Holtermans, Kok, and Yönder (2015) find lower spreads on corporate debt issuances collateralized against sustainable properties. However, spreads for individual debt securities at issuance are a different measure from the overall interest expense incurred by a real estate investment firm. Based on the results for interest rate spreads at issuance, and holding liabilities constant, we expect REITs with a larger share of sustainable investments to incur lower interest expenses.

Funds From Operations (FFO): Funds from operations is a US REIT-specific measure of accounting earnings or cash flow available for distribution to shareholders. FFO is the overall product of net operating income after G&A (management) expenses and corporate interest expenses. It is an empirical question how the individual effects of the different firm-level income and expense items influence the bottom line of funds from operations overall.

1.2 Discount rate and valuation effects

A corporate policy of investing in sustainable properties may also influence the denominator of the dividend (cash flow) discount valuation, the discount rate. The discount rate reflects the required rate of return on the firm's equity, which is driven by liquidity (Amihud and Mendelson, 1988) and systematic risk.

Liquidity: Corporate investment policies may affect the liquidity of a REIT's equity if these policies generate greater informational asymmetries (Harris, Kriebel, and Raviv, 1982) or if they increase the cost of collecting value-relevant information (Ippolito, 1989). The valuation of real estate requires intricate knowledge of the assets and their characteristics. This information is costly to acquire, causing significant informational asymmetries in REITs in spite of their otherwise transparent business model (Han, 2006). Sustainability certifications provide information on the

environmental performance of properties, potentially improving transparency. Higher liquidity (stock turnover) may signal a higher proportion of uninformed traders in the market (Baker and Stein, 2004). To the extent that better information about the fundamentals of a REIT's portfolio reduces uninformed trading, we expect that firms with a larger share of sustainability certified properties in their portfolio experience lower ratios of stock turnover.

Systematic risk: Sustainable property investment is often associated with the goal of making a portfolio more resilient to market-wide shocks such as shifts in energy prices for instance. On the property-level, resilience may be reflected in more stable occupancy rates and/or lower variation in operating expenses (Devine and Kok, 2015). To the extent that sustainable properties are a more stable source of rental income and subject to less volatile expenses, a portfolio with a higher exposure to sustainable buildings may generate more stable performance that is less sensitive to variation in the economic environment. Thus, we expect that firms with a higher share of sustainable properties have lower systematic risk.

Valuation: The cash flow and discount rate effects discussed above may increase the market value of a portfolio with a larger share of sustainable properties. Real estate assets actively trade in a secondary market. Therefore, we observe the market value of the firm's portfolio separately from the market value of the firm's equity. This circumstance allows us to measure the contribution of sustainable investments to the value of the firm beyond any contributions to the value of the underlying properties. Any such additional value differential would thus reflect a reputation or "halo" effect of sustainable investment.

2 Empirical method

2.1 Basic regression set-up

In order to explore the value and performance effects of sustainable investment, we specify a set of regression models similar to those employed in Capozza and Seguin (1999). First, we estimate the different components of cash flow effects in REIT value and performance, as discussed above. These include: (i) rental revenue, (ii) rental operating expense, (iii) property-level cash flows (NOI), (iv) interest expense, (v) general and administrative expense, (vi) corporate level cash flows available for distribution (FFO in the US, earnings in the UK). For instance, consider the following baseline model for rental revenue, RR_{it}:

$$RR_{it} = \beta_0 + \beta_1 L.AT_{it} + \beta_2 L.AT_{it}^2 + \beta_3 L.LT_{it} + \beta_4 L.LT_{it}^2 + f_i + d_t + u_{it} \qquad (5)$$

where AT_{it} is the depreciated book value of total assets, and LT_{it} is the book value of total liabilities. We address potential endogeneity by lagging all right-hand side variables, where $L.$ denotes the lag operator. [7] In this specification, the coefficient β_1 may be interpreted as a baseline property rental yield. We account for possible non-linearities by including squared terms of total assets and liabilities. We also include firm fixed effects, f_i, and time fixed effects, d_t. Lastly, u_{it} is the residual.

2.2 Effect of sustainable investment

We assess the influence of sustainable property investment by allowing the baseline rental yield to vary with the degree of sustainable investment. Consistent with Eichholtz, Kok, and Yönder (2012), we define the degree to which a REIT follows a

[7] Bellemare, Masaki, and Pepinsky (2015) note that lagged explanatory variables address endogeneity when there is (i) serial correlation in the potentially endogenous explanatory variable, and (ii) no serial correlation among the unobserved sources of endogeneity.

sustainable investment policy using the *Green Share* (GS) of firm i at time t:

$$GS_{it} = \frac{\sum_n^N Area_{it}^{Certified}}{\sum_m^M Area_{it}} \tag{6}$$

where the numerator sums the area (square footage) of all N sustainability-certified properties held by firm i at time t and the denominator sums the area of all M properties held in total by firm i at time t, so that the *Green Share* is a ratio in $[0, 1]$. As a result, we estimate the following model:

$$RR_{it} = \beta_0 + \beta_1(L.GS \times L.AT) + \beta_2 L.\mathbf{x}_{it} + f_i + d_t + u_{it} \tag{7}$$

where $\mathbf{x}$ stands for the lagged covariates from (5). In order to account for heteroskedasticity, we estimate (7) using weighted least squares (WLS) with the inverse of the area of total assets as weights. In subsequent variants of the model, we replace rental revenue as the dependent variable with the remaining components of REIT operational property- and corporate-level cash flows outlined above.

