NBER WORKING PAPER SERIES

TIMING SUSTAINABLE ENGAGEMENT IN REAL ASSET INVESTMENTS

Bram van der Kroft
Juan Palacios
Roberto Rigobon
Siqi Zheng

Working Paper 32646
http://www.nber.org/papers/w32646

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
July 2024

We thank Florian Berg, Kevin Chuah, Atreya Dey, Lukas Hauck, Florian Heeb, Jacques Gordon, Yichun Fan, Dongxiao Niu, Yasmine van der Straten, and seminar participants of the Massachusetts Institute of Technology Climate and Sustainability Consortium, Dutch Sustainable Network FECS workshop, CRED-MIT Workshop on Real Estate Economics, Maastricht University, and Open University. Bram van der Kroft gratefully acknowledges funding from the NWO (Dutch Science Foundation) Rubicon Grant 2023-3: 019.233SG.006 Juan Palacios gratefully acknowledges funding from the NWO (Dutch Science Foundation) VENI Grant. Roberto Rigobon gratefully acknowledges funding from the Massachusetts Pension Reserves Investment Management Board, Qontigo, and MFS Investment Management —members of the Aggregate Confusion Project Council — for their generous support of this research. Siqi Zheng gratefully acknowledges funding from MIT Climate and Sustainability Consortium, MIT Energy Initiative, and MIT Sustainable Urbanization Lab. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

NBER working papers are circulated for discussion and comment purposes. They have not been peer-reviewed or been subject to the review by the NBER Board of Directors that accompanies official NBER publications.

© 2024 by Bram van der Kroft, Juan Palacios, Roberto Rigobon, and Siqi Zheng. All rights reserved. Short sections of text, not to exceed two paragraphs, may be quoted without explicit permission provided that full credit, including © notice, is given to the source.

Timing Sustainable Engagement in Real Asset Investments
Bram van der Kroft, Juan Palacios, Roberto Rigobon, and Siqi Zheng
NBER Working Paper No. 32646
July 2024
JEL No. G11,M14,Q56,R0

ABSTRACT

This paper estimates the effect of sustainable shareholder engagement on firm's investments. We study the real estate industry where investments are sporadic and occur following depreciation cycles. SEC restrictions (rule 240.14a-8) on shareholder proposals, in combination with the asset depreciation cycles, create random variation enabling us to identify firms' sustainable investment decisions. Using unique micro-data tracking investments in all public US commercial real estate properties over the past two decades, we find that sustainable engagement effectively steers firms to initiate tangible and long-lasting sustainable retrofits. However, engagement is ineffective or impairs such investments when it does not coincide with reinvestment periods, or investors vote down the proposal.

Bram van der Kroft
Climate and Sustainability Consortium (MCSC)
Center for Real Estate (CRE)
Massachusetts Institute of Technology
bramvdk@mit.edu

Juan Palacios
Department of Finance
School of Business and Economics
Maastricht University
Tongersestraat 53, 6211 LM
Maastricht, Netherlands
jpalacio@mit.edu

Roberto Rigobon
MIT Sloan School of Management
100 Main Street, E62-516
Cambridge, MA 02142
and NBER
rigobon@mit.edu

Siqi Zheng
Sustainable Urbanization Lab
Center for Real Estate
Department of Urban Studies and Planning
Massachusetts Institute of Technology
Cambridge, MA 02139
sqzheng@mit.edu

1 Introduction

According to the United Nations, the world is facing a $4 trillion yearly funding gap in sustainable investments to transition to net zero carbon emission (UN, 2024), a gap too large to be solely filled by government spending. Furthermore, there are more than 5,000 institutional investors that claim to manage their assets following sustainable financing strategies (UNPRI, 2022). One of the most prevalent strategies is sustainable engagement, where investors file environmental or social shareholder proposals with the purpose to make firms initiate sustainable investments.[1] Understanding the impact of sustainable engagement on firm behavior and discerning its efficacy are vital questions for investors (Krueger, Sautner and Starks, 2020). However, there is little evidence on whether and under which conditions sustainable engagement positively affect firms actions and behavior.[2]

Determining how engagement affects sustainable investments is complex due to a selection bias in targeted firms. Sustainable investors employ only limited staff working on engagement campaigns. To illustrate, Vanguard, BlackRock, and State Street Advisors have 15, 24, and 10 employees respectively, that need to manage voting, initiate governance engagements, and file sustainable engagements for the 13,000, 14,000, and 9,000 companies in their portfolio (Bebchuk et al., 2017).[3] This number is small compared to the yearly 2,075 management and 864 shareholder proposal votes for respectively Russel 3,000 and S&P 1,500 firms alone (Babenko et al., 2023; ISS, 2024). Consequently, investors with limited engagement capacity

[1] Shareholder proposals are most common for firms listed in the US through the SEC but are a global phenomenon. In addition to sustainable engagement, investors also pursue screening strategies that evaluate investment opportunities based on environmental and social criteria, either excluding or including them from portfolios (Oehmke and Opp, 2020; Berk and van Binsbergen, 2021; Pástor et al., 2021; Edmans et al., 2022; Pástor et al., 2023). Certifications and labels provided by third-party entities often serve as (potentially inaccurate) signals for investors on the commitment, intentions, and performance in various social and environmental issues (Berg et al., 2022; Bams and van der Kroft, 2024).

[2] For instance, He et al. (2023) highlight that sustainable engagements do frequently not make a majority vote, resulting in subsequent environmental and social controversies; Levit (2019) theorize that sustainable engagement could be used as a last resort by investors when they have no direct access to management or firms are non-cooperative on an issue; Akey and Appel (2019), Naaraayanan et al. (2021), and Busch et al. (2023) find mixed evidence whether engagement initiates sustainable investments, or hinders firm growth by reducing the scope of production; and Broccardo et al. (2022) theoretically describe that the efficacy of engagement is strongly dependent on the share of sustainable versus conventional investors.

[3] There is a broad literature that addresses governance engagements and its financial outcomes (DeAngelo and DeAngelo, 1989; Brav et al., 2008; Alexander et al., 2010; Cuñat et al., 2012; Aggarwal et al., 2015; Appel et al., 2016; Cvijanović et al., 2016; Bebchuk et al., 2017, 2020; Gantchev and Giannetti, 2021; Gao and Huang, 2022; Li et al., 2022; Lewellen and Lewellen, 2022; Meirowitz and Pi, 2022; Brav et al., 2024) For notable exceptions, on sustainable engagements see Azar et al. (2021) and Li et al. (2023).

might optimize their impact by selectively engaging with firms that are more likely to adopt their recommendations, biasing estimates upward.[4]

This paper assesses the impact of sustainable engagement on commercial real estate firms. We use variation that exists between the timing of engagement and firms' decision to retrofit the assets in their portfolio. We find that when the engagement is synchronized with the decision to retrofit (when firms need investors' capital most), the asset owner is more likely to meet investors' demands and perform sustainable investments. Conversely, when the engagement is not synchronized engagement becomes ineffective (or even counterproductive). The intuition of this result is that commercial real estate is a long-lived asset, and hence, the ability to improve its sustainability footprint is tied to timing physical depreciation.

This logic extends to other long-lived real assets such as power plants, industrial machines, and vehicles. According to the U.S. Environmental Protection Agency (EPA), 90% of US emissions originate from industries heavily relying on real assets, such as real estate, manufacturing equipment, and transportation (EPA, 2022).[5] The costs of sustainable investments in such real assets vary over time as they are tied to their physical depreciation. Specifically, the capital adjustment cost literature shows that retrofitting physically depreciated real assets is significantly cheaper given the irreversibility of investments and operational downtime (Mauer and Ott, 1995; Cooper and Haltiwanger, 2006; Livdan and Nezlobin, 2021).[6] Consequently, investors filing sustainable engagements will likely have more success initiating sustainable investments when costs are lower, and firms' real assets are close to depreciated, than when retrofitting is expensive and firms' real assets are not yet due for major repairs.

The main analysis of the paper uses the universe of publicly listed real estate firms in the united states as a lab. The public real estate market provides an ideal laboratory to observe the effectiveness of engagement on firm behavior because every major retrofit is observable through government permits. Specifically, we use a proprietary database that collects and standardizes this daily building-level microdata covering 359,022 retrofit permits for the universe

[4]Investors often engage with firms that are more sustainable (Barko et al., 2021), profitable (Dimson et al., 2015), and large (Busch et al., 2023; Slager et al., 2023). Further, engagement success is higher when topics are financially material (Grewal et al., 2016; Bauer et al., 2022) or mitigate tail risk (Hoepner et al., 2021).

[5]The other 10% is related to agriculture and food production.

[6]See Akerlof (1970) on selection, Pulvino (1998) on fire sales, and Cooper and Haltiwanger (2006) on unnecessary operational downtime.

of buildings owned by US-listed real estate firms (N=61,870) from 1990 to 2022. This comprehensive dataset allows us to distinguish each buildings' sustainable retrofits (e.g., installing solar panels, improving insulation, or upgrading HVAC systems) from conventional ones (e.g., adjusting electrical wiring, plumbing, or mechanical work).[7] Using this information and a jump-detection algorithm (Lee and Mykland, 2008), we uncover listed real estate firms' retrofit cycles: periods when a significant share of their properties are sufficiently depreciated, and they apply for abnormal levels of permits. Additionally, we retrieve public engagement events from the Institutional Shareholder Services (ISS) S&P 1500 shareholder proposal dataset (following Busch et al., 2023; He et al., 2023).

Our results show that the timing of sustainable engagement relative to physical depreciation is critical in determining its impact on sustainable investment decisions. We find that the share of sustainable retrofits increases by 22% when engagement coincides with retrofit cycles. However, this effect disappears when we evaluate the impact of engagement unconditionally. Furthermore, the impact of engagement on sustainable investments is negative when engagement occurs outside retrofit cycles.

One endogeneity concern is that "higher quality" or "more impact-oriented" investors could be timing their engagements along retrofit cycles, potentially biasing our results. However, SEC rules alleviate this concern because investors' decisions to engage need to take place several months before firms decides to implement major capital expenses and retrofit their assets.[8] According to SEC rule 14a8, investors face a legal delay of at least 165 days between investors filing any engagement (SEC, 2022), and the engagement being voted, while retrofit announce-

[7]We validated our classification of sustainable permits by showing that they reduce energy consumption for a sub-sample of New York, Boston, and Cambridge (MA) office buildings after correcting for baseline energy consumption and in addition to frequently used third-party energy certificates (Eichholtz et al., 2010; Ling et al., 2020).

[8]Public real estate firms operate portfolios of often hundreds of properties in segregated local markets with different conditions. This induces information asymmetries that hinder investors from predicting physical depreciation at the asset level. Such information asymmetries in real estate are not unthinkable in the wake of the 2008/2009 financial crisis (Acharya and Richardson, 2009). This limits investors' ability to ex ante predict retrofit cycles without a public signal. We provide extensive evidence on this using macroeconomic conditions, accounting information, and past retrofitting.

ment can be as little as a month.[9] Indeed, we show that the timing of sustainable engagement relative to the physical depreciation of firms' real assets is virtually random as investors only time 12% of their engagements during retrofit cycles, just one percentage point higher than the unconditional probability of retrofit cycles taking place in our sample (11%). In other words, investors do not seem ex ante able to predict retrofit cycles due to large information asymmetries. However, this institutional restriction does not prevent investors from ex post observing when retrofit cycles have taken place and engagement will be certainly ineffective. In fact, we do not observe a single sustainable engagements after a retrofit cycle, when no new cycles occur for at least two years, while investors continue filing governance-related engagements during that exact same timeframe.

The second possible source of endogeneity is that investors could strategically file shareholder proposals at every meeting. However, repeat proposals fillings are limited by SEC rules (SEC, 2022). The SEC does not allow shareholder proposals on a similar topic to be filled at the same firm for more than four times in a row, and only when the first, second, and third filing attain respectively 5%, 10%, and 25% of votes in favor of the proposal and the proposal is not omitted.[10] Moreover, we only observe one repeat shareholder proposal in our data that is successful and timed during retrofit cycles.[11] Therefore, the combination of the micro-level data on retrofit permits and SEC rules on filing shareholder engagements allow us mitigate the endogeneity problem in estimating the effect of sustainable engagements on firms' sustainable investments.

In addition to the possibility of endogeneity in terms of timing, we explored the possibility of selection bias in investors' engagement across commercial real estate firms. Given their limited capacity to engage, it is conceivable that investors target firms more willing or able to

[9]Real estate firms first open a call for work when retrofitting their properties. Upon receiving all proposals, they select the best contractor and agree on the costs and timeline. Subsequently, they announce their retrofitting intentions the the public. This process is relatively quick and enables real estate firm to attain lower financing costs as they know the exact size of their notional and can instantly pay their contractors and utilize their funds. There could be potential endogeneity in the timing of retrofits by commercial real estate firms due to this system as our signal of sustainable retrofit decisions - which is measured through permits - also has a delay. However, this delay is small in comparison to the SEC rules.

[10]See SEC rule 14a8(i)(12), 2020 Adopting Release, supra note 2, at 70288 for further details (SEC, 2022). Meeting this 25% threshold is not a trivial endeavor as reflected in the low share of positive sustainable engagements votes (He et al., 2023).

[11]This proposal does not meaningfully affect our findings when we exclude it.

meet their requests as reflected in property characteristics and management quality. Regarding properties, we do not observe selection based on observable characteristics of the real assets of firms, such as buildings' state of disrepair, age, and size. However, management quality —potentially driving financial success and interest in sustainability— could pose a concern as investors frequently engage with larger real estate firms (operating more total square feet across all properties). To control for this possibility, our analysis compares the effectiveness of the engagement for the same commercial real estate firms across different retrofit cycles, i.e., controlling for those unobservable characteristics that are constant through time.[12]

We test the robustness of our results in four ways: First, the institutional context matters for the effectiveness of engagement. Engagements can either be "successful" and voted through by shareholders on annual meetings or pre-emptively accepted (withdrawn) by firms, or "unsuccessful" and voted down by shareholders or omitted by the SEC for legal reasons (see He et al., 2023). For successful engagements, we find that the positive effect during retrofit cycles is 2.99 times larger in economic magnitude compared to the baseline. Conversely, unsuccessful engagements always have a negative and pronounced impact on firms' sustainable retrofitting as they indicate investors insufficiently care about sustainability. Given the above, we show that the physical depreciation of real assets plays a pivotal role in the effectiveness of sustainable engagement.

Second, some engagement are not sustainability related but directed to the governance of firms (e.g., their pay, governance structure, or board elections). As a falsification analysis, we show that governance engagements do not improve firms' sustainable investments nor alter the impact of sustainable engagements when they are jointly analyzed. Third, we show that conventional permits (targeted to the general maintenance of properties) are unaffected by accurately timed sustainable engagements except for electrical permits required to install sustainable HVAC systems. Last, we show that sustainable engagement solely affects the intensive margin of sustainable investments and does not initiate firms to change the scope of

[12]The selection bias in sustainable investing has been discussed in the literature before, see Dimson et al. (2015), Busch et al. (2023), and He et al. (2023).

their operations by selling less sustainable properties to meet investor demands.[13]

Finally, we replicate our primary analysis using a sample of listed heavily polluting manufacturing firms in the EPA Toxic Release Inventory (TRI) (following Akey and Appel, 2019; Naaraayanan et al., 2021). EPA TRI is a dataset often used in economics and finance to capture the emissions, pollution prevention activities, and environmental fines of US's heaviest polluters, including manufacturing firms, petro-chemical production facilities, and utility companies (Levinson, 1999; Bui and Mayer, 2003; Shapiro and Walker, 2018; Banzhaf et al., 2019; Xu and Kim, 2021; Hsu et al., 2023). Along a large array of improvements in production processes, these firms can also regularly retrofit their buildings to reduce their operational environmental footprint (e.g., adding scrubbers to power plants). Consistent with our primary analysis, we find that only successful sustainable engagements timed during retrofit cycles increase the sustainable property retrofits of US heavy polluters. These actions are materially important since they can reduce EPA penalties (following Dasgupta et al., 2023).[14]

This paper shows that the effectiveness of engagement is affected by the synchronization between physical depreciation cycles and shareholder engagements. In particular, sustainable engagement is highly effective when it occurs just prior to investments taking place, but innocuous or even detrimental when unsynchronized with depreciation cycles. This suggests that some of the estimates in prior literature could be downward biased, especially for those firms with large long-lived assets where investments are irregular.[15] The fact that the effectiveness of the engagement depends on its timing also contributes to the discussion in the literature that

[13]Specifically, firms do not more frequently sell their properties when sustainably engaged, and sold properties receive similar sustainable retrofits after they are sold. Ruling out this potential outcome matters as Berk and van Binsbergen (2021) propose a similar mechanism where the impact of sustainable investors in portfolio tilting is offset by selling their stocks to less sustainable investors who further deteriorate their sustainable investments. This effect can be pronounced when capital costs are constrained and firms emit a lot (Hartzmark and Shue, 2023).

[14]This effect is solely present for material handling rather than chemical process or chemical use pollution prevention that should not be affected by sustainable property improvements

[15]Our paper fits within the literature that estimates the efficacy of sustainable shareholder engagement on financial performance (Dimson et al., 2015; Hoepner et al., 2021; Bauer et al., 2022) and especially sustainable performance, focusing on toxic releases in the US manufacturing industry (Akey and Appel, 2019; Naaraayanan et al., 2021); carbon emissions (Busch et al., 2023); big-three mutual fund ownership (Azar et al., 2021); collaborative engagement coalitions (Dimson et al., 2023; Slager et al., 2023); behind-the-scenes negotiations with management (Barko et al., 2021); or latent engagement through investors' sustainable orientation (Kahn et al., 2023).

compares engagement versus portfolio tilting (which includes divesting).[16] Even though we do not address this question directly, the synchronization of cheaper sustainable capital provided through portfolio tilting and shareholder engagements with investment decisions might be differentially affected — meaning that biases in efficacy could vary by the two tools used in sustainable financing to affect firms' behavior. In short, we underscore the pivotal role of timing sustainable investing in real assets by uncovering that sustainable engagement is only effective when firms need investors' capital. Consequently, it is not only *who* sustainable investors engage or tilt with, but also *when* they do so that determines the impact of sustainable financing in instigating sustainable investments.

The rest of the paper is structured as follows. Section 2 discusses the institutional setting of real estate and sustainable retrofitting. Section 3 describes and validates our data. Section 4 defines our empirical specification and elaborates on how we detect retrofit cycles in or data. Section 5 explains our results. Section 6 discusses our identification strategy. Section 7 analyzes internal validity. Section 8 replicates our results for the US heavy manufacturing EPA TRI sample and analyzes selection in engagement targets. Section 9 concludes.

2 Institutional setting

Buildings have a first-order environmental and social impact on the U.S. economy. On the environmental side, building sector is responsible for 30 to 39 percent of greenhouse gas emissions, the vast majority (72%) of which originates from operations of existing properties and its associated energy consumption (i.e., lighting, heating, and cooling) (EPA, 2022; GRESB, 2024). To illustrate its magnitude, reducing the operational emissions of the US built environment by 15% will more than offset the entire US aviation industry (3% of emissions) (EPA, 2024).

[16] Dating back to the classical debate on "exit" versus "voice" (Hirschman, 1972; McCahery et al., 2016), the sustainable investing literature frequently studies the cross-sectional conditions under which (partial) divestment or engagement can improve firms' sustainable investments (Broccardo et al., 2022). For instance, Oehmke and Opp (2020) show that sustainable investors need to internalize externalities in the cross-section regardless of ownership, Edmans et al. (2022) study the trade-offs between blanket exclusion and portfolio tilting in reducing the cross-section of externalities, Hartzmark and Shue (2023) find that investors ineffectively tilt their funds in the cross-section of firms, Berk and van Binsbergen (2021) argue that the current cross-sectional allocation of sustainably invested funds is insufficient to substantively reduce capital costs (tied to increasing sustainable investments) as conventional investors offset it, and Pástor et al. (2022) show that an increasing share of sustainable investors affects the expected financial consequences of investors' tastes for sustainable firms.

Buildings are also paramount from a social perspective as U.S. citizens spend 90% of their time indoors, stressing the importance of properties in shaping individual exposure to proper air quality, thermal conditions, airborne diseases, and other relevant environmental stressors (Jones, 1999; Allen et al., 2016; Park et al., 2020; EPA, 2023; Künn et al., 2023; Morawska et al., 2024).