2.3 Extension to discount rate and valuation effects

We explore discount rate effects through liquidity and systematic risk. As noted, strong sustainability practices may be associated with increased transparency about the quality of the underlying properties through the sustainability certification process. In this scenario, transparency reduces information asymmetry between insiders and outsiders of the firm, reducing uninformed trading and thus reducing stock turnover. Next, we examine the empirical link between sustainability and stock liquidity. Consider the following specification:

$$VT_{it} = \beta_0 + \beta_1 L.CO_{it} + \beta_2 L.CO_{it}^2 + \beta_3 L.LT_{it} + \beta_4 L.LT_{it}^2 + f_i + d_t + u_{it} \tag{8}$$

where variables are defined as in (5), except VT_{it} is the total number of common shares traded (trading volume) for firm i in period period t and CO_{it} is the number of common shares outstanding. In this specification, the coefficient β_1 may be interpreted as a baseline turnover ratio for the sample firms. Following the same logic as before, we augment this model as follows:

$$VT_{it} = \beta_0 + \beta_1(L.GS \times L.CO) + \beta_2 L.\mathbf{x}_{it} + f_i + d_t + u_{it} \tag{9}$$

where $\mathbf{x}$ is the same set of observable covariates included in (8). We include firm as well as time fixed effects as before. We estimate (9) using WLS with the inverse of the number of common shares outstanding as weights.

Sustainability practices may also make the portfolio of a REIT more resilient to market-wide shocks, reducing systematic risk. To explore this relationship, we estimate the following regression analogous to (7), only the dependent variable is the series of the individual firms' CAPM β coefficients, obtained from annual regressions of monthly firm returns on a broad stock market index:

$$Beta_{it} = \beta_0 + \beta_1(L.GS \times L.AT) + \beta_2 \mathbf{x}_{it} + f_i + d_t + u_{it} \tag{10}$$

where all variables are defined as in (7). Note that for scaling purposes, we multiply the firm's beta coefficient for a given year by the book value of its assets. We employ WLS as before, with the inverse of the firm's book value of assets as weights.

Lastly, strong sustainability practices may improve corporate reputation, inducing a valuation premium. Common measures of corporate value rely on the ratio of the market value of the firm's assets relative to their depreciated book value. Depreciated book value does not update through time and is thus unable to account for changes in cash flow and risk characteristics of sustainable properties. The traditional market-

to-book ratio thus conflates cash flow and risk effects of sustainable investment with corporate reputation effects. Given that we would like to examine corporate valuation effects separately, we use the price to net asset value (NAV) ratio as our measure of value. The NAV reflects the market value of the firm's properties and thus already incorporates any improvements in the operational performance and risk profile of those assets. Therefore, the ratio of the firm's stock price to the NAV of its properties measures the pure valuation effects of sustainable investments that affect only the firm's equity, such as reputation effects. As a final specification, we use market value of the firm's equity as the dependent variable, with the net asset value (NAV) on the right-hand side:

$$MC_{it} = \beta_0 + \beta_1 L.NAV_{it} + \beta_2 L.NAV_{it}^2 + \beta_3 L.LT_{it} + \beta_4 L.LT_{it}^2 + f_i + d_t + u_{it} \tag{11}$$

where variables are defined as in (5), except MC_{it} is the total market capitalization (share price multiplied by common shares outstanding) for firm i in period t and NAV_{it} is the net asset value at the end of the period. In this specification, the coefficient β_1 may be interpreted as a baseline price to NAV multiple. We then estimate the following augmented model:

$$MC_{it} = \beta_0 + \beta_1 (L.GS \times L.NAV) + \beta_2 \mathbf{x}_{it} + f_i + d_t + u_{it} \tag{12}$$

where $\mathbf{x}$ is the same set of observable covariates included in (11). We include firm as well as time fixed effects as before. The coefficient on the interaction between NAV and the *Green Share* captures pure valuation effects reflected in the price/NAV ratio. We estimate (12) using WLS with the inverse of the firm's NAV as weights.