We study sustainable engagement in the setting of the publicly listed real estate market. For firms to be (sustainably) engaged through shareholder proposals at the SEC, they need to be listed (SEC, 2020). The listed real estate market consists of 204 Real Estate Investment Trusts (REITs) in the US that operate a portfolio of properties similar to how mutual funds operate a portfolio of stocks (NAREIT, 2024b). REITs are non-negligible in size, with 32 being constituents of the S&P 500, 109 in the S&P 1500, and their combined market capitalization spanning 1.2 trillion USD, operating 3 trillion USD of managed properties (NAREIT, 2024a). To give an example of their magnitude, Boston Properties owns 187 office buildings with 53.5 million square feet, Prologis owns 1.2 billion square feet of warehouses shipping 2.7% of global GDP; American Towers owns 224,000 cell towers, providing internet access in over 20 countries; and Care Trust owns 207 nursing facilities hosting over 22,000 elderly.[17] Most REITs are highly specialized and focus on one specific property type, such as offices, multifamily, industrial, health care, shopping malls, hospitality, cell towers, self-storage, and data centers since operating them requires specialized knowledge.[18]

Listed real estate provides an ideal setting to study how the timing of sustainable engagement relative to physical depreciation affects firms' sustainable investments due to three institutional features that enable us to readily observe when and to what extent physical assets are replaced. However, the impact of the timing of sustainable engagement relative to the physical depreciation of assets on sustainable investments should generalize beyond our setting, albeit

[17]See https://investors.bxp.com/, https://www.prologis.com/about/news-press-releases/oxford-economics-prologis-properties-facilitate-goods-equal-nearly-3%23:~:text=According%20to%20the%20%22The%20Future,Prologis%20logistics%20property%20in%202022%29., https://www.americantower.com/global-presence%23:~:text=Our%20global%20portfolio%20of%20over,stages%20of%20wireless%20network%20deployment., and https://www.caretrustreit.com/.

[18]In addition to the equity REITs discussed here, there are also mortgage REITs that provide debt financing to the real estate industry by buying mortgages. We do not consider mortgage REITs in our study as they lack direct property control and cannot decide when to retrofit.

being more complex to observe.

First, depreciation and sustainable investment information is observable in real estate at the asset level for legal reasons. Unlike many other types of tangible assets, improving the physical condition of properties involves retrofits that require building owners or contractors to request permits from the local municipality.[19] Consequently, we can observe the initial decision of the property owner to retrofit the property at the daily level and assess what improvements are made. However, investors face information asymmetries in assessing this information as it is reported by municipality in an unstandardized way.

Second, timing sustainable investments in real estate is strongly tied to physical depreciation. The U.S. Department of Energy argues that substantive sustainable retrofitting is costly and often requires significant property restructuring (DOE, 2003).[20] Specifically, sustainably investing in a building involves improving its energy efficiency, changing the heating source from gas to electricity, installing socal panels, or making the property more comfortable for its tenants by providing better air quality or amenities. Performing these retrofits in tandem with conventional retrofits is economically more beneficial as both large conventional and sustainably retrofitting induces operational downtime because properties cannot legally be occupied without heating and cooling or while having direct exposure to the outdoors (Kontokosta, 2016). Moreover, most sustainable and conventional retrofits must also coincide because they are symbiotic. For example, it would be highly inefficient to install solar panels on a roof that needs to be replaced in a year, apply wall isolation after just painting and remodeling the walls, or replace a newly installed gas boiler with a heat pump. Thus, the costs of sustainable investments directly relate to conventional retrofitting and properties' physical depreciation.

Third, listed real estate firms simultaneously retrofit their properties, allowing us to trace their depreciation cycles readily. To create a fair playing field between REITs and mutual

[19]For an example of permits required to retrofit properties in Massachusetts, see `https://www.mass.gov/info-details/massachusetts-law-about-home-improvement%23:~:text=%E2%80%9CA%20permit%20for%20any%20remodeling,they%20are%20responsible%20for%20compliance.%E2%80%9D`.

[20]For further details on environmental and social retrofits, see the guidelines of EnergyStar, a governmental agency operated by the EPA, LEED, and WELL and Fitwel, the leading social property performance certifiers. EnergyStar and LEED identify HVAC systems, heating and cooling, and building envelope retrofits as critical ways to reduce energy consumption and curb emissions (EnergyStar, 2023; LEED, 2024). Further, WELL and Fitwel define healthy buildings as properties with good ventilation, air quality, temperature, moisture, dust & pests, safety & security, water quality, noise, lighting, and an aesthetically pleasing façade (Fitwel, 2024; International Well Building Institute, 2024).

funds, REITs are exempt from double taxation as they similarly pursue an investment strategy that involves passive ownership of a diversified portfolio of assets (see Geltner et al., 2014, for further details on REITs and their tax rules). To be classified for this tax break, REITs must pay at least 90% of their net income in dividends to shareholders, vastly reducing their ability to internally finance extensive retrofits through retained earnings. Due to the partially fixed costs of external financing (Smith Jr, 1986), REITs time their retrofits carefully so that they can simultaneously retrofit multiple properties by issuing new equity or debt, followed by extended periods without substantive retrofits. We call this pattern retrofit cycles. This spiky pattern in physical depreciation allows us to assess whether the impact of engagement on sustainable investments varies over the depreciation cycle of firms' real assets. For these reasons, real estate provides an ideal setting to investigate the effectiveness of sustainable engagement, even though our mechanism should generalize to other, less easily observable, real assets.

3 Data

We first describe how we collect information on the properties of REITs. Subsequently, we investigate REITs' sustainable investment at the property level. Last, we elaborate on how we assess sustainable engagements.

3.1 Real estate building characteristics and ownership

We collect property information from CoStar and S&P SNL Real Estate. CoStar and SNL are widely used datasets in the real estate finance and economics literature (see Eichholtz et al., 2010; Ling et al., 2020). The dataset contains a comprehensive range of property characteristics displayed in Table 1. We retrieve this information for the universe of REIT-operated properties from 1990Q1 to 2022Q4 (N=61,870). In Panel A, we show that the average property spans 103 thousand square feet and was built 31 years ago by the end of our sample in 2022. Of these properties, 14.8% are Class A (very modern properties in central business districts), 53.6% Class B (moderately desirable properties not exclusively in central business districts), and 31.6% Class C (older and less well-maintained properties in less desirable locations). In

Panel B, we show that our sample includes properties in the Retail & Shopping Center (31,254), Industrial (7,918), Office (7,148), Specialty & Self-Storage (6,049), Health Care (4,157), Multifamily (3,905), Hospitality & Hotel (1,289), and Manufactured Homes (150) segments. Further, where available, we collect EnergyStar, LEED, and WELL certificates for these properties.

Figure 1 displays the location of these properties. REIT-owned properties are geographically dispersed across the United States, emphasizing population-dense areas such as California, Florida, and New England regardless of the political leaning of the state.

In addition to property information, we collect REITs' accounting information from Compustat (total assets and book leverage), as well as their market capitalization and total returns from CRSP. Our final sample includes a total of 214 REITs operating in the Office (35), Shopping Center (32), Diversified (28), Specialty & Self-Storage (26), Hotel (20), Multifamily (18), Healthcare (17), Industrial (15), Other Retail (12), Self-Storage (7), and Manufactured Homes (4) segments. Most of these REITs remain active at the end of our sample (149), covering 82% of the market capitalization and the number of REITs in the market (NAREIT, 2024b).

3.2 Sustainable Investments in Real Assets

We use proprietary BuildZoom permit information to assess the property-level retrofit cycles and sustainable investments in the listed real estate market. BuildZoom is a data provider that collects property permit information on retrofits and new construction for commercial and residential properties throughout the United States. It standardizes regulatory permit depositories across most U.S. municipalities. The data includes a total of 112 million permits for 32.9 million properties, dating back to the start of the 20th century. These properties are dispersed across 50 states with a predominant focus on Florida (19.01%), California (15.70%), Texas (9.59%), and North Carolina (4.34%).

BuildZoom captures a sizeable portion of retrofitting activity because it is legally required to apply for permits when retrofitting or constructing properties in the US. To illustrate, the U.S. Census reports 44.4 million new construction permits since 1990, while BuildZoom identifies 108.5 million permits on new construction and retrofits of existing buildings over a similar timeframe (Census, 2024). Each record in the database includes the exact day and reason

for which the property permit is issued, information on the completion status of the permit, contractors involved in the retrofit, estimated execution costs, permit fees, and comprehensive information about the nature of the permit. In particular, the data includes 29 types of retrofits.[21]

We connect BuildZoom permit information to REITs' properties by geospatially matching addresses and coordinate information in ArcGIS. This approach results in permitting information for more than 99% of REIT-owned properties at a 99% matching accuracy. For these 62 thousand properties, we observe 281,081 conventional permits with an average reported value of 109,241 dollars per permit and 77,941 sustainable retrofit permits with an average value of 168,074 per permit, totaling 43.8 billion dollars.[22] This translates into 4.54 conventional and 1.26 sustainable permits per property during our study period.

We use this comprehensive microdata to separate sustainable from conventional retrofits at the property level. We implement the guidelines of EnergyStar, LEED, WELL, and Fitwel to segregate environmental, social, and conventional retrofits. In particular, EnergyStar and LEED are key environmental retrofitting authoroties that argue HVAC systems, heating and cooling, and building envelope retrofits are critical ways to reduce energy consumption and curb emissions (EnergyStar, 2023; LEED, 2024). Therefore, we classify doors and windows, HVAC systems, retaining walls, roofing, and solar installations as sustainable retrofits that contribute to the environmental performance of the property.

WELL and Fitwell are leading social real estate rating providers that assess the social and health performance of the built environment. They consider the accessibility of properties, water and air quality, amenities, and design as critical social performance indicators (Fitwel, 2024; International Well Building Institute, 2024). Correspondingly, we classify landscaping, patios, paving, driveways, and sidewalks as socially relevant retrofits because these permits most closely align with the exterior design, amenities, and accessibility of properties. WELL and Fitwell also include ventilation due to health benefits, already captured in the above HVAC

[21]Namely, Bathroom Remodelling, Decks and Porches, Demolition, Docks, Doors & Windows, Electrical Work, Excavation and Grading, Fences, Flatwork Concrete, Foundations, Garage Construction, HVAC systems, Home Addition, Kitchen Remodel, Landscape, Mechanical Work, Mobile Homes, Multi-Room Remodel, New Construction, Patios, Paving, Driveways, & Sidewalks, Plumbing, Pool and Spa Construction, Retaining Walls, Roofing, Sewer Laterals, Siding, Signage, Solar Installation.

[22]In private communication, BuildZoom told us that these permit values reflect a lower bound for realized expenses as permit fees paid to municipalities positively associate with reported permit costs.

retrofits. In Table 2, we display the frequency of all permits and their classification as conventional or sustainable based on these EnergyStar, WELL, and Fitwel guidelines.

To our knowledge, we are the first paper to use BuildZoom permit information to measure sustainable retrofits. Therefore, we validate the accuracy of our sustainable retrofit classification by showing that sustainable permits reduce environmental externalities. Large commercial properties in New York (NY), Boston (MA), and Cambridge (MA) have to report their energy consumption and (computed) carbon emissions on an annual basis, given the Local Law 87, BERDO, and BEUDO energy registry regulations (BERDO, 2024; BEUDO, 2024; NYC, 2024b).[23] We manually match this emission information to properties operated by REITs and analyze their permits.

In Table 3, we present the results of a regression of the CO_2 intensity of properties expressed as kilograms per square feet on a number of different types of sustainable investments, controlling for REIT- and time-fixed effects as well as the baseline property's emission intensity at the start of the sample. Table 3 Column (1) shows that each additional sustainable retrofit reduces CO_2 emission intensity by 0.193 kg per square footage. This effect is economically relevant compared to an average emission intensity of 8.695 kilograms per square footage, reflecting 2.22% of a property's emissions. When we decompose this impact for environmental and social permits in Columns (2) and (3), we find that solely environmental permits reduce emissions. In Columns (4) and (5), we perform falsification tests and see that the share of conventional permits has no explanatory power on emissions. Moreover, the impact of environmental permits on emission intensity is unchanged after we correct for overlap in the timing with social and conventional permits.

Environmental permits also explain CO_2 emission beyond commonly used third-party certificates (Eichholtz et al., 2010). In Columns (6) to (9), we regress CO_2 emission intensities on LEED, EnergyStar, and WELL certificates and find that primarily LEED certificates aid in explaining the emissions of properties. Nevertheless, environmental permits retain a large share of their impact on emissions beyond what is captured in certificates when we jointly regress certificates and permits in Column (10). Regarding economic impact, issuing eight environmental

[23] For further details on these laws, see Appendix A.

permits is reminiscent of transitioning a non-LEED-certified property to a LEED platinum one. These analyses validate that our classification of BuildZoom permits can adequately detect sustainable investments that meaningfully affect the environmental footprint properties.

3.3 Sustainable engagement records

As a last step, we collect information on all (sustainable) engagements of S&P1500 firms from the Institutional Shareholder Services (ISS) proxy voting dataset. One of the most common ways how shareholders can engage with firms on environmental, social, and governance issues is through filing shareholder proposals using Rule 14a-8 of the Securities Exchange Act of 1934 (Bebchuk et al., 2017; SEC, 2020).[24] The process of such engagements works as follows. First, a shareholder files a shareholder proposal through the SEC website to the firm at least 165 days before its annual meeting. When the firm does not contest this proposal, it will end up on its ballot and be voted on by fellow shareholders. This voting is a routine procedure and usually includes firm-sponsored proposals on management pay, board elections, and accounting firm renewals alongside shareholder proposals. When a shareholder proposal reaches a majority vote, it is generally adopted by the firm's management (Levit and Malenko, 2011).

When the management of a firm prefers not to have the proposal come to a vote, it can initiate a no-action request at the SEC to remove the proposal (SEC, 2020).[25] Following this request, the SEC can decide to omit the proposal when it violates shareholder rights, withdraw the proposal because the firm has "materially adopted the issue", or deny the no-action request and follow through with the vote in all other scenarios . Although rare, the firm can fight the SEC's no-action decision by filing a follow-on request or starting a legal procedure.

[24] Large institutional investors sometimes privately engage with firms as a first step in the engagement process (McCahery et al., 2016; Levit, 2019). Here, they directly talk with management and voice their opinion on the firm's (environmental and social) performance (Dimson et al., 2015; Bauer et al., 2022). When these private discussions are unsatisfactory, they can initiate a public proxy voting procedure observable in the ISS dataset. We do not have access to private engagement campaigns as they are often highly heterogeneous across investors, less coordinated between investors, and intentionally tricky to observe since they are kept private. However, our sole reliance on public engagements is likely to, if anything, underestimate the impact of engagement on sustainable investments because firms did not consent to stockholder demands in the private stage and thus oppose the engagement relatively more or face (less knowledgeable) investors without access to management (Levit, 2019). In addition to private engagement, very dissatisfied investors can file a proxy fight or proxy contest (distinct from a proxy vote) to oust a firm's board and ultimately replace its management by force without acquiring a majority share in the firm (Bebchuk et al., 2020).

[25] Either because it is certain to pass, exceeds shareholder rights and infringes management's ability to act independently, or is not in line with managers' private incentives (Bebchuk et al., 2017).

Given the above, withdrawn proposals or proposals that reach a majority vote can be considered "successful" and omitted proposals or proposals that did not hit the 50% threshold as "unsuccessful". One important nuance in the above is that "successful" or "unsuccessful" engagements do not imply that the firm substantively adopted the issue, the research question of this paper, but solely indicates that the issue is supported by its stakeholders or that the firm communicates to the SEC that it has preventatively implemented it. The conflicting outcomes of such "successful" engagement in prior literature (Akey and Appel, 2019; Naaraayanan et al., 2021; Busch et al., 2023) and the non-binding nature of its adoption by management (Levit and Malenko, 2011) stress our distinction.

The ISS dataset captures information on every step of this shareholder proposal process (Busch et al., 2023; He et al., 2023). In total, we gathered 229 instances where investors engage with REITs through shareholder proposals, 176 on governance issues, and 53 of a sustainable (environmental and social) nature. About half of these sustainable engagements (54.72%) are withdrawn or accepted by the firm before a vote, and 45.28% are omitted by the SEC or failed in a proxy vote. This distribution of successful and unsuccessful sustainable engagement events is reminiscent of existing literature in the field of sustainable finance (e.g., He et al., 2023), who similarly find that shareholder proposals are almost exclusively unsuccessful when they reach the proxy voting stage.[26]

4 Methods

The method section consists of two parts. First, we describe how we detect retrofit cycles using a jump-detection algorithm. Second, we elaborate on our empirical strategy for identifying the effect of sustainable engagement on firms' sustainable investments (increasing sustainable permits) conditional on the physical depreciation of real assets.

[26]He et al. (2023) argue that some engagements classified as socially responsible by ISS are governance engagements. In untabulated analyses, we adopt the ISS and the He et al. (2023) classification and find no economically meaningful differences in our results.

4.1 Detecting Retrofit Cycles

There is no standardized way to determine when the intensity with which REITs retrofit their properties classifies as a retrofit cycle. The thresholds for retrofit cycles likely differ across REITs, given their usual retrofitting behavior and the condition of their properties. To illustrate, Boston Properties has infrequent but large jumps in permits as retrofitting offices is expensive, Prologis has frequent but smaller retrofit cycles as retrofitting industrial warehouses requires less capital per property, and American Towers does not display large variation in retrofit behavior as it operates hundreds of thousands of cell towers, each facing relatively minor and ongoing repair expenses. Further, we cannot ex ante determine the duration of retrofit cycles. Since we do not attempt to predict when retrofit cycles occur but solely strive to observe them in sample, we could plot the time series of retrofits for each REIT and mark the periods with stark jumps. However, to ensure the objectivity and replicability of our results, we more formally assess when REITs initiate retrofit cycles using a jump-detection algorithm.

Jump detection algorithms are widely used in finance to detect abnormal shocks (or jumps) in stock prices (Lee and Mykland, 2008). They inductively detect large variations in time-series data without assuming any a priori pattern beyond two inputs, the duration of the jump, and the threshold for a shock in the data to be classified as a jump. Such an algorithm is ideally suited to detect retrofit cycles because we want to impose as little structure as possible on identifying retrofit cycles while employing an objective and replicable method. The following paragraphs will describe how we choose both parameters and validate their adequacy.[27]

Duration of Retrofit Cycles: BuildZoom provides four timestamps to trace the retrofitting process: the filing date, the approval date, the finalization date, and the termination date. The filing date is when a contractor or building owners initiates retrofitting and files a permit to its municipality. We consider this the start of the retrofitting process. Subsequently, a subset of municipalities records an approval date, almost always on or within a few days of the permit

[27]We expect REITs to experience a relatively low retrofitting baseline, followed by instantaneous and abnormally high levels of retrofitting activities when they raise capital. Since the 90% dividend payout rule constraints REITs in internally financing retrofits (Geltner et al., 2014), they will primarily rely on external funding to substantively retrofit their properties. Due to the associated fixed costs (Smith Jr, 1986), we anticipate the jump in permits to be stark and short-lived. We can observe these cycles because BuildZoom's permit information records retrofit starting and completion dates for every property in our sample.

filing date.[28] To finalize the process, municipalities record when the retrofit is completed. We use this date as the end date of the retrofit and compute the distance to the starting date as its duration in Figure 2.

Retrofit cycles last three quarters. Figure 2 shows the distribution of retrofit lengths for REIT-owned properties. We observe that these retrofits follow a hazard-model-like structure with multiple spikes at exactly half a year, one year, and two years from their filing date. We attribute these spikes to the heterogeneous record-keeping capacities of individual municipalities, carefully suggesting that some municipalities automatically record specific retrofits as completed after half a year, one year, or two years. The average duration for REIT-owned properties is 252.85 days, or 2.77 quarters. These automatically completed retrofits are not substantively affecting this average, see their relative proportion as reflected in Figure 2.[29]

Threshold of Retrofit Cycles: We determine the threshold when a jump in retrofitting is identified as a retrofit cycle through its magnitude and persistence. Since retrofit cycles last three quarters on average, we expect retrofits to be persistently higher for more than one period. To allow for a more persistent shock, we compute the difference between the current and one-quarter lead and the one- and two-quarter lagged level of retrofits for every REIT over time. Next, we determined that a one-standard-deviation difference between these pre and post-periods best fits our data and identifies retrofit cycles.[30] Using this approach, we identify 417 retrofit cycles out of 11,802 REIT-quarter observations, the average displayed in Figure 5. This is roughly one retrofit cycle every 7.1 years. Linking this back to the previous example, Prologis has most retrofit cycles (once every 5 years), followed by Boston Properties (once every

[28] In 0.35% of the cases, the permitting proccess got cancelled and the retrofit was not executed. We remove such instances from our sample.

[29] We replicate this analysis for every 112 million retrofits in the BuildZoom dataset in Appendix B and find an average duration of 246.88 days or 2.71 quarters with a similar hazard-style pattern.

[30] This results in the following formula: $\frac{Permits_{i,t}+Permits_{i,t+1}}{2} \geq \frac{Permits_{i,t-1}+Permits_{i,t-2}}{2} + \sigma_i$ and resembles the λ statistic presented in Lee and Mykland (2008) while allowing for forward-looking ($_{t+1}$) information to better calibrate the multi-period jumps in-sample. Moreover, this algorithm allows multiple periods in one retrofit cycle to be identified as the start of a retrofit cycle. Since retrofit cycles are periods with abnormal retrofit levels, their starting points should reflect the most significant jump in retrofits within the span of the retrofit cycle. Therefore, we remove all potential retrofit cycle starting points three quarters before, during, or after the most significant retrofit increase. Subsequently, we repeat this process iteratively, moving from the potential retrofit cycle starting point with the largest to the smallest retrofit increase until no overlap in timing remains. This iterative removal of jumps mechanically removes overlap in jump detection without imposing potentially too strict jump thresholds and type 1 errors.

6.31 years), and American Towers (once every 12.13 years). Further, the time in between these retrofit cycles significantly varies across and with firms, ranging from 2 to 10.75 years for just Boston Properties.

Figure 5 shows the time series number of retrofits in the quarters before, during, and after a retrofit cycle relative to the average number of retrofits of the REIT over the sample period. The figure indicates that our jump detection algorithm accurately detects retrofit cycles in two ways. First, the jump is sizeable, exceeding three times the usual number of retrofits at the start of retrofitting cycles. This signals that we are, on average, able to uncover high-retrofit periods. Second, the jump in retrofits is stark, as reflected by the lack of a pre-cycle increase in retrofitting and a negligibly higher number of retrofits just after retrofitting cycles. This carefully suggests that we detect retrofitting cycles' starting points and duration with reasonable precision. Given the above and a significant overlap in retrofit cycle dates among 48 alternative specifications presented in Appendix C, we can detect retrofit cycles reasonably well.[31]

4.2 Empirical specification

This section describes how we quantify the impact of sustainable engagement on firms' sustainable investments, given their physical depreciation (reflected in retrofit cycles). Equation 1 describes our main two-way fixed effects specification.

$$\begin{aligned}\text{Sustainable retrofits } (\%)_{i,t} = \alpha + \beta_1 * \text{Sustainable Engagement}_{i,t} + \beta_2 * \text{Retrofit Cycle}_{i,t} + \\ + \beta_3 * \text{Sustainable Engagement}_{i,t} * \text{Retrofit Cycle}_{i,t} + \gamma_{i,t} + \psi_i + \psi_t + \varepsilon_{i,t} \quad (1)\end{aligned}$$

Sustainable retrofits $(\%)_{i,t}$ measures the sustainable investments of REIT i at quarter t as their share of sustainable over total retrofits, as assigned in Table 2. Since sustainable engagement should be most effective in improving sustainable investments surrounding the retrofit cycles of REITs, we employ a two-way fixed effects setting with engagements and retrofit cycles. Specifically, Sustainable Engagement$_{i,t}$ is a dummy variable capturing whether REIT i

[31] Jump detection algorithms are sensitive to changing the height of the jump, the leads and lags used to identify the jump, and the length of the jump. In Appendix C, we vary these aspects of the jump detection algorithm as robustness. We find a roughly similar pattern in retrofit cycles across these for 48 alternative specifications with similar coefficient estimates. Please note that we solely try to observe when REITs initiate retrofit cycles in the sample with an objective measure rather than try to predict subsequent cycles with the detection algorithm.

receives a sustainable shareholder proposal at any day during quarter t. Further, the dummy variable Retrofit Cycle$_{i,t}$ indicates whether REIT i experiences a retrofit cycle at quarter t, lasting three quarters. The unit of analysis of this regression is REIT-quarter.

Since the effectiveness of sustainable engagement might vary by REIT size and profitability, we control for REIT's one-quarter lagged total return index, log total assets, and book leverage by introducing $\gamma_{i,t}$. ψ_i introduces REIT fixed effects to capture variation in sustainable retrofitting across REITs. This variation is critical as REITs with specific property types or locations might experience different incentives for sustainably retrofit. We further refine the specification by introducing time fixed effects (ψ_t) to correct for potential deviations in the average share of sustainable retrofits over time across REITs. Such variation corrects for changes in the price of sustainable over conventional retrofits over time, i.e., a reduction in the cost of solar panels since the early 2000s. Using the above empirical specification, we explore an event-study style two-way fixed effects setup.[32]

5 Results

5.1 Sustainable engagement, sustainable investments, and depreciation cycles

As a first step in analyzing the impact of sustainable engagement on sustainable investments, we plot the development of sustainable retrofits relative to retrofit cycles and engagement using

[32]We cannot use a classical Difference-in-Differences setup because both treatment (sustainably engaged firms) and control group assignment (non-engaged firms), as well as the treatment itself (retrofit cycles), are transitory; and we have little power. To elaborate, a REIT is only engaged for one quarter, and retrofit cycles last three quarters. To minimize the improper comparison possibilities and heterogeneous treatment effects (Callaway and Sant'Anna, 2021; Goodman-Bacon, 2021; Sun and Abraham, 2021; Roth et al., 2023), we solely consider the three quarters before, during, and after retrofit cycles in our analysis. This event-study window, in conjunction with REIT fixed effects and time fixed effects, should reduce the impact of heterogeneous treatment effects over time and improper comparisons as it considers within variation and constrains the number of periods in which REITs can be improperly assigned as a control group. Appendix D validates our results across five alternative two-way fixed effects specifications. We further curtail improper comparisons within REITs by removing cycles where REITs experience opposite engagement events. Specifically, we omit the three quarters before, during, and after retrofit cycles where REITs experience unsuccessful sustainable engagement when analyzing the impact of successful sustainable engagement and vice versa for unsuccessful sustainable engagement. Not omitting these instances shifts the REIT fixed effects and positively biases our results as the baseline level of retrofits is lower (higher) for (un)successful sustainable engagement, artificially increasing the magnitude of engagements on sustainable retrofits. In subsequent analyses, we also correct for overlap with governance engagements.

raw data in Figure 3. Specifically, each line in this graph represents REITs' quarterly sustainable retrofits over their total number of retrofits from three quarters before until five quarters after the initiation of a retrofit cycle. We split this by whether REITs experience no sustainable engagements, successful sustainable engagements, or unsuccessful sustainable engagements. The level of sustainable retrofits is demeaned with the average share of sustainable retrofits before the retrofit cycle starts. Even in a setting without controls, REITs perform more sustainable investments when sustainable engagement is successful during retrofit cycles, as indicated by the increase in sustainable retrofits relative to the no-engagement benchmark. In contrast, unsuccessful sustainable engagements appear to reduce the share of sustainable retrofits precisely when engagement coincides with retrofit cycles. These initial results seem to suggest that sustainable engagement might play a role in firms' sustainable investments, depending on their timing relative to real assets' physical depreciation.

In Table 4 Column (1), we regress REITs' share of sustainable retrofits on the occurrence of sustainable engagements and retrofit cycles following Equation 1. In aggregate, we do not observe a statistically significant effect of sustainable engagement on sustainable investments. Moreover, the effect is economically small and negative in sign. This estimate suggests that engagement is ineffective in improving firms' sustainable investments.

In Table 4 Column (2), we repeat the prior analysis while explicitly considering whether sustainable engagement occurs during or outside retrofit cycles. Unlike our preceding analysis, we find that sustainable engagement has the potential to impact firms' sustainable investments substantively. Engagement that occurs during retrofit cycles significantly increases the share of firms' sustainable retrofitting. In contrast, engagement significantly decreases sustainable retrofitting when it happens outside retrofit cycles. In economic terms, sustainable engagement during physical depreciation cycles increases the share of sustainable retrofits by 4.67 percentage points, or 22.62% relative to the average share of sustainable retrofits in our sample (i.e., 21.71%, see Table 2). Further, the share of sustainable retrofits declines by 4.99 percentage points or 22.99% for sustainable engagements outside retrofit cycles. These opposing signs provide evidence that accurately timing sustainable engagements relative to real asset depreciation is pivotal in improving firms' sustainable investments.

The effect of timing sustainable engagement during retrofit cycles should not be constant across engagement outcomes. In our data section, we mentioned that there are two potential types of engagement outcomes: "successful" engagements that are voted through on annual meetings or pre-emptively accepted (withdrawn) by the firm and "unsuccessful" engagements that are voted down or omitted for legal reasons by the SEC (Busch et al., 2023; He et al., 2023). We anticipate that successful engagements more positively impact sustainable investments precisely during retrofit cycles because substantive sustainable retrofitting is only possible at that time. However, we expect that unsuccessful engagement always impairs sustainable retrofitting since managers can stop performing minor retrofits outside retrofit cycles when investors signal a lack of appreciation for sustainability. As a falsification analysis, we separately test how successful or unsuccessful engagements affect sustainable retrofitting during retrofit cycles in respectively Columns (3) and (4) of Table 4.

Following our expectations, firms subject to successful sustainable engagement during their retrofit cycles increase their share of sustainable retrofits by 13.95 percentage points, or 64.26% over their average (Column (3)). This economic impact is significantly larger than the 22.62% increase when considering all sustainable engagement in general in Column (2). Furthermore, unsuccessful sustainable engagement reduces the share of sustainable retrofitting regardless of its timing relative to retrofit cycles. Specifically, it jointly significantly reduces the share of sustainable retrofits by 6.80 percentage points, or 31.23%, during retrofit cycles (see Table 4 Column (4)). This combination of increased sustainable investments for successful engagement and reductions for unsuccessful engagement further validates that timing sustainable engagement during the physical depreciation of real assets is central to steering firms' sustainable investment. However, it also signals sustainable engagement is a high-stake decision with potentially harmful consequences when it is unsuccessful.

5.2 Understanding the randomness between timing sustainable engagements and retrofit cycles

In this section, we provide a number of tests and details of the institutional setting that support the causal interpretation of our findings. In particular, we provide evidence showing that the

timing of sustainable engagement is unrelated to the timing of retrofit cycles. First, we show that sustainable engagement does not align with retrofit cycles and public information has little predictive power over retrofit cycles. Second, we show that investors cannot instigate retrofit cycles. Third, we show that SEC law prevents investors from using REITs' announcement of retrofit cycles to file engagements before retrofit cycles start. Last, we show that investors cannot iteratively file sustainable engagements and attain timing through brute force due to SEC legislation.

Independence of sustainable engagement timing and retrofit cycles One natural question to ask when engagement is more effective during retrofit cycles is why not all investors time their engagements to coincide with these cycles. Investors' ability to promptly recognize and respond to retrofit cycles within firms undermines the exogeneity of our empirical approach and challenges the causal interpretation of our findings. One major endogeneity concern for the estimation of effectiveness of engagement during retrofit cycles is that investors who time their engagements to coincide with retrofit cycles are more knowledgeable and file "higher quality" sustainable engagements. Such a channel would overestimate the role of physical asset depreciation on engagement, positively biasing our results.

Sustainable engagement and retrofit cycles do not align. As a first step in analyzing this question, we investigate the timing of sustainable engagements relative to the occurrence of retrofit cycles. We find that sustainable engagements occur only 12.00% of the time during retrofit cycles. This percentage is low compared to the 10.60% unconditional probability with which retrofit cycles occur, suggesting sustainable engagements do not align with retrofit cycles.[33]

Figure 4 displays event-study estimates when regressing the occurrence of retrofit cycles on multiple leads and lags of (sustainable) engagement dummies, using the quarter before engagement as the reference category. In every instance, we find that the engagement does not correlate with the occurrence of retrofit cycles. This suggests that investors appear not to

[33]We observe 417 retrofit cycles in our sample lasting 3 quarters each. Since we have 11,802 REIT-quarter observations, the unconditional probability is $\frac{417*3}{11,802} = 10.60\%$.

purposefully align their sustainable engagements with retrofit cycles.[34]

Next, we strive to provide a reason why investors appear not to be able to predict retrofit cycles. Public REIT-specific accounting information and macroeconomic indicators are two prominent channels though which investors might be able to predict retrofit cycles. However, capital and depreciation expenses on balance sheets are unlikely to aid investors in predicting retrofit cycles as physical depreciation is not mirrored in book depreciation because REITs linearly depreciate their properties for tax and accounting purposes.[35]

An alternative approach investors could take in identifying retrofit cycle starting points is specifying the macroeconomic or REIT-specific conditions under which retrofitting is more favorable. For instance, investors could argue that retrofits more frequently occur when the economy is recovering from a recession and properties are not fully leased, reducing the revenue losses of retrofits. Further, investors could predict retrofits using variation in the macroeconomic costs and benefits of retrofitting. Last, investors could analyze within-REIT property characteristics or location variation to predict retrofit cycles.

In Table 5, we test whether a large set of macroeconomic conditions, retrofit profitability, and within-REIT variation in property characteristics can explain retrofit cycles and sustainable engagement. In Columns (1) to (3), we regress the occurrence of retrofit cycles on NBER recessions, 10-year treasury rates, S&P 500 returns, real GDP growth rates, REIT industry returns (iShares Core U.S. REIT ETF), US construction spending index, US construction material costs, global energy prices, US housing returns, average square foot-weighted years since the properties of REITs last experienced a retrofit, the average square foot-weighted metropolitan area's vacancy rate in which REITs operate their properties, REIT fixed effects, and time fixed effects. Even though most of these aspects aid in predicting retrofit cycles, they jointly only explain 3.3% of the *in sample* squared variation in retrofit cycles. Furthermore, the timing of sustainable engagements is unaffected by these aspects, except for the construction material price index, which has an inverted sign. Therefore, we argue that investors do not use or are

[34]For further details on this plot, see Appendix E. Here, we also show that the likelihood of sustainable engagement success is unrelated to the its timing relative to retrofit cycles. This Appendix also shows that timing does not improve over time, ruling out potential concerns related to increasing investor attention in recent years.

[35]The US G.A.A.P. linear depreciation life-cycle for commercial properties is 39 years, 27.5 years for residential properties, and 15 years for land improvement costs. Land in itself cannot be depreciated.

unable to use public information to predict when REITs initiate retrofit cycles.

Information asymmetry: no initiation of retrofit cycles Investors cannot influence retrofit cycles with engagements because REITs retrofit a share of their portfolio of properties when these are physically depreciated. Even though the occurrence of sustainable engagements relative to retrofit cycles appears nearly random, we explore the possibility that engagements initiate retrofit cycles. Investors are unlikely able to shift REITs retrofit timing as property owners have little incentive to initiate major repairs due to two types of irreplaceability in the retrofitting process (following Cooper and Haltiwanger, 2006, who study physical asset replacement in manufacturing firms).

First, there is operational downtime. Large retrofits often force tenants to temporarily relocate and disrupt their operations, affecting the owner's cash flows. For instance, replacing a roof or windows would provide direct exposure to the outdoors, and upgrading HVAC systems temporarily stops the air circulation, leading to a lack of ventilation and no heating or cooling. Moreover, REITs might not even be legally allowed to initiate substantive retrofits when these are not strictly necessary, as they are often unable to displace tenants and wait until leases expire. On the flip side, when the depreciation of properties is sufficiently severe, REITs will be forced to retrofit before serious problems arise, indicating that retrofitting decisions are closely tied to physical property depreciation.

Second, there are no structured secondary markets for used building parts, vastly increasing the cost of early retrofitting. To illustrate, when a REIT installs triple-glazed windows, it cannot feasibly sell the existing 20-year-old single-sheet windows on a secondary market as construction firms would not choose inferior materials, and substantial safety risks are associated with relying on used products. This lowers the price of second-hand building parts. Further, the cost of carefully dismantling and shipping the used windows is potentially higher than that of a new window. Therefore, REITs have the incentive to delay initiating retrofit cycles as long as possible and are unlikely to be swayed by investor pressure to shift their timing.

Information asymmetry: no predictability of retrofit cycles Investor statistically predicting retrofit cycles is very challenging even for sophisticated investors as their occurrence fol-

lows a hazard model. Figure 6 Panel A plots the time between retrofit cycles in quarters. The time between retrofit cycles follows a hazard-model structure. Such a pattern is unsurprising as one could argue that physical depreciation occurs at a fixed rate with a significant noise parameter. The average time between retrofit cycles is 16.4 quarters but strongly varies across and within REITs. Moreover, we only observe the time between retrofits for REITs that retrofitted their properties within our sample, omitting REITs that retrofit less frequently. When we assume that every REIT retrofits its property at the end of our sample, the average time between these retrofit cycles is 36.5 quarters and accounts for 55.19% of the observations. Therefore, the physical depreciation underlying retrofit cycles indicate that predicting when REITs will announce and execute their retrofit cycles is complex, hindering investors from statistically timing their sustainable engagements accurately,

On the other hand, investors are not agnostic of firms' retrofitting announcements as they refrain from filing sustainable engagements when these are undoubtedly ineffective. Figure 6 Panels A and B display the occurrence of retrofit cycles and sustainable and governance engagements since the start of the prior retrofit cycle. One clear pattern in retrofitting cycles is that they never occur within seven-quarters of each other (Panel A). We argue that this is because REITs have already recently retrofitted all necessary properties, and there are fixed costs of raising external capital (Smith Jr, 1986). Accordingly, when investors know a REIT has just announced a retrofit cycle and there will be no new retrofit cycle for at least seven quarters, we should expect them to refrain from filing any sustainable engagements in the first seven quarters after the retrofit cycles. This is precisely the pattern we observe in Panel B since investors only start filing sustainable engagements ten quarters after the start of a retrofit cycle. In contrast, investors file governance engagements even within the first seven quarters, indicating they do not stop monitoring REITs. Therefore, investors appear not agnostic of REITs' retrofitting decisions but seem unable to accurately time them, leading to a random alignment of sustainable engagements and physical depreciation.

SEC rule §240.14a-8: timing shareholder proposals with retrofit announcements Investors cannot time their sustainable engagements even when REITs publicly announce retrofit cycles due to legal reasons. Given the 90% dividend rule, REITs are constrained in facilitating

extensive retrofits with their internal capital and often rely on external funding. To prevent dilution in share prices, REITs will communicate the reason for their fund-raising to investors, providing them with a direct signal of retrofit cycles. However, investors cannot use these signals to better align their sustainable engagements with retrofit cycles due to a mismatch in timing.

According to SEC rule 14a8 (SEC, 2020), investors need to file their engagements (shareholder proposals) at least 165 before the annual shareholder meetings of firms. This regulation stipulates that investors receive the voting ballots 45 days before the annual meeting, and states that investors should file their proxy votes to the SEC 120 days before the day that investors receive their ballots. These 120 days allow the SEC to check the legal nature of the engagement and for firms to withdraw the engagement and acquiesce to investors' demands preemptively. This imposes a lag of at least four months, potentially up to 12 months, between the day engagements are filled and voted on.

On the one hand, the time between retrofit announcement and retrofitting is rather short. REITs are incentivized to minimize the time between external capital acquisition and retrofits, as large quantities of unused cash on balance sheets are costly. Unlike initial public offerings, follow-on public offerings can be executed in a manner of days and do not require shareholder approval at exchanges such as NYSE or NASDAQ, given that the issuance does not exceed 25% of outstanding shares and the shares are pre-approved in REITs constituents. Further, REITs can privately negotiate their loans or bonds in a similar timespan without, in theory, requiring shareholder notice and approval.[36] Due to the short-lived nature of the public retrofitting announcements and the at least four-month response period of engagements, investors will be unable to affect retrofitting decisions once REITs' retrofitting intentions become public for legal reasons.

SEC rule §240.14a-8: iterative engagements One alternative way sustainable investors could ensure they timed their sustainable engagements correctly is by filing engagements en masse at every annual meeting and time their engagements correctly by brute force. However,

[36]Due to the high share of non-substantial shareholders, such as NGOs, labor unions, and religious organizations filing sustainable engagement (Slager et al., 2023), it is unlikely that investors who file sustainable engagements provide direct and sufficient funding to meet REITs' needs during retrofit cycles.

filing multiple engagements is an unlikely strategy to achieve engagement success for four reasons.

First, the SEC does not allow engagements on specific topics to be submitted more than four times in a row, and only under strict requirements. Specifically, engagements can only be re-submitted for a second, third, and fourth time when the firm does not omit them and they reached a 5%, 10%, and 25% vote in favor of the engagements at the prior annual meeting, respectively.[37] Second, filing repeated engagements is risky as it increases the likelihood of firms requesting the SEC to omit the engagement under rule 14a8(i)(4). Third, when a engagement on a specific topic by a particular investor is omitted through a no-action request at the SEC, all other investors cannot initiate a engagement on the same subject under the duplication clause in SEC rule 14a8(i)(11), and that specific investor cannot initiate engagements on any other topic to the firm for a period of up to three years. Last, firms are free to pursue legal actions against a shareholder by filing shareholder engagements on different topics not directly (but indirectly) related to the engagement. Since the benefits from constraining a repeat issuing shareholder are greater, shareholders who file multiple engagement could face higher litigation risks.