3 Data

In order to estimate the models outlined above, we employ financial reporting and property portfolio data on listed US equity REITs as well as UK REITs and property companies from the SNL Financial database. For the calculation of the *Green Share*, we first identify the addresses of the buildings owned by the sample firms at any given point in time from SNL. We then collect the addresses of all sustainability-certified properties in the US and the UK directly from the certification providers, including the certification date. Lastly, we employ GIS techniques to match the addresses of the properties held by the sample firms with the addresses of all certified properties. This matching exercise produces a list of certified properties held by the sample firms through time.

3.1 Certification programs

Each of the country markets we study have their own environmental certification programs for commercial real estate: BREEAM in the UK and LEED as well as Energy Star in the US.[8] In each case, the programs hold dominant market shares.

The UK certification program BREEAM, the Building Research Establishment's Environmental Assessment Method was founded in 1990 and is the world's oldest sustainability labeling program for buildings. The certification process involves independent, licensed assessors evaluating the procurement, design, construction, and operations of a property against performance benchmarks.

LEED was created in 1998 by the U.S. Green Building Council (USGBC) to provide building owners and operators with a framework to identify and implement green building design, construction, operations, and maintenance solutions. LEED certifi-

[8] The majority of sample firms with a positive *Green Share* hold a mix of different environmentally certified properties. Our *Green Share* metric captures properties certified under any of the three certification programs.

cation comes in two categories: design-based, which is earned during development or redevelopment and retained for the life of the building; and, operations based, which is valid for a five-year period.

The Energy Star program was created by the U.S. Environmental Protection Agency (EPA) in the early 1990s, with labeling available on new homes and commercial buildings since 1999. To earn Energy Star certification, a building must be more energy efficient than 75% of similar buildings nationwide. The program uses third-party engineers and architects to verify successful inclusion of energy efficient features in order to qualify for certification. Certification must be sought annually and focuses on operations.

3.2 Sample description

We compile a data set of US and UK real estate investment firms from SNL Financial. The study period begins in 2000 for the US (when comprehensive certification data is first available), in 2009 for the UK (when BREEAM data is first available), and ends in 2014 for both countries. Throughout these sample periods, we adopt an unbalanced panel approach to mitigate survivorship bias (Baum, 2006). Firms enter the sample when they first appear on SNL and meet the data requirements, and exit when they become inactive (acquired/defunct). Our final sample contains 956 and 297 firm-year observations in the US and UK, respectively.

Figure 1 shows the evolution of the sustainability measures in our sample. Green property holdings have increased as a proportion of US REIT portfolios. In 2014, green properties on average account for more than 6% of portfolio square footage. In the UK sample, the share of sustainable properties is lower, reaching an average of 2% by area in 2014, but shows an upward trend similar to the US sample.

[Figure 1 about here.]

Table 2 presents the sample characteristics. In order to mitigate any undue influence of outliers, all variables are winsorized at the 1^{st} and 99^{th} percentiles. Table 3 presents pairwise correlation coefficients between the key financial ratios and the sustainability measures in our study. We find some significant unconditional correlations between the financial key ratios and measures of sustainability.

[Tables 2 and 3 about here.]

4 Results

4.1 Cash flow effects

Tables 4 and 5 show the regression results for the operational effects of sustainable investment in the US equity REITs and the UK listed property companies, respectively. Note that we control for firm and time fixed effects in all of our regressions in order to account for unobservable firm-specific factors such as management quality and market-wide influences such as sentiment.

[Table 4 about here.]

Column (1) of Table 4 presents the effects of sustainable investment on rental revenue relative to total assets for US REITs. The estimated conditional average rental yield is 13.3%. The positive significant coefficient on the (Assets) $\times$ (Certified share) variable suggests that a larger share of certified sustainable properties is associated with a higher rental yield. Economically, a REIT with a share of sustainable assets equal to the sample mean of 2% (based on area) plus one standard deviation, resulting in a green share of 8%, has an expected rental yield of 13.7% [=0.133+(0.053$\times$0.08)]. The positive effect of environmental certification on rental values is consistent with the evidence on the building level. It further suggests that the effects on rental levels carry over to rental revenue on the portfolio level.

Column (2) shows the effects of sustainability on rental operating expenses. We find that investment in sustainable properties increases the operating costs of US REITs. While the overall conditional average ratio of operating expenses to total assets is 3.8%, this measure increases to 4% for a REIT with a share of sustainable assets equal to the sample mean plus one standard deviation. To our knowledge, we are the first to document this effect of sustainable investment on the operating cost of a REIT. Our finding is consistent with the notion that the technological sophistication of sustainable properties may increase operating costs as compared to conventional properties (Fullbrook, Jackson, and Finlay, 2006; Kats, 2010)

Next, we explore the net effect of sustainable investment on rental revenue and operating expense by considering property-level cash flows (NOI) in Column (3). In the US, we find that the NOI remains unaffected. Our finding implies that the increase in rental revenue fully compensates for the higher operating costs associated with the ownership of sustainable properties.

The second layer of possible operational effects relates to corporate-level costs. Column (4) presents the effect of sustainable investment on G&A expenses. We find that higher shares of sustainable investment are not associated with significant changes in G&A expenses, suggesting that sustainable property portfolios require the same level of management expenses as conventional properties. We believe that we are the first to explore this effect of sustainable investment on corporate-level (management) expenses, as distinct from property-level operating costs.

Column (5) shows that higher shares of sustainable investment are associated with lower interest expenses in the US sample, holding firm size as well as liabilities constant. Our finding is consistent with Eichholtz, Holtermans, Kok, and Yönder (2015) who document lower spreads on debt collateralized against sustainable properties. However, we quantify the effect of sustainable investment on the overall level of

corporate interest expenses. In economic terms, a firm with an average share of sustainable assets has an expected conditional interest expense ratio of 0.57% of total assets. This ratio drops to 0.47% for a REIT with a share of sustainable assets equal to the sample mean plus one standard deviation.

The net effect of property level and corporate level revenue and expenses is summarized in corporate-level cash flows available for distribution to shareholders. For US REITs that is measured as funds from operations (FFO). As per Column (6) of Table 4, we find a statistically significant positive effect of sustainable investment for US REITs. In economic terms, while the average conditional FFO yield is 6.2% of total assets, this figure increases to 6.5% for a REIT with a share of sustainable investments one standard deviation above the sample mean.

[Table 5 about here.]

In Columns (1) and (2) of Table 5, we document insignificant findings for the UK firms in terms of rental revenue and operating expenses. Yet, we find a positive and significant effect of sustainable investment on NOI. We find insignificant effects for sustainable investments on G&A and interest expenses. Still, the improved NOI levels seem to carry through to earnings, as we find significantly higher earnings yields for a UK firm with a higher share of sustainable investments.

We interpret the lack of nuance in the UK findings relative to the US results as follows: In the UK, Energy Performance Certificates (EPCs) are required for any property being leased or sold, with fees in place for properties which fail to comply. [9] This compulsory environmental disclosure may lay bare any significant environmental under-performance and thereby gradually improve the average level of environmen-

[9] Beginning on April 1, 2018, properties must additionally meet at least a grade E (scale: A to G; A being best) in order to be leased or sold to a private party. See: https://www.gov.uk/energy-performance-certificate-commercial-property/overview.

tal sustainability of the local building stock. This effect may in turn attenuate the marginal benefits from voluntary sustainability labels in the UK relative to a market without requisite reporting, such as the US.

4.2 Discount rate and valuation effects

Tables 6 and 7 show the regression results for the discount rate and valuation effects in the US and the UK respectively, as a function of sustainable investment and the control variables.

[Tables 6 about here.]

First, we explore the notion that sustainable investment improves transparency and thus reduces uninformed trading, lowering stock turnover. Column (1) of Table 6 shows that a higher share of certified sustainable properties in a US REIT's portfolio is associated with a lower turnover ratio for that firm's stock. According to our estimates, the expected conditional turnover ratio for an average REIT is 12.5%. Our results suggest that the turnover ratio drops to 11.5% for a REIT with a share of sustainable properties one standard deviation above the mean.

Column (2) of Table 6 shows that US REIT stock returns with a larger share of sustainable investments carry less systematic risk; in other words, they are less sensitive to variation in the returns on a broad stock market index (in our analysis, the S&P500). In economic terms, the risk-reducing effect of sustainable investment is also significant. An average REIT in our sample has an expected conditional beta of approximately 1. Our results suggest that a REIT with share of sustainable properties of 8% (one standard deviation above the sample mean) has an expected beta of 0.80, a reduction of 20 basis points.

We find that a higher share of sustainable investment is associated with a significant improvement in the price to NAV ratio for US REITs (Column 3). Our results suggest that a REIT with an average share of sustainable properties has an expected conditional P/NAV ratio of 0.912. If the share of sustainable investments increases by one standard deviation, we expect the P/NAV ratio to increase to 0.972, an improvement of 60 basis points. Our findings suggest that a higher share of sustainable investment supports firm value beyond any improvement in the market value of the underlying asset. This result implies that, in addition to tangible improvements in cash flows from sustainable properties, and in addition to lower required rates of return, the market value of the firm benefits from a larger share of sustainable investments. We interpret this finding as a reputation effect.

[Tables 7 about here.]

We find no statistically significant effect of sustainable investment in terms of liquidity or systematic risk for UK firms (Table 7). With regards to liquidity, the difference to the US findings may be due to the lack of requisite environmental performance reporting in that market. In the UK, voluntary environmental certifications are not the only source of information about the environmental performance of investment properties, as environmental performance certificates are mandatory for any property leased or sold. As a result, the signaling value of voluntary environmental certifications may be reduced in the UK, where information about the environmental performance of investment properties is more easily available.