Further, we observe a similar pattern in our data, where only 20% of engaged firms experience sustainable engagements in consecutive years. These engagements frequently do not originate from the same shareholder and can be on different sustainability aspects. Notably, there is only one instance in our sample where repeat engagement in a REIT is effective. Specifically, solely one REIT is successfully sustainably engaged during a retrofit cycle on the fourth year of consecutive engagements (by different investors). Conversely, two REITs are repeat engaged (by different investors) and experience unsuccessful sustainable engagements during retrofit cycles. For these reasons, we argue that investors are legally and practically constrained in using consecutive engagements as a strategy to time their engagements with retrofit cycles through brute force.

Given the above, we argue that the timing of sustainable engagements relative to retrofit cycles is random as sustainable engagements do not coincide above moderately often with retrofit cycles, predicting retrofit cycles is complicated due to their hazard-style occurrence, public

[37] See SEC rule 14a8(i)(12), 2020 Adopting Release, supra note 2, at 70288 for further details (SEC, 2022).

accounting and macroeconomic variation providing little insights in retrofit timing, investors cannot act on retrofit cycle announcements by REITs due to the timing of SEC shareholder proposal law and contractor agreements, investors cannot consecutively file engagements according to SEC law, and investors are unlikely to shift the timing of retrofit cycles due to high costs. However, we argue the impact of engagements on retrofit cycles is significant when they coincide in timing. To minimize the time REITs have unused cash on their balance sheets, they will first negotiate with contractors, subsequently raise funds, and consecutively initiate retrofit cycles. This negotiation process must occur before fundraising, as REITs need to determine the scope of planned retrofits, affecting how much capital they should raise. Consequently, investors can play a pivotal role in this process by strongly nudging REITs that they are willing to provide the needed capital for sustainable investments or, potentially, funding sustainable retrofits at a discount (McCahery et al., 2016; Broccardo et al., 2022, see also).

6 Robustness checks

Now that we have shown that the timing of sustainable engagement is unrelated to the timing of retrofit cycles, we further verify the internal validity of our results by studying governance engagements, property sales, and conventional retrofitting activities.

6.1 Falsification test: Governance engagement

In addition to sustainable engagements, firms often engage in governance issues, such as management pay, board selection, and anti-takeover mechanisms (Bebchuk et al., 2017). In our setting, such governance engagements should have a significantly lower impact than sustainable engagements on sustainable retrofitting as they address different issues.[38] Therefore, governance engagements pose a falsification test for the impact of sustainable engagements on sustainable investments during retrofit cycles.

Table 6 presents the estimated impact of governance engagements on sustainable retrofits.

[38]The economic impact of governance engagement on sustainable investments does not need to be zero as investors could strive to indirectly improve REITs' sustainable investments by strategically electing directors with a sustainability agenda through governance engagements.

Column (1) estimates the effect of governance engagement on sustainable retrofitting as falsification analysis using Equation 1. Here, we observe a slight reduction in the share of sustainable retrofits of 0.84 percentage points when REITs experience a governance engagement outside retrofit cycles. Further, we see an insignificant decrease in sustainable retrofits when governance engagement coincides with retrofit cycles. Since governance engagements appear to reduce rather than increase the extent to which REITs sustainably retrofit their properties, they are unlikely to drive the positive effect of successful sustainable engagement during retrofit cycles. Even though the impact of governance engagement is negligible, we explicitly test whether introducing outside and during retrofit cycle governance engagements in Columns (2) to (5) affects our results. Across these specifications, we observe a random pattern in the estimated coefficient of governance engagements during or outside retrofit cycles, indicating that its effect is highly unstable (as is desirable for a falsification analysis).

However, we still observe that sustainable engagements do not significantly affect REITs' share of sustainable retrofits unconditionally on the occurrence of retrofit cycles after controlling the impact of governance engagements in Column (3). Further, the impact of sustainable engagement conditional on retrofit cycles is qualitatively and quantitatively indistinguishable from our main results, see Columns (4) and (5). Last, we observe similar increases and declines in sustainable retrofits during retrofit cycles for successful and unsuccessful sustainable engagements, with coefficients changing from 13.95 to 14.32 percentage points and negative 6.80 to negative 4.90 percentage points, respectively. In other words, the impact of sustainable engagements on sustainable retrofits is not driven by investors steering on sustainability through governance engagements.

6.2 Intensive or extensive margin of sustainable engagement: Property sales

We analyze whether the impact of sustainable engagement is driven by improvements at the extensive or intensive margin. REITs can improve their sustainable performance through two channels: sustainable retrofits (the intensive margin) and selling unsustainable properties (the extensive margin). Selling less sustainable properties could further reduce their sustainable

performance as they could be sold to less sustainable owners who perform fewer sustainable retrofits.[39] For this reason, we analyze whether successful sustainable engagements initiate portfolio reallocations and property sales.

In theory, large-scale property disposition cannot drive our results for legal reasons as REITs need to generate 90% of their income from property operations and market values of properties often far exceed book values due to appreciation of market prices and depreciation in books (Geltner et al., 2014). In practice, we similarly do not find that property sales affect the impact of sustainable engagement on sustainable performance. Table 7 analyzes property sales in a similar setting to Equation 1. In Columns (1) to (3), we regress the share of the properties liquidated by REITs over their total number of properties in the prior quarter on all, successful, and unsuccessful sustainable engagements, respectively. We do not observe that sustainable engagements or successful sustainable engagements induce abnormal property sales regardless of retrofit cycles. However, unsuccessful engagement during retrofit cycles reduces property sales by 0.27 percentage points. This provides an initial indication that property sales do not substantively offset the sustainable investments associated with successful sustainable engagement and potentially worsen its negative consequences when engagement is unsuccessful .[40]

To further support this claim, we analyze sustainable retrofitting for a sub-sample of liquidated properties. BuildZoom permit data traces retrofits regardless of ownership, enabling us to test whether the owners of previously REIT-owned properties perform similar sustainable retrofits compared to their past owner. We were unable to exactly replicate the analysis above as REITs sell their properties so seldom that we ran out of degrees of freedom. Specifically, property sales are so infrequent that we only retain a tenth of the observations, forcing us to omitting the interaction terms for outside and during retrofit cycles and REIT fixed effects, as well as replacing time fixed effects with year fixed effects. Using this adjusted specification in Column (4), we do not observe any statistically significant reduction in the share of sustainable retrofits after property sales due to successful or unsuccessful sustainable engagement. Given the absence of abnormal property sales due to engagement, the low baseline level of prop-

[39] See Berk and van Binsbergen (2021) for an analogous line of reasoning for sustainable investors who divest from high externality stocks and conventional investors attaining voting rights.

[40] We perform a similar analysis for property acquisitions similarly find no significant effect.

erty sales, and the persistence in sustainable retrofits after the sale, we rule out the impact of property sales on the efficacy of successful sustainable engagement in sustainable investments.

6.3 Conventional retrofits

In addition to property liquidation, the extent to which REITs alter their conventional retrofitting activities is relevant for the "additionality" of sustainable engagement in improving sustainable performance. We previously argued that engagement is exogenous of retrofit cycles because these cycles are driven by depreciation in the physical characteristics of properties. One consequence of physical property depreciation is that properties need to be improved regardless of sustainable engagement pressures. Therefore, if sustainable engagements force REITs to adopt sustainable retrofits at the expense of conventional retrofits due to capital constraints, REITs might be forced to retrofit their properties less conventionally. Consequently, they might face increased safety or financial concerns because their conventional maintenance is overdue by predominantly focusing on sustainable retrofits.

We investigate this channel by considering the impact of sustainable engagement on the number of *conventional* retrofits issued by REITs. We anticipate that the number of conventional retrofits does not substantially decline when REITs receive successful sustainable engagement during retrofit cycles. However, the number of electrical retrofits could marginally increase as performing major retrofits to HVAC systems also requires REITs to file additional conventional electrical retrofits. Therefore, an increase in the share of sustainable retrofits in conjunction with no decrease in non-electrical conventional retrofits would provide direct evidence of the additionality of sustainable engagement in increasing sustainable investments.

Table 8 follows Equation 1 using the number of conventional retrofits as the dependent variable in Columns (1) to (3). We find that sustainable engagement increases the number of conventional retrofits by 4.79, 6.62, and 3.28 for all, successful, and unsuccessful sustainable engagements during retrofit cycles, respectively. Despite statistical significance, these increases in conventional retrofits are economically marginal, given a standard deviation of 80.28 in conventional retrofits in our sample.

This increase in conventional retrofits is entirely explained by the rise in electrical retrofits,

required for HVAC installation. In Columns (4) to (6), we observe statistically significant increases in electrical retrofits for all and successful sustainable engagement during retrofit cycles. However, unsuccessful sustainable engagements that do not improve HVAC retrofits display no (jointly) significant effect on electrical retrofits. Further, we observe no effect of any, successful, or unsuccessful sustainable engagement on non-electrical conventional retrofits during retrofit cycles. These results validate that sustainable engagement does not substantively harm REITs' conventional retrofitting efforts.

7 External Validity

7.1 REIT selection

Where our findings show that the timing of sustainable engagement within firms matters for its impact on sustainable investments, prior studies focus on variation in the effectiveness of engagement across firms, arguing that larger (Busch et al., 2023), more profitable (Dimson et al., 2015), and more sustainable (Barko et al., 2021) firms are being engaged more often on topic material to risks (Hoepner et al., 2021) or financial considerations (Grewal et al., 2016; Bauer et al., 2022).

One potential critique is that our results stem from a very selective sample, challenging the external validity of our results. We provide supportive evidence that selection across REITs will unlikely drive our results. Figure 7 displays the density functions of 1) the number of retrofits per property, 2) the property size, 3) the property age, and 4) the combined firm-level square footage separately for engaged firms (before their first engagement) and never-engaged firms.

The figure shows that engaged and non-engaged firms have similar properties in age and size. Moreover, properties appear reminiscent of physical conditions as the number of retrofits per property is indistinguishably different. This indicates that selection across firms at the intensive margin will unlikely affect our results substantially. However, sustainable investors are not wholly agnostic about their selection of engagement targets as they engage with firms that are larger at the extensive margin, i.e., operate more combined square footage. To illustrate

the importance of size, firms in the S&P 500 were 17.53 times more likely to be engaged than firms outside of the index. Since selection occurs solely by REIT size rather than property characteristics, we argue that selection across (less sustainable) REITs with poorly maintained properties will unlikely drive our results.

7.2 Replication exercise: US Heavily Polluting Plants with Real Assets

This section provides evidence that our results generalize beyond the listed real estate setting into the heavily polluting manufacturing and utility industry.

Prior literature investigated the impact of sustainable engagement on pollution for heavily polluting manufacturing firms captured in the EPA Toxic Release Inventory (TRI) dataset (Akey and Appel, 2019; Naaraayanan et al., 2021). We gather the universe of manufacturing plant locations in the EPA TRI dataset, matching these locations with our permit and engagement datasets. Our final sample includes 692 firms, 2,295 plants, and 170,539 plant-year-chemical observations, 31,890 of which have sustainable engagements. We identify property retrofit cycles through a two-standard deviation jump in retrofits from the mean.[41] Subsequently, we replicate our main results results (see Table 4) for TRI plants.

Table 9 presents our estimates for TRI manufacturing plans while correcting for plant times chemical and chemical times time fixed effects (following Akey and Appel, 2019; Naaraayanan et al., 2021). As with our primary analysis, we do not observe that sustainable engagement improves the sustainable property investments of manufacturing firms when we do not correct for physical depreciation cycles (Column (1) in Table 9). However, we find that the aggregate effect of sustainable engagement on sustainable retrofits is negative when we analyze its impact during retrofit cycles in Column (2). This effect is not overly surprising as it combines the impact of successful and unsuccessful engagement, the latter likely more impactful due to the costly nature of sustainable investments in the real estate of heavily polluting firms compared

[41] We perform the jump detection algorithm of REITs using quarterly retrofit information. We detect cycles when the average over two quarters exceeds one standard deviation. However, TRI reports its data on a yearly frequency, preventing us from using the same methodology. To stay as close to our prior approach, we assume retrofit cycles occur for the entirety of a year and adopt a two standard deviation threshold that resembles our two times one standard deviation requirement for quarterly data.

to more sustainable REITs.[42]

In line with this and our primary analysis, we find that successful sustainable engagements only increase the share of sustainable retrofits during retrofit cycles. This effect is economically sizeable as the 7.59 percentage points increase in the share of sustainable retrofits reflects 149.12% more sustainable retrofits (Column (3) in Table 9). In contrast, unsuccessful sustainable engagement reduces the share of sustainable retrofits by 1.09 percentage points, or 21.41%, during retrofit cycles in Column (4). Finding that stainable engagements spur sustainable investments in the heavily polluting manufacturing sector during retrofit cycles provides external validity to our results beyond the public real estate market.

Conducting sustainable retrofits has substantive consequences on manufacturers' sustainable decision-making and sustainable investments. Sustainable retrofitting is the predominant way that already-built real estate improves its sustainable investments. However, it is not self-evident that enhancing the properties of the manufacturing sector has such a first-order sustainable impact given the presence of a polluting production process and manufacturing equipment for which we have no permits. We estimate whether these additional sustainable retrofits translate into meaningful sustainability outcomes by analyzing their effect on pollution prevention activities and EPA environmental fines in Table 10.

In Column (1), using EPA pollution prevention data, we find that sustainable retrofits are associated with more pollution prevention activities. These pollution prevention activities indicate that sustainable engagements trigger sustainable investments sufficiently prominent that firms report to the EPA. However, they might also include abatement activities unrelated to real estate and closely tied to their production process or chemical use. To address this potential endogeneity concern, we use these prevention activities across the handling of materials directly related to how firms operate their properties and thus sustainable retrofits, production processes, and chemical use pollution prevention activities that should be less affected in Columns (2) to (4). Per this intuition, material handling pollution prevention activities are positively associated with sustainable retrofitting. In contrast, chemical use or process improvements unrelated to

[42]Specifically, industrial plants are often less scrutinized than offices, multifamily, nursing homes, and hotels, providing more leeway for manufacturing firms to forgo expensive renovations. Moreover, REITs keep the relatively better-located properties within these asset classes, reducing the relative costs of retrofits compared to total property (and land) value.

sustainable retrofitting are unaffected.

In addition to pollution prevention, we also find that manufacturers receive less intense and frequent EPA fines after sustainably retrofitting their properties. Following Xu and Kim (2021) and Dasgupta et al. (2023) in using EPA ECHO records, we capture the frequency and intensity of EPA fines over five years. Using a similar specification to Columns (1) to (4), we find that manufacturers who issue more sustainable retrofits experience fewer EPA litigation with a lower notional in Columns (5) and (6). In economic terms, successful sustainable engagement during retrofit cycles decreases the likelihood of EPA penalties by 1.49% through initiating sustainable retrofits.[43] With pollution prevention being costly and fines averaging 2.1 million dollars, we carefully argue that sustainable engagement positively influences firms' sustainable investments beyond a real estate setting.[44] Given the above, our results suggest that accurately timing sustainable engagement to coincide with the physical depreciation cycles of real assets can play an essential role in steering sustainable investments.

8 Conclusion

This paper provides evidence that sustainable engagement improves firms' sustainable investments only when its timing aligns with the ("real" not "book") depreciation of their physical assets. Using unique identification in the public real estate market and a novel dataset on property-level permits, we find that successful sustainable engagement reduces the intensive margin of sustainable investments through sustainable retrofits when its timing aligns with its physical deprecation of assets. In contrast, unsuccessful sustainable engagement curtails firms' sustainable investments. These results persist when correcting for governance engagements, asset disposition, and correcting for already required physical retrofits. Further, our results appear unexplained by a selection in REITs and are generalized to the US heavy manufacturing industry, heavily relying on real assets. Therefore, this paper argues that sustainable engage-

[43] Sustainable engagement increases the share of sustainable retrofits by 7.59 percentage points (Table 9, Column (3)). A one percentage point increase in sustainable retrofits reduces the likelihood of penalties by $0.016/8.14 = 0.197\%$. Jointly, this makes $7.59 * 0.197\% = 1.49\%$. This effect is economically not that large but in addition to plant-chemical and chemical-time variation in EPA fines.

[44] Xu and Kim (2021) show that legal clean-up costs associated with SEC fines in the EPA ECHO dataset can even exceed imposed penalties and fines.

ment poses an effective tool to improve firms' sustainable investments when accurately aligned with the depreciation cycles of their physical assets.

Our paper provides policy recommendations for sustainable investors and regulators. As with any corporate finance decision, cheaper capital is most needed when a firm undergoes significant and long-term investments. In the periods after this investment, the firm is supposed to earn revenue to recoup these investments and will need less external capital. Our work suggests that timing sustainable investing initiatives to coincide with such real asset retrofit periods is critical (see also Xu and Kim, 2021). Accordingly, sustainable investors could jointly engage, tilt their portfolios, and provide debt financing for firms in need of capital investments at the right time rather than focus on a sub-sample low emission firms in the cross-section (see also Hartzmark and Shue, 2023) or those that have already made their investments and won't do so again for a long time. Getting this timing right is of first-order importance to attaining net-zero emissions by 2050, as missed engagement opportunities right now lead to locked-in unsustainable assets. This is particularly true for heavily polluting but substitutable goods with a long lifespan, such as electric vs. gasoline vehicles (roughly 15 years), coal and natural gas plants or renewable energy (approximately 40 years), or building more energy efficient properties (50+ years). Therefore, policymakers could focus on stimulating new sustainable investments rather than emphasizing the level of firms' pollution. From a policy perspective, regulation could focus on providing investors more in-depth information on physical asset depreciation or reduce the lag from shareholder proposal to vote in SEC rules.

Bibliography

Acharya, V. V. and Richardson, M. (2009). Causes of the financial crisis, *Critical review* **21**(2-3): 195–210.

Aggarwal, R., Saffi, P. A. and Sturgess, J. (2015). The role of institutional investors in voting: Evidence from the securities lending market, *Journal of Finance* **70**(5): 2309–2346.

Akerlof, G. A. (1970). The Market for "Lemons": Quality Uncertainty and the Market Mechanism, *Quarterly Journal of Economics* **84**(3): 488–500.

Akey, P. and Appel, I. (2019). Environmental externalities of activism, *Available at SSRN 3508808* .

Alexander, C. R., Chen, M. A., Seppi, D. J. and Spatt, C. S. (2010). Interim news and the role of proxy voting advice, *Review of Financial Studies* **23**(12): 4419–4454.

Allen, J. G., MacNaughton, P., Satish, U., Santanam, S., Vallarino, J. and Spengler, J. D. (2016). Associations of cognitive function scores with carbon dioxide, ventilation, and volatile organic compound exposures in office workers: a controlled exposure study of green and conventional office environments, *Environmental health perspectives* **124**(6): 805–812.

Appel, I. R., Gormley, T. A. and Keim, D. B. (2016). Passive investors, not passive owners, *Journal of Financial Economics* **121**(1): 111–141.

Azar, J., Duro, M., Kadach, I. and Ormazabal, G. (2021). The big three and corporate carbon emissions around the world, *Journal of Financial Economics* **142**(2): 674–696.

Babenko, I., Choi, G. and Sen, R. (2023). Management (of) proposals, *Available at SSRN 3155428* .

Bams, D. and van der Kroft, B. (2024). Tilting the wrong firms? How inflated ESG ratings negate socially responsible investing under information asymmetries, *Available at SSRN:* **4126986**.

Banzhaf, S., Ma, L. and Timmins, C. (2019). Environmental justice: The economics of race, place, and pollution, *Journal of Economic Perspectives* **33**(1): 185–208.

Barko, T., Cremers, M. and Renneboog, L. (2021). Shareholder engagement on environmental, social, and governance performance, *Journal of Business Ethics* pp. 1–36.

Bauer, R., Derwall, J. and Tissen, C. (2022). Private shareholder engagements on material ESG issues, *Available at SSRN 4171496* .

Bebchuk, L. A., Brav, A., Jiang, W. and Keusch, T. (2020). Dancing with activists, *Journal of Financial Economics* **137**(1): 1–41.

Bebchuk, L. A., Cohen, A. and Hirst, S. (2017). The agency problems of institutional investors, *Journal of Economic Perspectives* **31**(3): 89–112.

BERDO (2024). Building emissions reduction and disclosure.
URL: *https://www.boston.gov/departments/environment/building-emissions-reduction-and-disclosure*

Berg, F., Koelbel, J. F. and Rigobon, R. (2022). Aggregate confusion: The divergence of ESG ratings, *Review of Finance* **26**(6): 1315–1344.