Consistent with the US results, we find a positive effect on the P/NAV ratios of the UK sample firms that is associated with a larger share of sustainable investments. In economic terms, our findings suggest an improvement in firm value relative to NAV of almost 4%. Our findings suggest that UK firms also experience value gains from improved corporate reputation associated with sustainable investment that are

independent of any cash flow or discount rate effects.

4.3 Robustness tests

We explore a number of robustness tests around our main results. First, in the regressions exploring cash flow effects, we replace the book value of assets with the firm's gross asset value as a current market-based metric of the firm's asset value instead of depreciated historical cost. Our findings are robust to using gross asset value: all statistically significant variables of interest retain their significance and sign for both the US and the UK samples.

Further, SNL provides net (depreciated) book value figures for individual assets held over time by US firms, but not for UK firms. For robustness, we estimate the US results with the *Green Share* based on net book value instead of area. Our findings are robust to using net book value instead of square footage for calculating the *Green Share*.

Lastly, we control for the quality of property portfolio of a REIT or a listed property company. The *Green Share* may capture the impact of portfolio quality as green properties are of higher quality. We create two measures of portfolio quality, the weighted average age of the properties and the share of properties in the firms' portfolios that have been renovated. Our findings are robust to including these proxies for portfolio quality. The results of all of our robustness tests are available upon request.

5 Conclusion

In this study, we provide a systematic decomposition of the effects of sustainable real estate investment on corporate performance metrics across the two leading country-markets in terms of sustainable property certifications. We provide novel insight in-

side the black box of sustainable property investments by REITs and listed property companies, and how associated costs and benefits accrue to different financial outcome measures. To our knowledge, this is the most complete picture of the relationship between sustainable property investments and operating as well as investment performance documented from the corporate perspective. As a result, we are able to clarify, for investors and managers alike, the economic channels through which sustainability practices contribute to firm value and performance across country-markets with different approaches to achieving sustainability.

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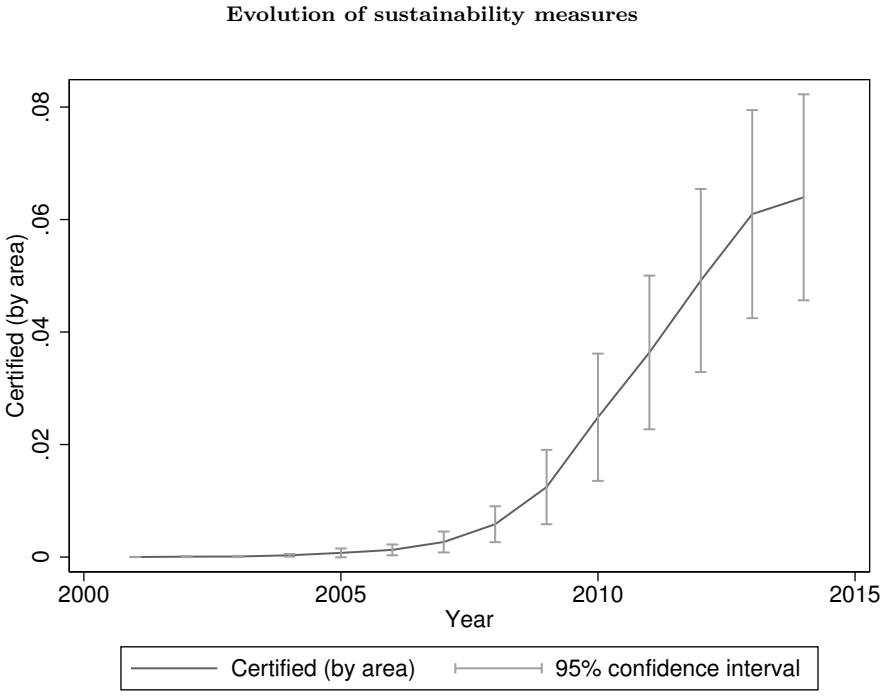
Figures and Tables

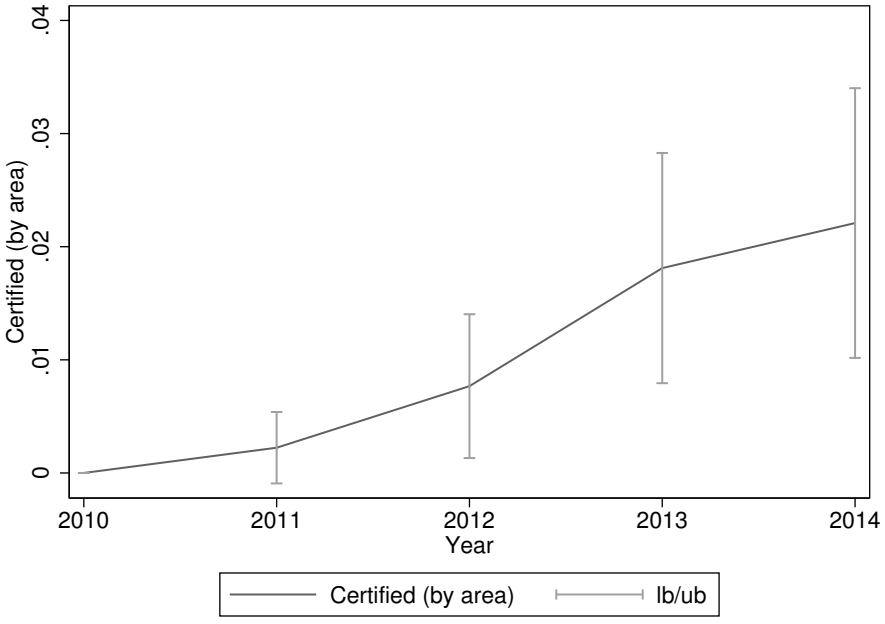
Pro forma REIT income statement and valuation schematic

PERFORMANCE LEVEL		ITEM
PROPERTY		Rental revenue
	-	Rental operating expense
	=	Property-level cash flow
CORPORATE	-	Interest expense
	-	General & administrative expense
	=	Corporate cash flows
MARKET	÷	Discount rate
		(Risk, Liquidity)
	=	Firm value

Table 1
The table presents a schematic of a typical pro forma income statement and basic corporate valuation for an equity REIT.



(a) Mean share of certified area to total area



(b) Mean share of BREEAM area to total area

Fig. 1. The figure shows the evolution of annual mean green shares by book value of assets (Panel (a)) and the total square footage (area) (Panel (b)) over the period 2000 to 2014. The bars indicate a 95% confidence interval around the mean estimate.

Firm characteristics, US and UK firms

Panel (a) US firms							
Variables	Mean	SD	P25	Median	P75	Min	Max
Financial ratios, scaled by book value of assets							
Rental revenue	0.12	0.03	0.10	0.12	0.14	0.02	0.24
Rental operating expense	0.04	0.02	0.03	0.04	0.05	0.00	0.14
NOI	0.08	0.02	0.07	0.08	0.10	0.02	0.21
G&A expense	0.01	0.01	0.01	0.01	0.01	0.00	0.06
Interest expense	0.03	0.01	0.02	0.03	0.03	0.00	0.09
Funds from operations	0.05	0.02	0.04	0.05	0.06	-0.06	0.20
Market leverage	0.47	0.15	0.37	0.46	0.57	0.01	0.99
MB ratio	1.34	0.34	1.12	1.29	1.49	0.54	3.28
Market value to NAV	1.01	0.20	0.90	1.02	1.13	0.15	3.15
Turnover	0.11	0.08	0.06	0.09	0.13	0.00	0.78
Certified (by area)	0.02	0.06	0.00	0.00	0.02	0.00	0.29
Certified (by assets)	0.05	0.12	0.00	0.00	0.04	0.00	0.54
Panel (b) UK firms							
Variables	Mean	SD	P25	Median	P75	Min	Max
Financial ratios, scaled by book value of assets							
Rental revenue	0.06	0.02	0.04	0.06	0.07	0.00	0.13
Rental operating expense	0.01	0.01	0.01	0.01	0.02	0.00	0.05
NOI	0.03	0.06	0.02	0.04	0.05	-0.93	0.12
SG&A expense	0.02	0.05	0.01	0.01	0.02	0.00	0.88
Interest expense	0.02	0.01	0.01	0.01	0.02	0.00	0.08
Earnings	0.06	0.08	0.01	0.05	0.09	-0.44	0.70
Market leverage	0.46	0.19	0.32	0.45	0.60	0.04	0.94
MB ratio	0.95	0.13	0.89	0.96	1.04	0.54	1.31
Market value to NAV	0.91	0.23	0.78	0.91	1.06	0.26	1.48
Turnover	0.36	0.27	0.15	0.34	0.50	0.00	1.89
Certified (by area)	0.01	0.03	0.00	0.00	0.00	0.00	0.12

Table 2
The table presents the descriptive statistics of the sample firms on an annual basis. N=956 in the US and N=297 in the UK. All firm-level accounting and portfolio information is obtained from SNL. Financial key ratios are scaled by book value of assets, unless otherwise indicated. Market leverage is the ratio of total liabilities plus mezzanine items to the market value of assets. Market value of assets is book value of assets minus book value of common equity plus market value of equity (number of common shares outstanding multiplied by the end of quarter share price). The market-to-book (MB) ratio is the market value of assets over the book value of assets. The market value to NAV ratio is the market capitalization of the firm (market value of equity) divided by the firm's NAV (net asset value (NAV) per share multiplied by the number of shares outstanding). Turnover is the total number of shares traded in a period over the total number of shares outstanding at the beginning of the period. Sustainability characteristics are scaled as indicated, by book value of assets or area (property square footage). In the UK, the equivalent expense to G&A expenses reported is Selling, General and Administrative (SG&A) expenses. Furthermore, we use earnings instead of FFO in the UK as listed property companies in the UK do not report FFO.