Berk, J. and van Binsbergen, J. H. (2021). The impact of impact investing, *Available at SSRN:* **3909166**.

BEUDO (2024). Building energy use disclosure ordinance.
URL: *https://www.cambridgema.gov/CDD/zoninganddevelopment/sustainabledevelopment/buildingenergy*

Brav, A., Jiang, W., Li, T. and Pinnington, J. (2024). Shareholder monitoring through voting: New evidence from proxy contests, *Review of Financial Studies* **37**(2): 591–638.

Brav, A., Jiang, W., Partnoy, F. and Thomas, R. (2008). Hedge fund activism, corporate governance, and firm performance, *Journal of Finance* **63**(4): 1729–1775.

Broccardo, E., Hart, O. and Zingales, L. (2022). Exit versus voice, *Journal of Political Economy* **130**(12): 3101–3145.

Bui, L. T. and Mayer, C. J. (2003). Regulation and capitalization of environmental amenities: Evidence from the toxic release inventory in massachusetts, *Review of Economics and statistics* **85**(3): 693–708.

Busch, T., Scheitza, L., Bauckloh, T. and Klein, C. (2023). ESG and firm value effects of shareholder proposals, *Available at SSRN 4341964* .

Callaway, B. and Sant'Anna, P. H. (2021). Difference-in-differences with multiple time periods, *Journal of Econometrics* **225**(2): 200–230.

Census (2024). New privately-owned housing units authorized in permit-issuing places: Total units. FRED.
URL: *https://fred.stlouisfed.org/series/PERMIT*

Cooper, R. W. and Haltiwanger, J. C. (2006). On the nature of capital adjustment costs, *The Review of Economic Studies* **73**(3): 611–633.

Cuñat, V., Gine, M. and Guadalupe, M. (2012). The vote is cast: The effect of corporate governance on shareholder value, *Journal of Finance* **67**(5): 1943–1977.

Cvijanović, D., Dasgupta, A. and Zachariadis, K. E. (2016). Ties that bind: How business connections affect mutual fund activism, *Journal of Finance* **71**(6): 2933–2966.

Dasgupta, S., Huynh, T. D. and Xia, Y. (2023). Joining forces: The spillover effects of EPA enforcement actions and the role of socially responsible investors, *Review of Financial Studies* **36**(9): 3781–3824.

DeAngelo, H. and DeAngelo, L. (1989). Proxy contests and the governance of publicly held corporations, *Journal of Financial Economics* **23**(1): 29–59.

Dimson, E., Karakaş, O. and Li, X. (2015). Active ownership, *Review of Financial Studies* **28**(12): 3225–3268.

Dimson, E., Karakaş, O. and Li, X. (2023). Coordinated engagements, *European Corporate Governance Institute–Finance Working Paper* (721).

DOE (2003). Best practices guide for residential hvac retrofits.
URL: *https://www.osti.gov/biblio/824856*

Dyck, A., Lins, K. V., Roth, L. and Wagner, H. F. (2019). Do institutional investors drive corporate social responsibility? International evidence, *Journal of Financial Economics* **131**(3): 693–714.

Edmans, A., Levit, D. and Schneemeir, J. (2022). Socially responsible divestment, *Available at SSRN:* **4093518**.

Eichholtz, P., Kok, N. and Quigley, J. M. (2010). Doing well by doing good? green office buildings, *American Economic Review* **100**(5): 2492–2509.

EnergyStar (2023). Building Upgrades, `https://www.energystar.gov/buildings/save_energy_commercial_buildings/ways_save/building_upgrades`.

EPA (2022). Sources of greenhouse gas emissions. Retreived from `https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions`.

EPA (2023).
URL: *https://www.epa.gov/report-environment/indoor-air-quality*

EPA (2024). Regulations emissions vehicles and engines.
URL: *https://www.epa.gov/regulations-emissions-vehicles-and-engines/regulations-greenhouse-gas-emissions-aircraft*

Fitwel (2024). Fitwel - esg solutions: Social performance by fitwel®.
URL: *https://www.fitwel.org/esg*

Gantchev, N. and Giannetti, M. (2021). The costs and benefits of shareholder democracy: Gadflies and low-cost activism, *Review of Financial Studies* **34**(12): 5629–5675.

Gao, M. and Huang, J. (2022). Informed voting, *Available at SSRN 3777316* .

Geltner, D., Miller, N. G., Clayton, D. J. and Eichholtz, P. (2014). *Commercial real estate analysis and investments*, Vol. 1, South-western Cincinnati, OH.

Goodman-Bacon, A. (2021). Difference-in-differences with variation in treatment timing, *Journal of Econometrics* **225**(2): 254–277.

GRESB (2024). What is embodied carbon in the real estate sector and why does it matter?
URL: *https://www.gresb.com/nl-en/what-is-embodied-carbon-in-the-real-estate-sector-and-why-does-it-matter/*

Grewal, J., Serafeim, G. and Yoon, A. (2016). Shareholder activism on sustainability issues, *Available at SSRN 2805512* .

Hartzmark, S. M. and Shue, K. (2023). Counterproductive impact investing: The impact elasticity of brown and green firms, *Available at SSRN 4359282* .

He, Y. E., Kahraman, B. and Lowry, M. (2023). ES risks and shareholder voice, *Review of Financial Studies* **36**(12): 4824–4863.

Hirschman, A. O. (1972). *Exit, voice, and loyalty: Responses to decline in firms, organizations, and states*, Harvard university press.

Hoepner, A. G., Oikonomou, I., Sautner, Z., Starks, L. T. and Zhou, X. (2021). ESG shareholder engagement and downside risk, *Available at SSRN 2874252* .

Hsu, P.-H., Li, K. and Tsou, C.-Y. (2023). The pollution premium, *Journal of Finance* **78**(3): 1343–1392.

International Well Building Institute (2024). International well building institute, International Well Building Institute.
URL: *https://www.wellcertified.com/*

ISS (2024). Shareholder proponent data. ISS.
URL: *www.iss-corporate.com/solutions/governance-solutions/shareholder-proponent-data*

Jones, A. P. (1999). Indoor air quality and health, *Atmospheric environment* **33**(28): 4535–4564.

Kahn, M. E., Matsusaka, J. and Shu, C. (2023). Divestment and Engagement: The effect of green investors on corporate carbon emissions, *Technical report*, National Bureau of Economic Research.

Kontokosta, C. E. (2016). Modeling the energy retrofit decision in commercial office buildings, *Energy and buildings* **131**: 1–20.

Krueger, P., Metzger, D. and Wu, J. (2020). The sustainability wage gap, *Swedish House of Finance Research Paper* (20-14): 21–17.

Krueger, P., Sautner, Z. and Starks, L. T. (2020). The importance of climate risks for institutional investors, *Review of Financial Studies* **33**(3): 1067–1111.

Künn, S., Palacios, J. and Pestel, N. (2023). Indoor air quality and strategic decision making, *Management Science* .

Lee, S. S. and Mykland, P. A. (2008). Jumps in financial markets: A new nonparametric test and jump dynamics, *Review of Financial Studies* **21**(6): 2535–2563.

LEED (2024). Leed rating system.
URL: *https://www.usgbc.org/leed*

Levinson, A. (1999). State taxes and interstate hazardous waste shipments, *American Economic Review* **89**(3): 666–677.

Levit, D. (2019). Soft shareholder activism, *Review of Financial Studies* **32**(7): 2775–2808.

Levit, D. and Malenko, N. (2011). Nonbinding voting for shareholder proposals, *Journal of Finance* **66**(5): 1579–1614.

Lewellen, J. and Lewellen, K. (2022). Institutional investors and corporate governance: The incentive to be engaged, *Journal of Finance* **77**(1): 213–264.

Li, S. Z., Maug, E. and Schwartz-Ziv, M. (2022). When shareholders disagree: Trading after shareholder meetings, *Review of Financial Studies* **35**(4): 1813–1867.

Li, T., Naaraayanan, S. L. and Sachdeva, K. (2023). Conflicting objectives of eSG funds: Evidence from proxy voting, *Available at SSRN 3760753* .

Ling, D. C., Wang, C. and Zhou, T. (2020). A first look at the impact of COVID-19 on commercial real estate prices: Asset-level evidence, *The Review of Asset Pricing Studies* **10**(4): 669–704.

Livdan, D. and Nezlobin, A. (2021). Investment, capital stock, and replacement cost of assets when economic depreciation is non-geometric, *Journal of Financial Economics* **142**(3): 1444–1469.

Mauer, D. C. and Ott, S. H. (1995). Investment under uncertainty: The case of replacement investment decisions, *Journal of Financial and Quantitative Analysis* **30**(4): 581–605.

McCahery, J. A., Sautner, Z. and Starks, L. T. (2016). Behind the scenes: The corporate governance preferences of institutional investors, *Journal of Finance* **71**(6): 2905–2932.

Meirowitz, A. and Pi, S. (2022). Voting and trading: The shareholder's dilemma, *Journal of Financial Economics* **146**(3): 1073–1096.

Morawska, L., Allen, J., Bahnfleth, W., Bennett, B., Bluyssen, P. M., Boerstra, A., Buonanno, G., Cao, J., Dancer, S. J., Floto, A. et al. (2024). Mandating indoor air quality for public buildings, *Science* **383**(6690): 1418–1420.

Naaraayanan, S. L., Sachdeva, K. and Sharma, V. (2021). The real effects of environmental activist investing, *European Corporate Governance Institute–Finance Working Paper* (743).

NAREIT (2024a). Reits in s&p indexes.
URL: *https://www.reit.com/data-research/reit-indexes/reits-sp-indexes*

NAREIT (2024b). What's a reit (real estate investment trust)?
URL: *https://www.reit.com/what-reit*

NYC (2024a). Local law 84.
URL: *https://www.nyc.gov/site/buildings/codes/benchmarking.page*

NYC (2024b). Local law 87.
URL: *https://www.nyc.gov/html/gbee/html/plan/ll87.shtml*

NYC (2024c). Local law 97.
URL: *https://www.nyc.gov/site/sustainablebuildings/ll97/local-law-97.page*

Oehmke, M. and Opp, M. M. (2020). A theory of socially responsible investment, *Available at SSRN:* **3467644**.

Park, R. J., Goodman, J., Hurwitz, M. and Smith, J. (2020). Heat and learning, *American Economic Journal: Economic Policy* **12**(2): 306–39.

Pástor, L., Stambaugh, R. F. and Taylor, L. A. (2021). Sustainable investing in equilibrium, *Journal of Financial Economics* **142**(2): 550–571.

Pástor, L., Stambaugh, R. F. and Taylor, L. A. (2022). Dissecting green returns, *Journal of Financial Economics* **146**(2): 403–424.

Pástor, L., Stambaugh, R. F. and Taylor, L. A. (2023). Green tilts, *Technical report*, National Bureau of Economic Research.

Pulvino, T. C. (1998). Do asset fire sales exist? An empirical investigation of commercial aircraft transactions, *Journal of Finance* **53**(3): 939–978.

Roth, J., Sant'Anna, P. H., Bilinski, A. and Poe, J. (2023). Whats trending in difference-in-differences? A synthesis of the recent econometrics literature, *Journal of Econometrics* .

SEC (2020). Shareholder proposals §240.14a-8.
URL: *https://www.sec.gov/divisions/corpfin/rule-14a-8.pdf*

SEC (2022). Exclusion preclusion: Statement on the shareholder proposals proposal.
URL: *https://tinyurl.com/mrk5fe7m*

Shapiro, J. S. and Walker, R. (2018). Why is pollution from us manufacturing declining? The roles of environmental regulation, productivity, and trade, *American Economic Review* **108**(12): 3814–54.

Slager, R., Chuah, K., Gond, J.-P., Furnari, S. and Homanen, M. (2023). Tailor-to-target: Configuring collaborative shareholder engagements on climate change, *Management Science* **69**(12): 7693–7718.

Smith Jr, C. W. (1986). Investment banking and the capital acquisition process, *Journal of Financial Economics* **15**(1-2): 3–29.

Sun, L. and Abraham, S. (2021). Estimating dynamic treatment effects in event studies with heterogeneous treatment effects, *Journal of Econometrics* **225**(2): 175–199.

UN (2024). Un chief urges "surge in investment" to overcome 4 trillion financing gap.
URL: *https://tinyurl.com/8r23r8wj*

UNPRI (2022).
URL: *www.unpri.org/annual-report-2021/how-we-work/building-our-effectiveness/enhance-our-global-footprint*

Xu, Q. and Kim, T. (2021). Financial Constraints and Corporate Environmental Policies, *Review of Financial Studies* **35**(2): 576–635.
URL: *https://doi.org/10.1093/rfs/hhab056*

Tables and Figures

Table 1: Summary Statistics: Property & REIT characteristics

This table displays summary statistics on the characteristics of properties (Panel A) and the property and REIT segments (Panel B). In Panel A, property size is expressed in square footage, and property age is the year in which it was built. Property Classes indicate the quality of properties is and are only available for a subset of our data. Class A properties are high-amenity properties in central business districts of metropolitan areas (i.e. offices and multifamily), Class B are medium-amenity properties in the city center or suburbs of cities (retail, shopping centers, and hospitality), and Class C properties are in less desirable locations and condition (industrial and specialty). The EnergyStar, LEED, and WELL certificates are time-weighted for every property since the start of our sample in 1990. EnergyStar and LEED capture the environmental aspects and Well social aspects of properties. In Panel B, we classify properties and REITs by segment. The number of properties cannot be directly linked to the number of REITs by segment, as some REITs do not specialize in one asset class and diversify across multiple property segments.

Panel A: Property characteristics

	Mean	Std Dev	Count
Square Footage	103,591	180,785	61,870
Building year	1991.11	17.73	61,870
Property Class A	0.148	0.355	41,809
Property Class B	0.536	0.499	41,809
Property Class C	0.316	0.465	41,809
EnergyStar	0.012	0.080	61,870
LEED	0.005	0.049	61,870
WELL	0.002	0.039	61,870

Panel B: Property and REIT segments

	Property	REITs
Retail & Shopping Centers	31,254	44
Industrial	7,918	15
Office	7,148	35
Specialty & Self-Storage	6,049	33
Health Care	4,157	17
Multifamily	3,905	18
Hospitality & Hotels	1,289	20
Manufactured Homes	150	4
Diversified	-	28
Total	61,870	214

Table 2: Classifying sustainable retrofits

This table displays the number of sustainable retrofits across the 29 BuildZoom categories. Sustainable retrofits populate 21.71% of the sample, 21.23 percentage points of which we classify as environmental, and 0.48 percentage points as social given EnergyStar, Fitwel, and Well documentation (EnergyStar, 2023; Fitwel, 2024; International Well Building Institute, 2024). Heating Ventilation Air Conditioning (HVAC) systems equally qualify to be identified as environmental and social due to their impact on energy sources and consumption as well as health outcomes. For the analysis of Table 3, we classify HVAC systems as environmental only because we strive to measure environmental improvements. Hence, it is displayed as Yes in the environmental category and (Yes) in the social retrofit category.

Retrofit categories	Number of retrofits	Sustainable	Environmental	Social
Bathroom Remodel	805			
Decks	37			
Demolition	1,512			
Docks	1			
Doors and Windows	340	Yes	Yes	
Electrical	219,613			
Excavation and Grading	173			
Fences	47			
Flatwork & Concrete	351			
Foundations	258			
Garage Construction	158			
HVAC	56,259	Yes	Yes	(Yes)
Home Addition	4,695			
Kitchen Remodeling	1,233			
Landscape	85	Yes		Yes
Mechanical Work	16,496			
Mobile Homes	613			
Multi-Room Remodeling	31			
New Construction	6,187			
Patios	870	Yes		Yes
Paving, Driveways, and sidewalks	432	Yes		Yes
Plumbing	18,500			
Pool and Spas	792			
Retaining Walls	106	Yes	Yes	
Roofing	18,965	Yes	Yes	
Sewer Laterals	103			
Siding	351	Yes		Yes
Signage	9,476			
Solar Installations	533	Yes	Yes	
Total	359,022	77,941	76,203	1,738

Table 3: Validating sustainable retrofit classification with CO_2 Emission data

This table analyzes the impact of sustainable retrofits on the CO_2 emissions of properties. It does so by matching BuildZoom permit data with the Local Law 87 (New York, NY), BERDO (Boston, MA), and BEUDO (Cambridge, MA) energy registries. These energy registries require large commercial properties to report their exact energy use, energy source, and CO_2 emissions yearly. We analyze the CO_2 emission intensity of properties in annual kilogram to square foot emissions as the dependent variable in every specification. Baseline CO_2 emissions represent the first observed CO_2 emissions of a property in the dataset. Using the baseline emissions is preferable over using property fixed effects as fixed effects compress the impact of permit issuance by removing the average emissions of properties before and after retrofitting (similar in thought to an event study approach). In addition, we also analyze whether permit issuance explains CO_2 emissions beyond frequently used third-party certification of sustainable properties such as LEED, EnergyStar, and WELL. LEED and EnergyStar are indicators of the environmental performance of properties, whereas WELL captures the Social aspect. EnergyStar and WELL are either 0 or 1 depending on whether the property has the certificate. LEED takes the values 0 (no certificate), 1 (Bronze), 2 (Silver), 3 (Gold), and 4 (Platinum). REIT-clustered standard errors are given in parentheses. ***, **, and * denotes significance at the 1%, 5%, and 10% level.

	CO_2 emission intensity									
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Sustainable permits	-0.193***									
	(0.066)									
Environmental permits		-0.194***			-0.243***					-0.179***
		(0.066)			(0.084)					(0.061)
Social permits			0.409		0.303					-0.143
			(0.260)		(0.520)					(0.592)
Conventional permits				0.025	0.097					0.108
				(0.081)	(0.093)					(0.095)
LEED						-0.484***			-0.389***	-0.375***
						(0.170)			(0.120)	(0.113)
EnergyStar							-0.971		-0.500	-0.467
							(0.679)		(0.645)	(0.659)
WELL								-0.455	-0.273	-0.285
								(0.428)	(0.296)	(0.294)
Average CO_2 intensity (kg/sqft)	8.695	8.695	8.695	8.695	8.695	8.695	8.695	8.695	8.695	8.695
Observations	3,996	3,996	3,996	3,996	3,996	3,996	3,996	3,996	3,996	3,996
Adjusted R-squared	0.714	0.714	0.714	0.714	0.714	0.715	0.715	0.714	0.715	0.716
Time fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
REIT fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Baseline CO_2 intensity	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Table 4: Sustainable engagement, sustainable investments, and physical depreciation

This table regresses the impact of sustainable engagement on sustainable retrofits unconditionally in Column (1). We consider the ratio of sustainable over total retrofits for all properties owned by a REIT as a dependent variable. Cycle represents a dummy variable equal to 1 in the three quarters during which REITs experience retrofit cycles and 0 in the three quarters before or after these cycles. Sustainable engagement is a dummy variable that indicates whether a REIT experiences a sustainable engagement. In Columns (2) to (4), we estimate the impact of sustainable engagements, successful sustainable engagements, and unsuccessful sustainable engagements conditional on the occurrence of retrofit cycles. Observations with unsuccessful and successful engagements have been removed from Columns (3) and (4) to allow for a fair comparison of the impact of successful and unsuccessful sustainable engagement. REIT controls capture quarterly total returns, REIT size (ln total assets), and leverage. We solely consider an event study style setup by analyzing the three quarters before, during, and after a cycle to reduce the likelihood of improper comparisons (Callaway and Sant'Anna, 2021; Goodman-Bacon, 2021; Sun and Abraham, 2021; Roth et al., 2023). The marginal effects capture the difference in the share of sustainable retrofits REITs perform when they face sustainable engagement during retrofit cycles compared to no engagement outside retrofit cycles. This equates to adding the estimated coefficients of the cycle, sustainable engagement, and interaction term. Standard errors clustered at retrofit cycle level in parentheses. ***, **, and * denotes significance at the 1%, 5%, and 10% level.