Pairwise correlations of Green Share measure with key firm financial metrics

Variables	Certified space US	Certified space UK
Rental revenue	-0.1169*	-0.1378
Rental operating expense	0.0161	-0.1310
NOI	-0.1909*	0.0224
G&A expense (SG&A expense)	-0.0439	-0.0698
Interest expense	-0.1925*	-0.0180
Funds from operations (Earnings)	-0.0995*	0.0698
Market leverage	-0.0273	-0.0731
MB ratio	-0.0902*	0.1594
Market value to NAV	0.0297	0.1848*
Turnover	0.0429	0.1387

Table 3
The table presents the pairwise Pearson correlation coefficients for the financial and sustainability characteristics of the US equity REITs and UK equity REITs as well as listed property investment firms in the sample over the study period. N=956 in the US and N=297 in the UK. All variables are defined as in Table 2. The asterisk denotes significance of the difference of correlation coefficients from zero at the 1% level.

Regression results for US operational effects, all certified sustainable area

Variables	(1) Rental revenue	(2) Operating expense	(3) NOI	(4) G&A expense	(5) Interest expense	(6) FFO
(Assets) × (Certified area)	0.053**	0.029***	0.004	0.000	-0.016***	0.035**
	(2.55)	(2.77)	(0.32)	(-0.01)	(-3.50)	(2.01)
Total assets	0.133***	0.038***	0.101***	0.004***	0.006***	0.062***
	(15.00)	(8.36)	(17.02)	(3.50)	(2.83)	(8.36)
$(\text{Assets})^2$	-0.002***	-0.000**	-0.002***	0.000	-0.000*	0.000
	(-4.56)	(-2.34)	(-6.50)	(0.75)	(-1.92)	(1.50)
Total liabilities	-0.049***	-0.003	-0.053***	0.002	0.036***	-0.037***
	(-3.38)	(-0.41)	(-5.50)	(0.89)	(11.28)	(-3.05)
$(\text{Liabilities})^2$	0.002	0.000	0.002***	0.000	0.000	-0.003***
	(1.51)	(0.43)	(3.36)	(0.16)	(-1.57)	(-3.20)
Observations	956	956	956	956	956	956
R-squared	0.974	0.952	0.973	0.920	0.976	0.914
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 4
The table presents the regression results estimating the firm-year observations of the operational ratios for US equity REITs as a function of the share of all certified sustainable properties held by the firm, (Assets) × (Certified share), and firm characteristic control variables. Variables are defined as in Table 2. Columns (1) to (6) correspond to the results for the individual operational performance measures as indicated in the column headings. Assets squared $(\text{Assets})^2$ and Liabilities squared $(\text{Liabilities})^2$ are scaled by (10^{-6}). Firm and year fixed effects are included as indicated to control for time- and firm-invariant unobservables, respectively. Robust t-statistics, obtained via WLS with the inverse of the book value of the firm's assets used as weights, are shown in parentheses. Significance is indicated as follows: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Regression results for UK operational effects, all certified sustainable area

Variables	(1) Rental revenue	(2) Operating expense	(3) NOI	(4) SG&A expense	(5) Interest expense	(6) Earnings
(Assets) × (Certified area)	0.009	-0.002	0.049**	-0.008	0.001	0.426***
	(0.47)	(-0.29)	(2.54)	(-0.91)	(0.15)	(3.27)
Total assets	0.024***	0.004*	0.009	0.014***	-0.001	0.197***
	(3.81)	(1.82)	(1.38)	(4.54)	(-0.55)	(4.54)
$(\text{Assets})^2$	-0.001	0.000	-0.001	0.000	0.000	-0.013***
	(-1.46)	(0.12)	(-1.25)	(-1.55)	(-1.11)	(-3.18)
Total liabilities	0.046***	0.006	0.047***	-0.014**	0.038***	-0.283***
	(4.10)	(1.55)	(4.16)	(-2.59)	(8.50)	(-3.72)
$(\text{Liabilities})^2$	-0.003	0.000	-0.003*	0.001	-0.001*	0.056***
	(-1.45)	(0.16)	(-1.71)	(0.77)	(-1.84)	(4.20)
Observations	297	297	297	297	297	297
R-squared	0.985	0.977	0.963	0.916	0.979	0.791
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 5
The table presents the regression results estimating the firm-year observations of the operational ratios for UK equity REITs and listed property companies as a function of the share of all certified sustainable properties held by the firm, (Assets) × (Certified share), and firm characteristic control variables. Variables are defined as in Table 2. Columns (1) to (6) correspond to the results for the individual operational performance measures as indicated in the column headings. Assets squared $(Assets)^2$ and Liabilities squared $(Liabilities)^2$ are scaled by (10^{-6}). Firm and year fixed effects are included as indicated to control for time- and firm-invariant unobservables, respectively. Robust t-statistics, obtained via WLS with the inverse of the book value of the firm's assets used as weights, are shown in parentheses. Significance is indicated as follows: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Regression results for US valuation, liquidity and risk effects, all certified sustainable area