	Share sustainable permits (%)			
VARIABLES	(1)	(2)	(3)	(4)
Sustainable Engagement	-1.223	-4.992***		
	(4.781)	(0.656)		
Cycle X Sustainable Engagement		9.902***		
		(1.323)		
Sustainable Engagement successful			-3.191***	
			(0.919)	
Cycle X Sustainable Engagement successful			17.528***	
			(1.136)	
Sustainable Engagement unsuccessful				-5.631***
				(0.661)
Cycle X Sustainable Engagement unsuccessful				-0.961
				(4.671)
Cycle	-0.190	-0.243**	-0.385**	-0.208***
	(0.124)	(0.113)	(0.128)	(0.095)
Average share sustainable permits (%)	21.71	21.71	21.71	21.71
Marginal Effects: Sustainable Engagement during cycle (%)	-	4.67	13.95	-6.80
Observations	3,076	3,076	3,025	3,025
Adjusted R-squared	0.162	0.162	0.163	0.166
REIT controls	YES	YES	YES	YES
Time fixed effects	YES	YES	YES	YES
REIT fixed effects	YES	YES	YES	YES

Table 5: Predicting retrofit cycles with public information

This table regresses indicators of property depreciation, vacancy rates, and macroeconomic conditions on retrofit cycles and sustainable engagements. Years since retrofit indicates the number of years each individual property belonging to a REIT has not experienced a retrofit, averaged to the REIT level. Vacancy rate metropolitan (%) reflects the square-footage-weighted U.S. Census vacancy rate of the metropolitan area where each individual property resides, averaged to the REIT level. The construction spending and materials price indexes are retrieved from the US bureau of Labor Statistics. The global energy price index is retrieved from the International Monetary Fund. House price returns (%) indicate logarithmic returns on the US Federal Housing Agency house price index. REIT returns capture Ishares US REIT core ETF stock price returns. NBER recessions indicate quarters that are flagged as economic downturns by NBER. The construction materials price index reflects the US Bureau of Labor Statistics material construction index. 10-year Treasury rates, S&P stock returns, and real GDP growth are collected from the FRED. The dependent variable in Columns (1) to (3) are dummies indicating retrofit cycles, and the dependent variable in Columns (4) to (6) indicates sustainable engagements retrieved from ISS. The R^2 captures overall, not within variation. REIT-level clustered standard errors are given in parentheses. ***, **, and * denotes significance at the 1%, 5%, and 10% level.

	Retrofit Cycles			Sustainable engagements		
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Years since retrofit	0.006	0.006	0.004	-0.000	0.001	0.002
	(0.007)	(0.007)	(0.009)	(0.002)	(0.002)	(0.003)
Vacancy rate metropolitan	0.008	0.009	0.006	0.002	0.002	0.003
	(0.006)	(0.006)	(0.006)	(0.002)	(0.002)	(0.003)
Construction spending index	0.020***	0.021***	0.016*	-0.001	-0.003*	-0.003
	(0.007)	(0.008)	(0.009)	(0.002)	(0.002)	(0.003)
Construction materials price index	-0.052***	-0.052***	-0.055***	0.004**	0.005**	0.006**
	(0.010)	(0.010)	(0.010)	(0.002)	(0.002)	(0.003)
Energy price index	0.031***	0.031***	0.033***	0.001	-0.000	-0.001
	(0.006)	(0.006)	(0.007)	(0.001)	(0.001)	(0.001)
House price returns	-0.012***	-0.012***	-0.013***	0.001	0.001	0.001
	(0.004)	(0.004)	(0.004)	(0.001)	(0.001)	(0.001)
REIT returns	-0.006	-0.005	-0.005	-0.000	-0.000	0.000
	(0.004)	(0.004)	(0.004)	(0.001)	(0.001)	(0.001)
NBER Recession	-0.058***	-0.058***	-0.059***	-0.001	-0.000	-0.001
	(0.016)	(0.016)	(0.017)	(0.003)	(0.002)	(0.003)
10-year Treasury rate	-0.007	-0.007	-0.005	-0.000	0.001	0.001
	(0.008)	(0.008)	(0.008)	(0.002)	(0.002)	(0.002)
S&P 500 returns	0.003	0.003	0.003	0.000	0.001	0.001
	(0.004)	(0.004)	(0.004)	(0.001)	(0.001)	(0.001)
Real GDP Growth rate	-0.005*	-0.005**	-0.005*	-0.002	-0.002	-0.002
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
Observations	11,360	11,360	11,360	11,360	11,360	11,360
Adjusted R-squared	0.014	0.014	0.033	0.002	0.007	0.007
REIT controls	NO	YES	YES	NO	YES	YES
REIT FX	NO	NO	YES	NO	NO	YES

Table 6: Governance vs sustainable engagements

This table provides a falsification analysis of the impact of sustainable engagements on sustainable retrofitting by considering the impact of governance engagements. In Column (1), we regress governance engagements outside and during retrofit cycles on the share of sustainable retrofits. In Columns (2) to (5), we replicate the results of Table 4 when explicitly correcting for governance engagement. REIT controls capture quarterly total returns, company size (ln total assets), and leverage. The marginal effects capture the difference in the share of sustainable retrofits REITs perform when they face sustainable engagement during retrofit cycles compared to no engagement outside retrofit cycles. This equates to adding the estimated coefficients of the cycle, sustainable engagement, and interaction term. Standard errors clustered at retrofit cycle level in parentheses. ***, **, and * denotes significance at the 1%, 5%, and 10% level.

	Share sustainable permits (%)				
VARIABLES	(1)	(2)	(3)	(4)	(5)
Governance Engagement	-0.835**	-0.792***	-0.199	-0.793*	-0.408
	(0.345)	(0.201)	(0.425)	(0.465)	(0.341)
Cycle X Governance Engagement	-0.503	-0.539	-1.310***	-1.029***	-0.023
	(0.326)	(0.126)	(0.320)	(0.349)	(0.582)
Sustainable Engagement		-0.350	-4.710***		
		(4.411)	(0.164)		
Cycle X Sustainable Engagement			9.788***		
			(0.535)		
Sustainable Engagement successful				-2.737***	
				(0.534)	
Cycle X Sustainable Engagement successful				17.435***	
				(1.565)	
Sustainable Engagement unsuccessful					-4.822***
					(0.024)
Cycle X Sust. Engagement unsuccessful					0.129
					(3.992)
Cycle	-0.194*	-0.192	-0.224**	-0.379***	-0.209**
	(0.109)	(0.127)	(0.106)	(0.115)	(0.085)
Average share sustainable permits (%)	21.71	21.71	21.71	21.71	21.71
Marginal Effects: Sustainable Engagement during cycle (%)	-	-	4.85	14.32	-4.90
Observations	3,076	3,076	3,076	3,025	3,025
Adjusted R-squared	0.161	0.161	0.161	0.163	0.165
REIT controls	YES	YES	YES	YES	YES
Time FX	YES	YES	YES	YES	YES
REIT FX	YES	YES	YES	YES	YES

Table 7: The extensive margin of sustainable engagement

This table analyzes the impact of sustainable engagement on abnormal property sales (Columns (1) to (3)) and sustainable permit issuance after properties are sold (Column (4)). In Columns (1) to (3), we use the share of properties sold in percentage points as a dependent variable. In Column (4), we take the value-weighted 1-year forward-looking share of sustainable retrofits of properties that REITs have sold as a dependent variable. REIT controls capture quarterly total returns, company size (ln total assets), and leverage. We change the specification in Column (4) as we have insufficient degrees of freedom to estimate the REIT and time fixed effects due to the very low instances where REITs sell properties. Standard errors clustered at retrofit cycle level in parentheses. ***, **, and * denotes significance at the 1%, 5%, and 10% level.

	Sold (%)			Sustainable retrofits after sale (%)
VARIABLES	(1)	(2)	(3)	(4)
Sustainable engagement	0.843*			
	(0.468)			
Cycle X Sustainable engagement	-0.153			
	(0.692)			
Sustainable engagement successful		1.837		-7.339
		(2.838)		(13.703)
Cycle X Sust. engagement successful		-0.141		
		(2.926)		
Sustainable engagement unsuccessful			0.625***	-10.321
			(0.092)	(6.865)
Cycle X Sust. engagement unsuccessful			-0.991***	
			(0.271)	
Cycle	0.113***	0.115***	0.094***	1.782
	(0.037)	(0.037)	(0.035)	(1.499)
Observations	3,076	3,025	3,025	286
Adjusted R-squared	0.138	0.138	0.130	0.033
REIT controls	YES	YES	YES	YES
Year FX	NO	NO	NO	YES
Time FX	YES	YES	YES	NO
REIT FX	YES	YES	YES	NO

Table 8: Conventional retrofitting during sustainable engagement

This table regresses all, successful, and unsuccessful sustainable engagement specifications during and outside retrofit cycles on the occurrence of conventional retrofits in Columns (1) to (3), electrical retrofits in Columns (4) to (6), and conventional non-electrical retrofits in Columns (7) to (9). We expect no additional impact of sustainable engagement on conventional retrofitting except for an increase in electrical retrofits required for HVAC installation. Therefore, we separately regress all conventional retrofits, electrical conventional retrofits that should increase with sustainable retrofits, and non-electrical conventional retrofits that should be unaffected. REIT controls capture quarterly total returns, company size (ln total assets), and leverage. Standard errors clustered at retrofit cycle level in parentheses. ***, **, and * denotes significance at the 1%, 5%, and 10% level.

	Conventional			Electrical (related)			Non-Electrical (non-related)		
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Sustainable Engagement	-4.128***			-3.002**			-1.126***		
	(0.925)			(1.321)			(0.397)		
Cycle X Sustainable Engagement	8.922***			6.098***			2.824*		
	(1.635)			(0.123)			(1.512)		
Sustainable Engagement successful		-4.122***			-3.964**			-0.158	
		(0.541)			(1.736)			(1.195)	
Cycle X Sustainable Engagement successful		10.740***			9.410***			1.330	
		(2.118)			(0.271)			(2.389)	
Sustainable Engagement unsuccessful			-4.094***			-2.801			-1.293
			(1.083)			(1.815)			(0.733)
Cycle X Sustainable Engagement unsuccessful			7.376***			3.835**			3.541*
			(0.130)			(1.821)			(1.951)
Cycle	10.658***	10.668***	10.635***	8.953***	8.978***	8.946***	1.706***	1.690***	1.689***
	(0.477)	(0.485)	(0.458)	(0.440)	(0.443)	(0.429)	(0.037)	(0.042)	(0.029)
Observations	3,076	3,025	3,025	3,076	3,025	3,025	3,076	3,025	3,025
Adjusted R-squared	0.929	0.930	0.929	0.911	0.912	0.911	0.786	0.787	0.786
REIT controls	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FX	YES	YES	YES	YES	YES	YES	YES	YES	YES
REIT FX	YES	YES	YES	YES	YES	YES	YES	YES	YES

Table 9: Heavy polluters, sustainable engagements, retrofit cycles, and sustainable investments

This table replicates the results in Table 4 for the US heavily polluting manufacturing firms. We consider the ratio of sustainable over total retrofits issued by heavily polluting production facilities screened by the EPA TRI as a dependent variable across these specifications. Cycle represents a dummy variable equal to 1 in the year during which plants experience retrofits two standard deviations above their firms' mean. Sustainable engagement is a dummy variable that indicates whether firms operating production facilities experience sustainable engagements. Periods with both unsuccessful and successful engagements have been removed and are highly uncommon. All specifications carry plant times chemical and chemical times time fixed effects to correct for plant-specific, chemical, and time variation in retrofitting needs at the facility level (following Akey and Appel, 2019; Naaraayanan et al., 2021). Standard errors clustered at plant-chemical level in parentheses. ***, **, and * denotes significance at the 1%, 5%, and 10% level.

	Share sustainable permits (%)			
VARIABLES	(1)	(2)	(3)	(4)
Sustainable engagement	0.041	0.193		
	(0.270)	(0.281)		
Cycle X Sustainable engagement		-2.655***		
		(0.712)		
Sustainable engagement successful			0.259	
			(0.372)	
Cycle X Sustainable engagement successful			5.160***	
			(1.903)	
Sustainable engagement failed				-0.713*
				(0.402)
Cycle X Sustainable engagement failed				-2.725***
				(0.935)
Cycle	2.244***	2.401***	2.172***	2.345***
	(0.214)	(0.221)	(0.215)	(0.220)
Average share sustainable permits (%)	5.09	5.09	5.09	5.09
Marginal Effects: Sustainable Engagement during cycle (%)	-	-0.06	7.59	-1.09
Observations	166,374	166,374	166,374	166,374
Adjusted R-squared	0.084	0.084	0.084	0.084
Plant X Chemical fixed effects	YES	YES	YES	YES
Chemical X Time fixed effects	YES	YES	YES	YES

Table 10: Sustainable retrofits, abatement activities, and EPA fines

This table investigates whether sustainable retrofits affect abatement activities and EPA penalties for heavy polluters traced by the EPA TRI. Specifically, it regresses the share of plant-level sustainable retrofits over total retrofits on EPA pollution prevention (P2) events in Columns (1) to (4). Column (1) contains the total number of abatement activities. In Columns (2) to (4), we split this by material handling abatement events that should be affected by the property and substitute in chemicals or changes in production processes that should be unaffected. In Columns (5) to (6), we analyze how the share of sustainable permit issuance affects the average number of EPA penalties over a 5-year window (where possible, else we use a smaller timeframe) and the natural logarithm of one plus the average fine amount over a 5-year window (following Dasgupta et al., 2023). All specifications carry plant times chemical and chemical times time fixed effects to correct for plant-specific, chemical, and time variation in retrofitting needs at the facility level (following Akey and Appel, 2019; Naaraayanan et al., 2021). Standard errors clustered at plant-chemical level in parentheses. ***, **, and * denotes significance at the 1%, 5%, and 10% level.

	Pollution Prevention (P2)				**Penalties (ECHO)**	
	All	Material Handling	Substitute Materials	Production Process	Number	Amount
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Sustainable retrofits (%)	0.024***	0.023***	0.000	0.001	-0.016***	-0.002***
	(0.003)	(0.003)	(0.001)	(0.003)	(0.004)	(0.000)
Mean dependent variable	11.21	4.96	0.97	5.28	8.14	1.37
Observations	28,835	28,835	28,835	28,835	166,374	166,374
Adjusted R-squared	0.709	0.585	0.415	0.555	0.221	0.230
Plant X Chemical FE	YES	YES	YES	YES	YES	YES
Chemical X Time FE	YES	YES	YES	YES	YES	YES

Figure 1: Property location

Figure 1 displays the location of all REIT-owned properties in our sample by county. The majority of properties reside in population-dense areas such as New England, the Bay Area, Florida, Texas, Seattle, and Chicago.

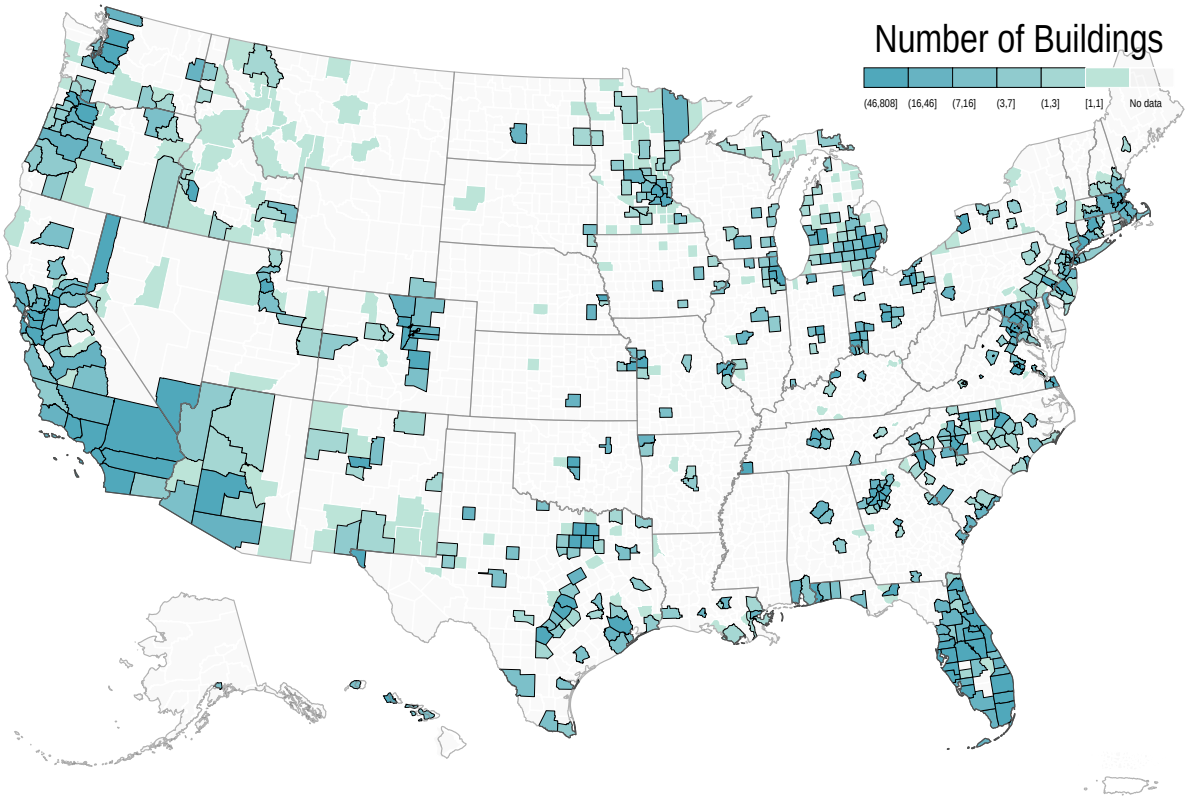


Figure 2: Duration of retrofit cycles

Figure 2 shows the average time between when a permit is filled at the municipality where a property is located and the time the permit is completed for all REIT-owned properties. Spikes in permits occur at exactly half a year, one year, and two years due to automated completion times at certain municipalities.

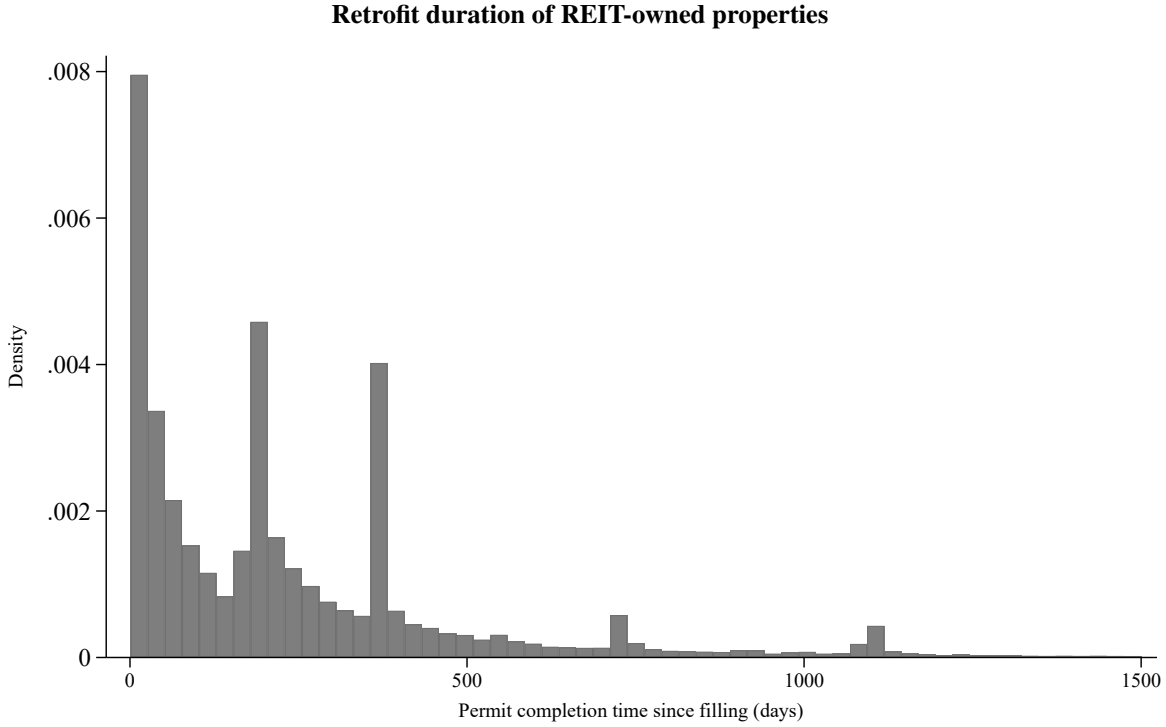


Figure 3: Sustainable engagement, Sustainable investments, and Retrofit cycles

Figure 3 displays the unadjusted share of sustainable over total retrofits before, during, and after retrofit cycles demeaned at the pre-retrofit cycle level. To investigate the impact of sustainable engagement on sustainable retrofitting during retrofit cycles, the distance from -1 to 0 should also be interpreted as we use Epanechnikov kernel densities. The time to retrofit cycle indicates the distance in time between the current time and the quarter that signals the start of a retrofit cycle. To elaborate, the values -2 or 3, respectively, represent two quarters before and three quarters after the initiation of a retrofit cycle.

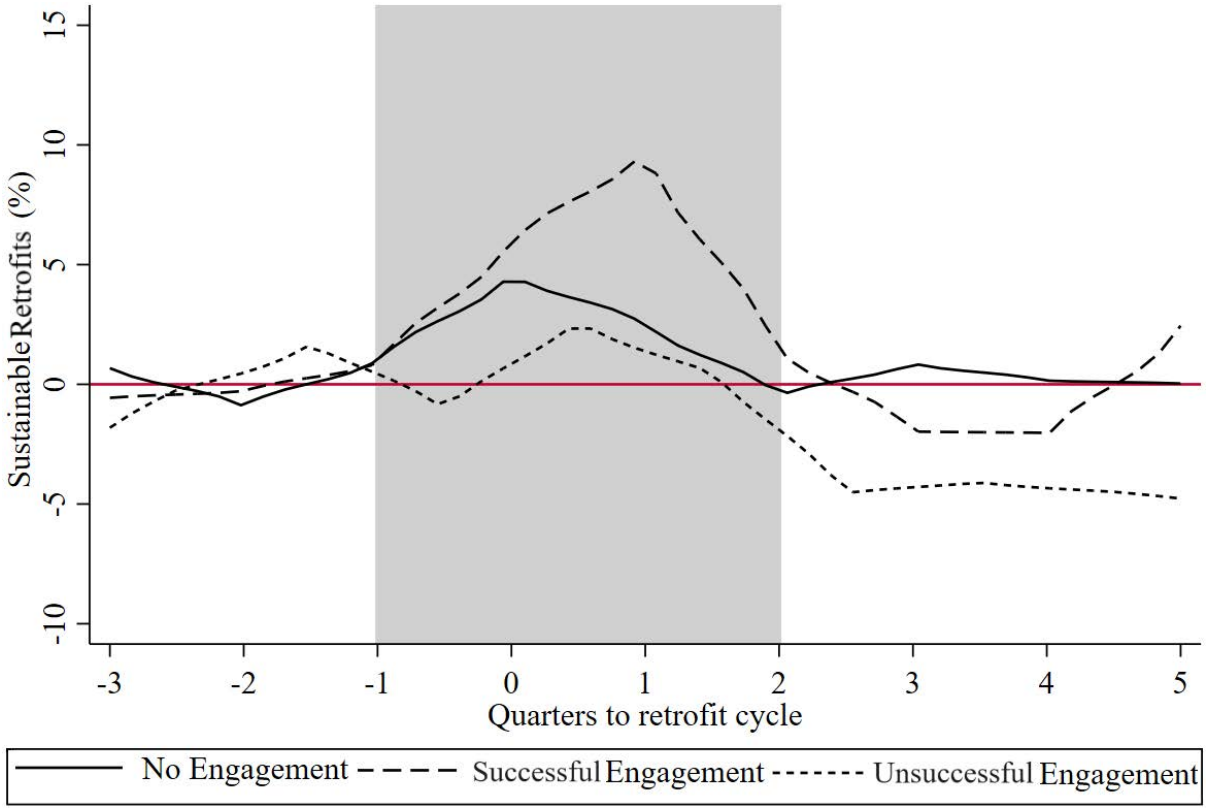


Figure 4: Does Engagement Predicts Retrofit Cycles?

Figure 4 shows that engagement has no predictive power over the timing of retrofit cycles. The x-axis represents lags and leads in engagements relative to the current time q. Spikes represent the 90% and 95% confidence intervals around the estimated coefficients. The periods $< q-3$ and $> q+3$ represent a categorical variable that indicates whether a REIT was engaged at any point in time more than a year ago or more than a year after the engagement. Period $q-1$ is removed as a reference category. The y-axis represents the probability of retrofit cycles.

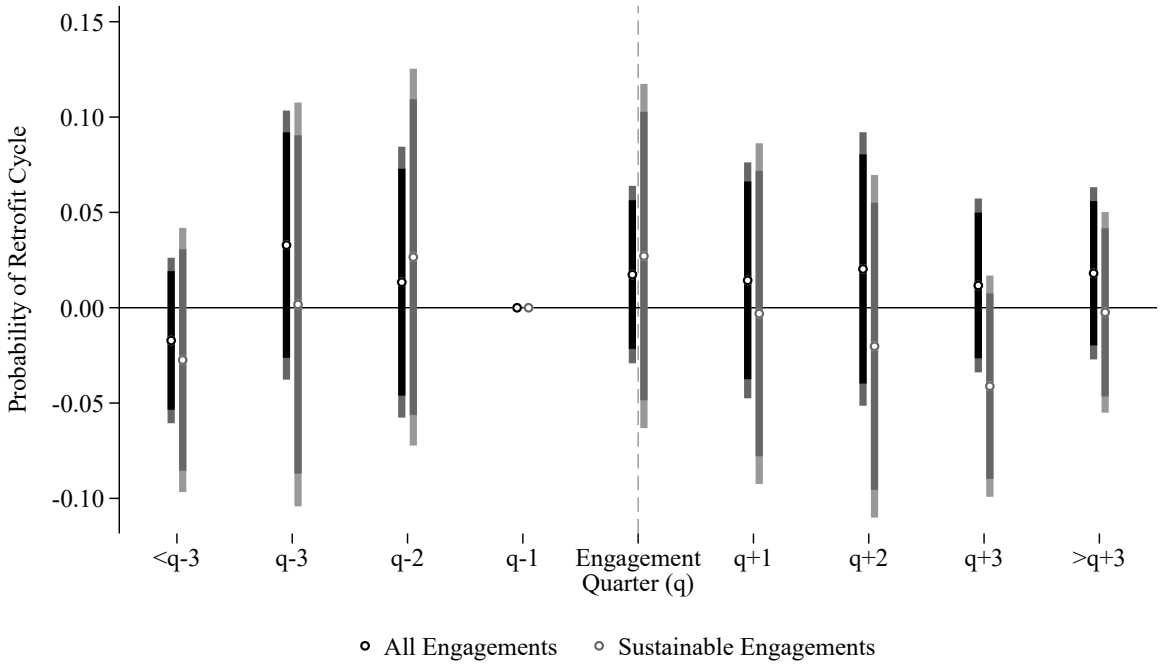


Figure 5: Timing of retrofit cycles

Figure 5 displays permit issuance around retrofit cycles. Permit issuance is expressed as percentage deviations from the REITs' average permit issuance on a quarterly basis. Our identification of retrofit cycles is at least moderately accurate due to the sharp increase in permit issuance that is almost exclusively present during identified retrofitting cycles. The distance from -1 to 0 should also be interpreted as we use Epanechnikov kernel densities.

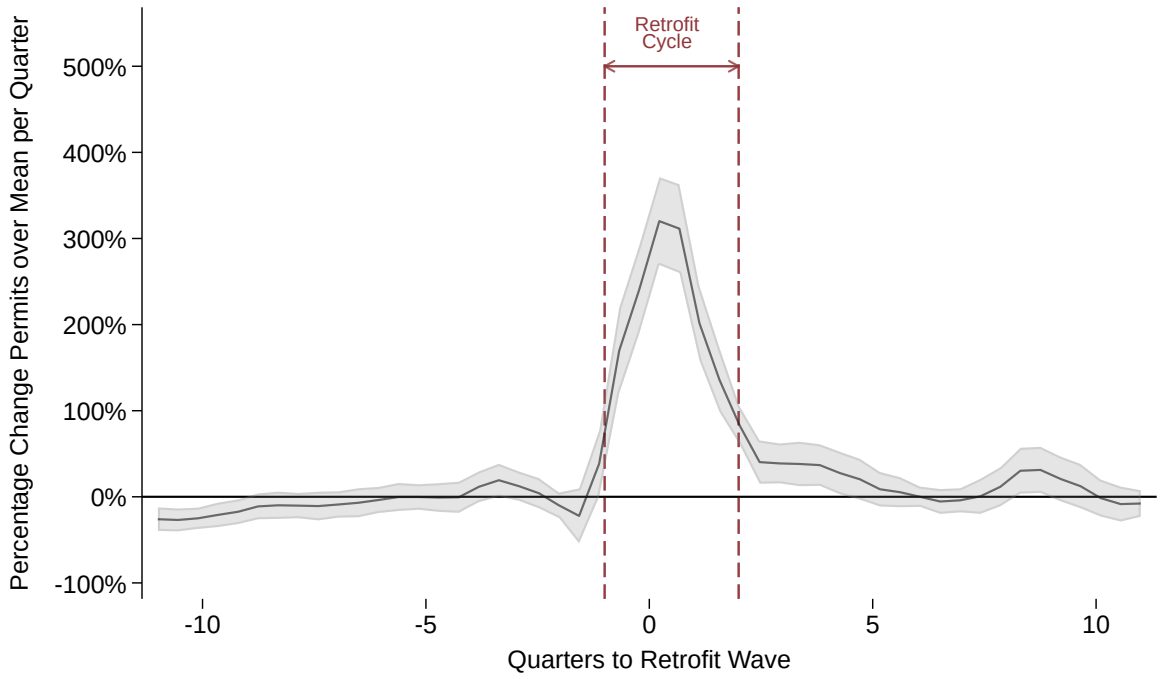
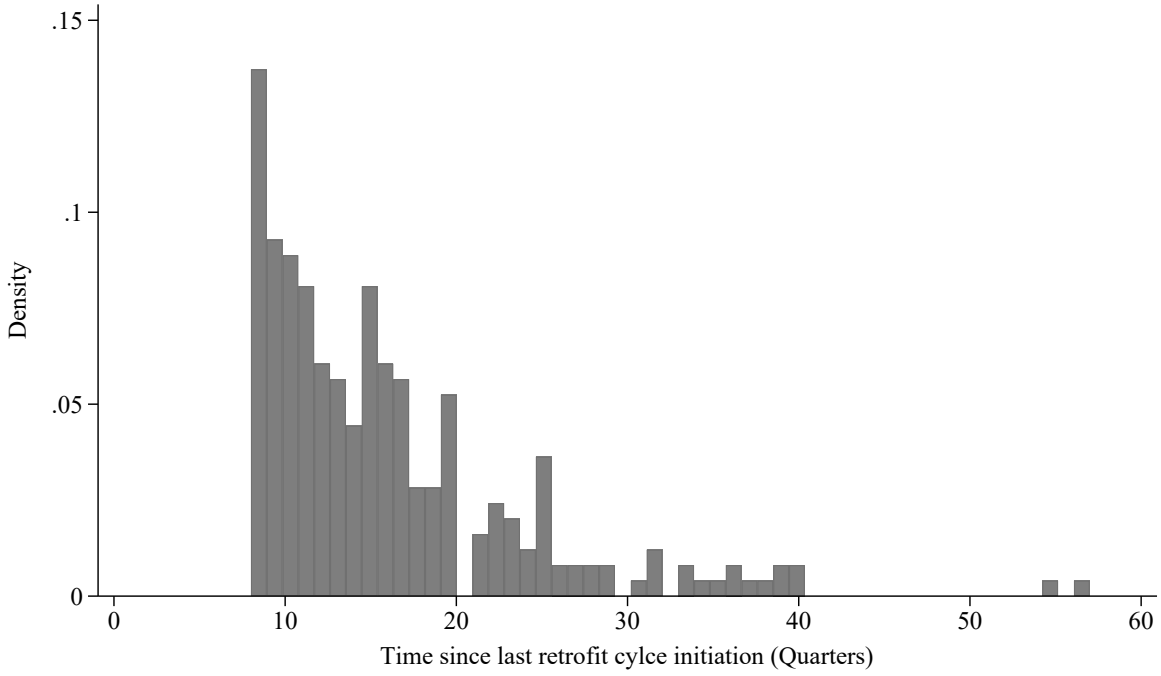


Figure 6: (Lack of) predictability in retrofit cycles

Figure 6 Panel A shows the time in quarters from the start of a retrofit cycle until the occurrence of a new retrofit cycle. These numbers are conservative, as many REITs initiate renovation cycles at such large intervals they fall outside of our sample at the end of 2022Q4. When we assume that REITs always initiate renovation cycles at the end of our sample, we would add 55.19% of observations to our sample with a mean time between renovation cycles of 36.5 quarters as opposed to the 16.4 quarters for observed next cycles. Panel B displays the timing of sustainable and governance engagements relative to the start of a renovation cycle.

Panel A: Time between retrofit cycles



Panel B: Engagement after retrofit cycles

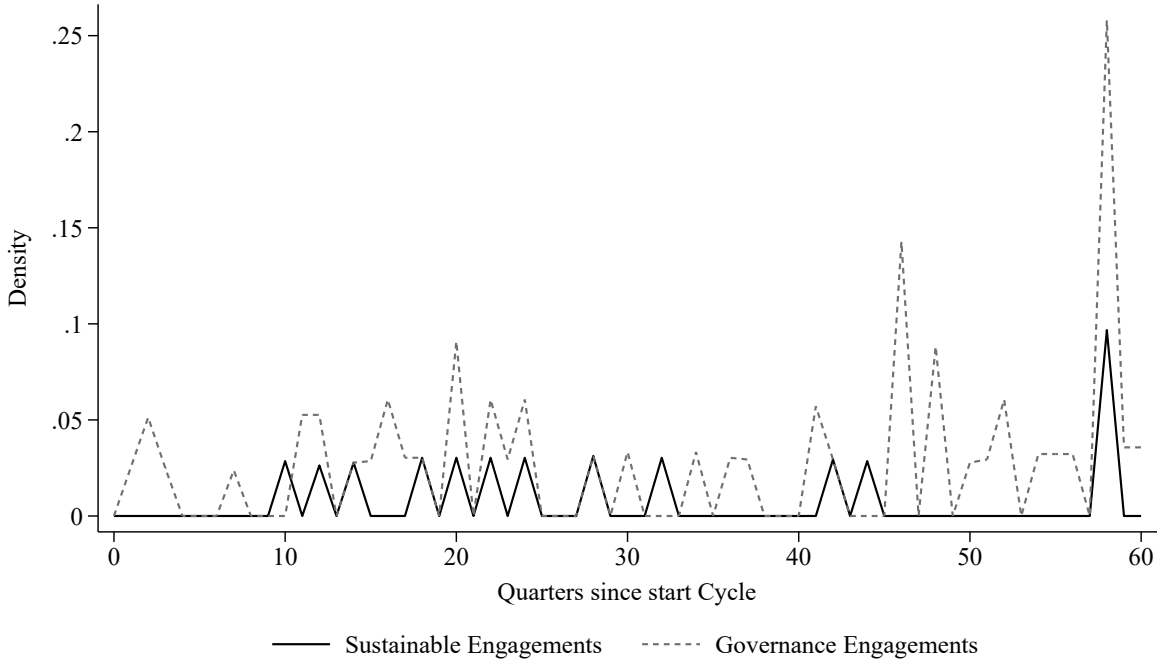
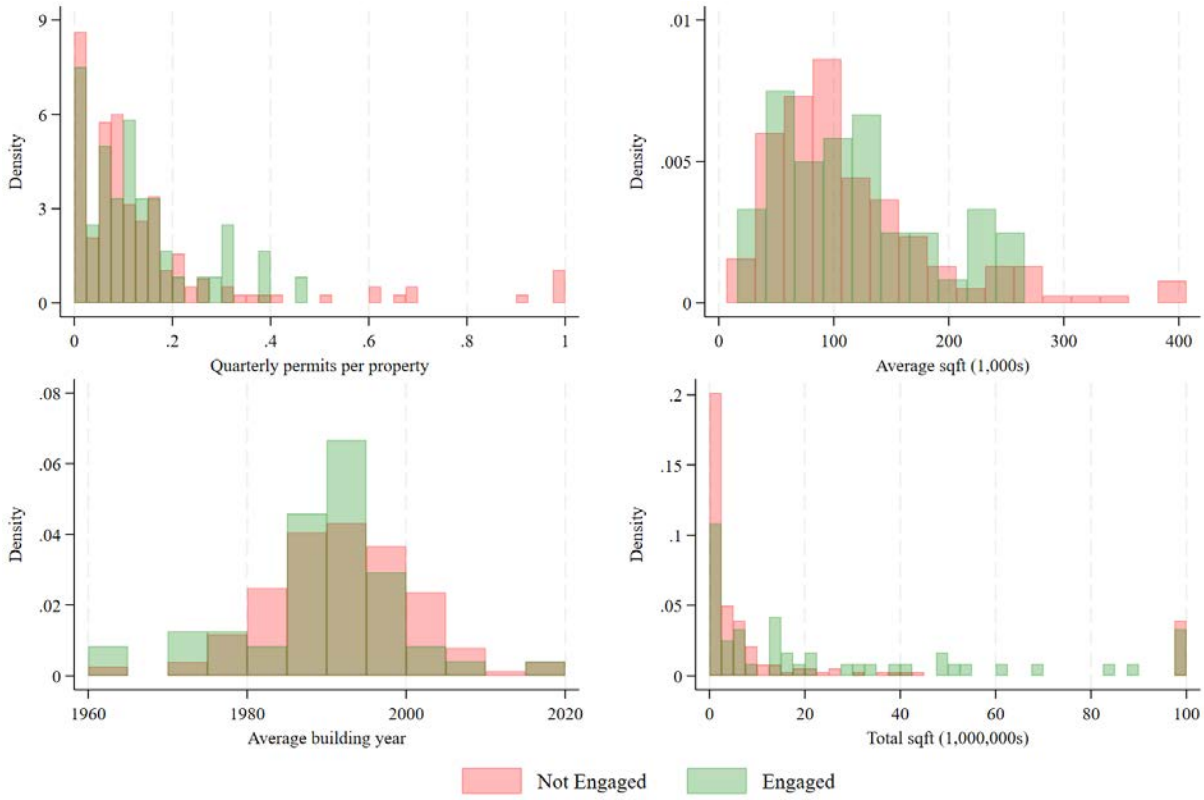


Figure 7: No engagements selection of REITs

Figure 7 shows that there is little selection across engaged and non-engaged REITs. We display multiple property characteristics before the first engagement by REITs that are or are never engaged. The first histogram displays the permits per property per quarter by REIT. The second histogram shows the property size in thousands of square feet. The third histogram displays the average building year of all properties in the sample. The last histogram displays the combined property size of REITs. For the sake of enhancing readability, we have winsorized all positive outliers. The observed patterns remain unchanged regardless of this winsorization. All distributions, with the exception of the total square footage, are statistically indistinguishable from each other at the 1% level.



Internet Appendix

Appendix A Energy Registries

Appendix A elaborates on the New York, Boston, and Cambridge (MA) energy consumption registries. Starting in 2010, New York introduced report requirements on energy consumption and source through Local Law 84 (NYC, 2024b). The purpose of this law was to provide a clear overview of the city's energy consumption without imposing restrictive reporting requirements on smaller properties. For this reason, Local Law 84 prescribes that owners of commercial properties over 50,000 square feet (or multiple properties on a lot with over 100,000 square feet) should report annually. In addition, properties of over 50,000 square feet have to perform stringent energy audits and make a retrofitting plan once every ten years according to Local Law 87 (NYC, 2024a). Violations to partake in these activities result in penalties, potentially in the tens of thousands of dollars. The purpose of Local Law 84 and 87 was to initiate Local Law 97, which imposes a tax on excess energy consumption, which was only possible to execute given this energy consumption information. This law applies to properties over 25,000 square feet or all properties on a tax lot that jointly exceeds 50,000 square feet (NYC, 2024c).

Local Law 84 provides a wealth of information on the energy consumption, energy source, and CO_2 emissions of properties. First, it contains the direct, indirect, and total metric tonnes of CO_2. Second, it includes the energy source used per rata, such as electricity, natural gas, steam, fuel oil, and diesel. Last, it contains the property size, energy intensity, and location. From 2010 to 2021, the sample grew from 10,329 properties to 29,842 as reporting became more widely applicable and enforced.

BERDO and BEUDO of Boston and Cambridge follow a similar setup and structure as Local Law 84 (BEUDO, 2024; BERDO, 2024; NYC, 2024b). Boston and Cambridge started reporting in 2014 and 2015 and reported on 1,860 and 859 properties in 2021.