	(1)	(2)	(3)
Variables	Liquidity	Risk	Valuation
(CSHO) × (Certified area)	-0.126***		
	(-2.63)		
Common shares outstanding	0.125***		
	(7.76)		
(Common shares outstanding)^2	-0.000**		
	(-2.21)		
(Assets) × (Certified area)		-2.598***	
		(-4.64)	
Total assets		1.009***	
		(3.00)	
(Assets)^2		-0.070***	
		(-4.85)	
(NAV) × (Certified area)			0.752***
			(2.82)
Net asset value			0.912***
			(15.32)
(Net asset value)^2			-0.001
			(-0.30)
Total liabilities	1.667***	0.926*	-0.016
	(4.63)	(1.71)	(-0.19)
(Liabilities)^2	-0.016	0.192***	-0.011
	(-0.62)	(4.99)	(-1.58)
Observations	956	956	956
R-squared	0.779	0.757	0.898
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Table 6

The table presents the regression results estimating the firm-year observations of the liquidity, risk, and firm value measures for US equity REITs as a function of the share of certified sustainable properties held by the firm and firm characteristic control variables. Column (1) considers the number of shares traded relative to the total number of shares outstanding (turnover) as a measure of liquidity. Column (2) considers systematic risk (CAPM beta, obtained in relation to the S&P 500 index, scaled by net book value of assets). Column (3) considers the ratio of stock price to net asset value as a proxy for firm value. Variables are defined as in Table 2. Common shares outstanding squared $(CSHO)^2$, Assets squared $(Assets)^2$, Net asset value squared $(NAV)^2$, and Liabilities squared $(Liabilities)^2$ are scaled by (10^{-6}). Firm and year fixed effects are included as indicated to control for time- and firm-invariant unobservables, respectively. Robust t-statistics, obtained via WLS, with the inverse of the total number of common shares outstanding, the net book value of assets, and the net asset value, respectively, used as weights, are shown in parentheses. Significance is indicated as follows: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Regression results for UK valuation, liquidity and risk effects, all certified sustainable area

Variables	(1) Liquidity	(2) Risk	(3) Valuation
(CSHO) × (Certified area)	0.316		
	(1.39)		
Common shares outstanding	0.331***		
	(3.78)		
(Common shares outstanding)^2	0.000		
	(-1.09)		
(Assets) × (Certified area)		0.585	
		(0.53)	
Total assets		0.521	
		(1.42)	
(Assets)^2		-0.029	
		(-0.86)	
(NAV) × (Certified area)			1.400***
			(3.26)
Net asset value			1.497***
			(16.22)
(Net asset value)^2			-0.110***
			(-6.90)
Total liabilities	24.146	-0.096	-0.199**
	(0.90)	(-0.15)	(-2.34)
(Liabilities)^2	8.250*	0.091	0.014
	(1.88)	(0.81)	(0.73)
Observations	297	297	297
R-squared	0.954	0.848	0.975
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Table 7
The table presents the regression results estimating the firm-year observations of the liquidity, risk, and firm value measures for UK equity REITs and listed property companies as a function of the share of certified sustainable properties held by the firm and firm characteristic control variables. Column (1) considers the number of shares traded relative to the total number of shares outstanding (turnover) as a measure of liquidity. Column (2) considers systematic risk (CAPM beta, obtained in relation to the FTSE 100, scaled by net book value of assets). Column (3) considers the ratio of stock price to net asset value as a proxy for firm value. Variables are defined as in Table 2. Common shares outstanding squared $(CSHO)^2$, Assets squared $(Assets)^2$, Net asset value squared $(NAV)^2$, and Liabilities squared $(Liabilities)^2$ are scaled by (10^{-6}). Firm and year fixed effects are included as indicated to control for time- and firm-invariant unobservables, respectively. Robust t-statistics, obtained via WLS, with the inverse of the total number of common shares outstanding, the net book value of assets, and the net asset value, respectively, used as weights, are shown in parentheses. Significance is indicated as follows: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.