Appendix B Permit completion time

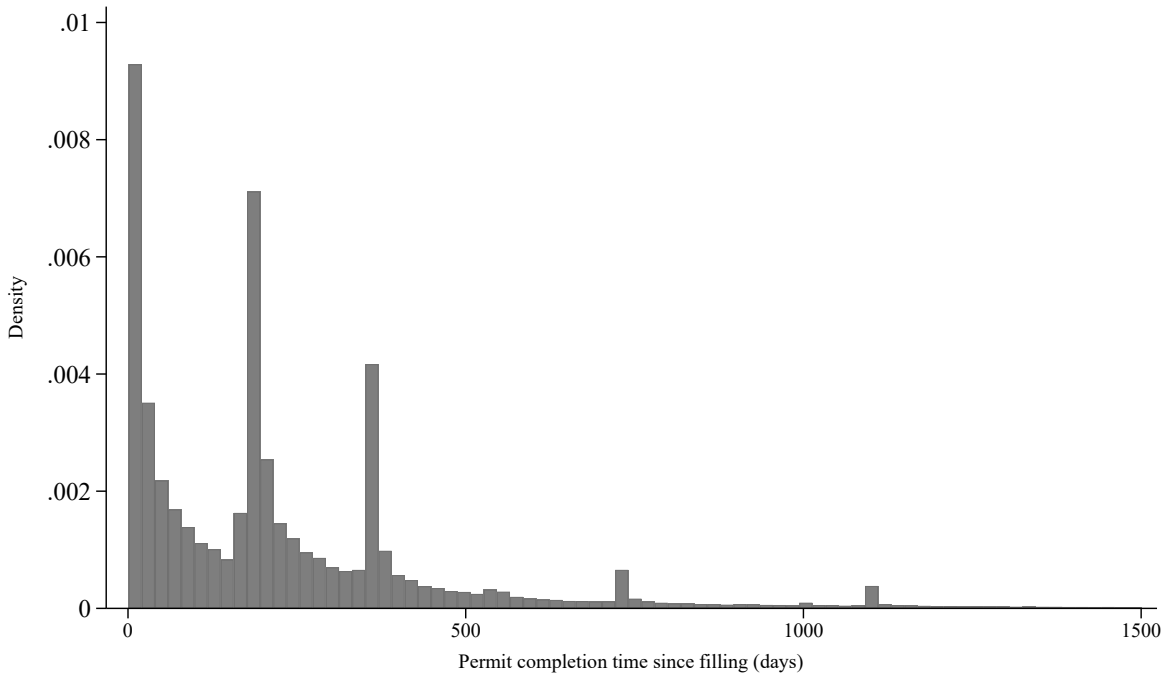
In this Appendix, we provide further information on the permit completion time. It could be the case that permit completion times differ for the REIT sample from the entire US population. On the one hand, REITs perform much more extensive retrofits on a significantly larger scale, such as improving the heating system of a hospital or changing the glass of a New York skyscraper. On the other hand, REITs almost exclusively hire contractors when retrofitting, while residential homes often perform retrofits themselves or higher contractors that operate on a lower (and possibly less efficient) scale. Therefore, we cannot anticipate whether there will be significant variations in the permit completion times across samples.

In Figure B1, we display the distribution of permit completion times in days for the total sample of 112 million BuildZoom permits (Panel A), and for comparison, the REIT-owned sample (Panel B, identical to the main manuscript). As can be seen, both distributions are highly similar in shape, and both experience spikes in permits surrounding half a year, one year, and two years past permit issuance, arising from administrative procedures. The average permit duration is also comparable at 246.88 days for the total sample and 252.85 days for the REIT sample.

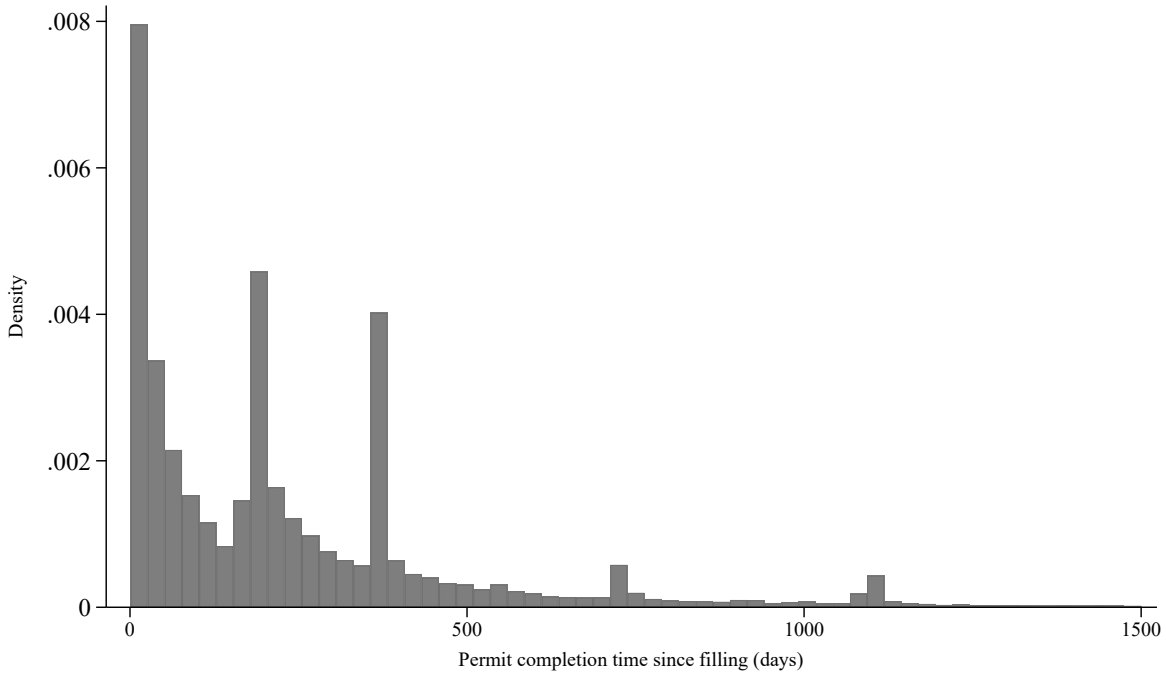
Figure B1: Duration of retrofit cycles

Figure B1 Panels A and B show the average time between when a permit is filled at the municipality where a property is located and when the permit is completed for all retrofits in the BuildZoom dataset (Panel A) and all REIT-owned properties (Panel B). Spikes in permits occur at exactly half a year, one year, and two years due to automated completion times at certain municipalities.

Panel A: Retrofit duration of US properties



Panel B: Retrofit duration of REIT-owned properties



Appendix C Jump detection algorithm validation

In this Appendix, we provide further robustness on our retrofit detection strategy. Accurately detecting retrofit cycles is paramount for the reliability of our findings, as we use the timing of these cycles to detect the impact of sustainable engagement on sustainable investments. We strive to be as accurate as possible in detecting retrofit cycles using property-level permit information. The advantage of this microdata is that it shows us the exact date REITs start retrofitting their properties with great accuracy. However, the drawback of this approach is that we need to use a detection algorithm to identify the duration and timing of retrofit cycles, as there is no pre-defined approach in the literature. To alleviate concerns that the choice of retrofit cycle detection algorithm drives our results, we provide 35 alternative retrofit cycle detection approaches and validate our findings. This Appendix shows that substantial deviations in our retrofit cycle detection algorithm result in limited differences in detected retrofit cycles across REITs. Moreover, we reproduce Table 5 and find that different cycle detection strategies produce similar results.

Retrofit detection algorithms can differ in three key dimensions, namely the length of retrofit cycles, the manner of jump detection, and the stringency of the jump threshold. The equation below represents a generalized detection setup.

$$\frac{\sum_{j=1}^{q} Permit_{i,t-1+j}}{q} \quad - \quad \frac{\sum_{j=1}^{q} Permit_{i,t-j}}{q} \quad \geq \quad Threshold_i \quad (2)$$

In this Equation, $Permits_{i,t}$ represents the number of permits REIT i receives at quarter t on its properties. q describes the number of lags used to detect jumps. $Threshold_i$ determines the REIT-specific threshold that REIT i must clear to identify the quarter as a retrofit cycle starting point. The retrofit cycle algorithm that best fits our data uses three-quarter retrofit cycle lengths, a two-lag identification period (q=2), and a one standard deviation jump threshold ($Threshold_i$ = σ). To validate robustness, we deviate our detection by varying the retrofit cycle length, the number of lags used to observe jumps in permits, and the threshold that classifies jumps in permits as initiations of retrofit cycles.

The first way in which we deviate our detection strategy is by employing retrofit cycle

lengths of two, three, and four quarters. The length of retrofit cycles is paramount for our specification as it alters the event window in our two-way fixed effects estimation. We reduce type two errors when we assume retrofit cycles are relatively short, as fewer quarters are classified as retrofit cycles. However, having shorter retrofit cycle windows increases the odds of type one errors in correctly identifying retrofit cycles. The inverse is true for using broader retrofit cycle lengths. Incorrectly detecting the start of retrofit cycles could affect our results as we would classify during retrofit engagements as outside retrofit cycle engagements and vice versa. We use retrofit cycle lengths of two, three, and four quarters to alleviate these concerns.

The second way we deviate our detection algorithm is by altering the number of lags used to detect jumps in permits (q). We measure permit jumps by computing the difference between contemporaneous and forward-looking compared to backward-looking permits. In other words, we detect jumps in permits by analyzing how many permits are being issued right now and in the upcoming quarter(s) compared to the past quarters' level of permits. The advantage of introducing more lags is that it enforces a relatively long-lived deviation in the level of permits. However, the disadvantage of using additional lags is that it more readily detects shallow permit increases as retrofit cycles. Since we argue that retrofit cycles represent sharp increases in the number of permits and using one lag ($q = 1$) overidentifies insufficiently persistent permit jumps as retrofit cycles, we initially chose two lags ($q = 2$). Nevertheless, we adopt different levels of forward-looking and backward-looking permit windows using one, two, three, and four lags to validate robustness.

Last, we adopt multiple retrofit cycle jump detection thresholds. In the initial model, we use a one standard deviation difference between forward-looking and backward-looking permits as the condition to detect retrofit cycles. Since we used two lags, it would mean that the average of the two periods' forward-looking and backward-looking permits is jointly one standard deviation. The threshold stringency can affect our findings as an insufficiently stringent threshold could detect conventional property maintenance as retrofitting cycles. Introducing these false positives would underestimate the true impact of sustainable engagement during retrofit cycles on sustainable permits. In contrast, too stringent thresholds might detect only the most prominent retrofit cycles and could lead to overestimated and selective results. To vali-

date the persistence of detected retrofit cycles under different thresholds, we adopt one standard deviation, one standard deviation divided by the number of lags employed, and two standard deviations divided by the number of lags used as thresholds.

Our retrofit cycle detection algorithm is highly correlated with the 35 robustness specifications. To ensure a valid retrofit detection algorithm, we show that changing its parameters does not substantially affect retrofit cycle detection. Table C1 shows correlations across the main and 35 robustness retrofit detection algorithms. In most cases, perfect correlations are impossible by construction due to deviations in retrofit cycle lengths. Nevertheless, when we consider detection algorithms that deviate in one way from our main specification, we observe average correlations of 70.49%. Our primary measure has an average correlation of 50.31% to overall 35 specifications. Correlations are structurally lowest when permit jumps are observed using one or four lags, as many small spikes in permit issuance and relatively long but shallow increases are detected as retrofit cycles. Since sudden jumps in permits characterize retrofit cycles, it is understandable that deviating from the detection period significantly impacts accuracy. Our specification is not substantively affected by the jump detection threshold or the length of retrofit cycles. Last, the 35 robustness specifications are also strongly correlated with each other, indicating at least a common trend in the detection of retrofit cycles regardless of specification.

Table C1: Correlation matrix of alternative retrofit cycle detection

This table shows the coefficients of 35 retrofit detection algorithms. Column (1) represents our preferred specification that best fits the observed permit data, the other 35 Columns represent alternative detection algorithms that differ in three dimensions, The first dimension is the length of retrofit cycles of two, three, and four quarters (L). The second dimension of variation is the number of lags employed to measure jumps in permits, ranging from one to four quarters (q). Last, we differ the threshold to make the detection of retrofit cycles more or less frequent (T). The thresholds we employ are one standard deviation σ, one standard deviation divided by the number of lags employed to detect the jump $\frac{\sigma}{n}$, and two standard deviations divided by the number of lags employed to detect jumps in permits $\frac{2*\sigma}{n}$. Correlations equal to one are displayed as -.

L	q	T	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)	(36)
3	2	σ	-																																			
2	1	σ	0.403	-																																		
2	2	σ	0.804	0.445	-																																	
2	2	σ	0.478	0.312	0.557	-																																
2	4	σ	0.360	0.225	0.433	0.593	-																															
2	1	$\frac{\sigma}{n}$	0.403	-	0.445	0.312	0.225	-																														
2	2	$\frac{\sigma}{n}$	0.647	0.479	0.819	0.460	0.352	0.479	-																													
2	3	$\frac{\sigma}{n}$	0.428	0.342	0.514	0.695	0.427	0.342	0.604	-																												
2	4	$\frac{\sigma}{n}$	0.357	0.269	0.444	0.470	0.635	0.269	0.471	0.603	-																											
2	1	$\frac{2*\sigma}{n}$	0.355	0.851	0.395	0.259	0.179	0.851	0.481	0.346	0.276	-																										
2	2	$\frac{2*\sigma}{n}$	0.588	0.443	0.752	0.418	0.319	0.443	0.918	0.582	0.462	0.485	-																									
2	3	$\frac{2*\sigma}{n}$	0.393	0.316	0.476	0.643	0.392	0.316	0.565	0.925	0.581	0.347	0.592	-																								
2	4	$\frac{2*\sigma}{n}$	0.333	0.253	0.417	0.439	0.597	0.253	0.450	0.576	0.939	0.272	0.468	0.603	-																							
3	1	σ	0.455	0.799	0.345	0.242	0.171	0.799	0.365	0.253	0.199	0.668	0.331	0.229	0.184	-																						
3	3	σ	0.599	0.328	0.515	0.807	0.513	0.328	0.424	0.546	0.398	0.271	0.382	0.500	0.369	0.359	-																					
3	4	σ	0.477	0.237	0.416	0.569	0.808	0.237	0.335	0.397	0.498	0.187	0.301	0.362	0.465	0.258	0.652	-																				
3	1	$\frac{\sigma}{n}$	0.455	0.799	0.345	0.242	0.171	0.799	0.365	0.253	0.199	0.668	0.331	0.229	0.184	-	0.359	0.258	-																			
3	2	$\frac{\sigma}{n}$	0.812	0.423	0.653	0.390	0.288	0.423	0.797	0.504	0.385	0.426	0.725	0.468	0.366	0.483	0.493	0.386	0.483	-																		
3	3	$\frac{\sigma}{n}$	0.547	0.347	0.473	0.553	0.368	0.347	0.555	0.796	0.523	0.353	0.530	0.729	0.498	0.381	0.686	0.462	0.381	0.647	-																
3	4	$\frac{\sigma}{n}$	0.477	0.269	0.413	0.446	0.506	0.269	0.447	0.560	0.796	0.282	0.437	0.538	0.742	0.300	0.511	0.626	0.300	0.519	0.660	-															
3	1	$\frac{2*\sigma}{n}$	0.398	0.674	0.300	0.193	0.130	0.674	0.364	0.255	0.200	0.792	0.365	0.253	0.195	0.843	0.295	0.203	0.843	0.485	0.387	0.309	-														
3	2	$\frac{2*\sigma}{n}$	0.741	0.391	0.596	0.352	0.257	0.391	0.728	0.483	0.378	0.429	0.793	0.489	0.380	0.443	0.445	0.347	0.443	0.913	0.620	0.510	0.488	-													
3	3	$\frac{2*\sigma}{n}$	0.503	0.318	0.436	0.510	0.336	0.318	0.519	0.733	0.505	0.353	0.538	0.792	0.522	0.349	0.632	0.422	0.349	0.603	0.921	0.637	0.387	0.629	-												
3	4	$\frac{2*\sigma}{n}$	0.446	0.252	0.386	0.416	0.473	0.252	0.426	0.534	0.745	0.280	0.444	0.560	0.793	0.280	0.476	0.586	0.280	0.495	0.631	0.936	0.305	0.515	0.663	-											
4	1	σ	0.387	0.678	0.295	0.197	0.136	0.678	0.307	0.200	0.157	0.555	0.273	0.176	0.143	0.848	0.296	0.209	0.848	0.403	0.304	0.238	0.701	0.363	0.272	0.219	-										
4	2	σ	0.854	0.350	0.687	0.407	0.305	0.350	0.542	0.354	0.291	0.300	0.488	0.319	0.269	0.429	0.532	0.415	0.429	0.680	0.473	0.401	0.371	0.615	0.430	0.372	0.472	-									
4	3	σ	0.559	0.312	0.442	0.691	0.441	0.312	0.359	0.454	0.331	0.254	0.319	0.412	0.306	0.357	0.857	0.583	0.357	0.456	0.571	0.446	0.290	0.408	0.521	0.412	0.375	0.618	-								
4	4	σ	0.465	0.261	0.389	0.503	0.693	0.261	0.314	0.340	0.413	0.208	0.279	0.306	0.382	0.285	0.625	0.857	0.285	0.375	0.431	0.519	0.225	0.333	0.390	0.482	0.294	0.507	0.683	-							
4	1	$\frac{\sigma}{n}$	0.387	0.678	0.295	0.197	0.136	0.678	0.307	0.200	0.157	0.555	0.273	0.176	0.143	0.848	0.296	0.209	0.848	0.403	0.304	0.238	0.701	0.363	0.272	0.219	-	0.472	0.375	0.294	-						
4	2	$\frac{\sigma}{n}$	0.686	0.363	0.552	0.327	0.240	0.363	0.674	0.417	0.318	0.359	0.606	0.382	0.299	0.446	0.433	0.332	0.446	0.846	0.560	0.443	0.445	0.764	0.517	0.419	0.496	0.804	0.504	0.410	0.496	-					
4	3	$\frac{\sigma}{n}$	0.507	0.328	0.403	0.467	0.309	0.328	0.473	0.672	0.441	0.329	0.446	0.610	0.418	0.373	0.579	0.410	0.373	0.598	0.845	0.587	0.377	0.568	0.770	0.558	0.393	0.557	0.676	0.477	0.393	0.662	-				
4	4	$\frac{\sigma}{n}$	0.457	0.292	0.383	0.388	0.426	0.292	0.421	0.482	0.671	0.303	0.408	0.461	0.621	0.320	0.485	0.527	0.320	0.504	0.616	0.843	0.334	0.493	0.593	0.783	0.337	0.500	0.528	0.616	0.337	0.553	0.689	-			
4	1	$\frac{2*\sigma}{n}$	0.331	0.566	0.249	0.150	0.096	0.566	0.303	0.198	0.156	0.666	0.302	0.193	0.151	0.708	0.235	0.156	0.708	0.401	0.307	0.244	0.840	0.402	0.304	0.238	0.835	0.407	0.302	0.229	0.835	0.494	0.397	0.349	-		
4	2	$\frac{2*\sigma}{n}$	0.623	0.333	0.501	0.292	0.211	0.333	0.612	0.398	0.313	0.364	0.667	0.399	0.313	0.407	0.388	0.294	0.407	0.768	0.535	0.435	0.450	0.841	0.539	0.437	0.451	0.730	0.452	0.365	0.451	0.908	0.631	0.543	0.499	-	
4	3	$\frac{2*\sigma}{n}$	0.466	0.300	0.369	0.428	0.280	0.300	0.441	0.616	0.425	0.331	0.454	0.666	0.439	0.339	0.531	0.372	0.339	0.558	0.774	0.567	0.378	0.577	0.840	0.588	0.355	0.510	0.620	0.433	0.355	0.615	0.917	0.664	0.396	0.641	-
4	4	$\frac{2*\sigma}{n}$	0.426	0.273	0.356	0.359	0.397	0.273	0.400	0.458	0.625	0.301	0.411	0.481	0.666	0.298	0.451	0.492	0.298	0.479	0.588	0.786	0.330	0.498	0.619	0.840	0.313	0.465	0.490	0.574	0.313	0.525	0.656	0.932	0.344	0.547	0.693	-

Appendix D Alternative Two-way fixed effects Specifications

This Appendix explores eight alternative two-way fixed effects specifications as robustness to Table 4. These analyses aim to validate the underlying assumptions imposed by our empirical setup.

As a first step, we analyze the impact of using an event-style setup two-way fixed effects estimator. Our identification strategy relies on the principle that sustainable engagement is primarily effective in promoting sustainable retrofitting during retrofit cycles. To accommodate this, we choose a relatively constrictive event window to measure the effects of engagement surrounding retrofit cycles. One potential downside of using this event window approach is that it eliminates a large share of the sample and is possibly too constrictive. To address this concern, we repeat our analysis for the entire sample of observation and anticipate smaller effect sizes in this alternative specification as our identification becomes less precise.

We start by assessing the aggregate effect of engagement on the share of sustainable permits without enforcing an event-style setup in Column (1). In Panels A to C, we observe no impact of all, successful, or unsuccessful sustainable engagement on the share of sustainable permits. These analyses indicate that the timing of successful sustainable engagement is essential in its impact on sustainable investments.

Our main findings are not driven by the event study two-way fixed effects specification. In Columns (2) of Panels A to C, we perform our analyses without constraining the sample to the three quarters before, during, and after the event study. We find a reminiscent impact to Table 4 for all, successful, and unsuccessful sustainable engagements during retrofit cycles on the share of sustainable permits. For all, successful and unsuccessful engagements during retrofit cycles, the marginal effects are 2.82, 13.33, and -7.76 for the non-event study and 4.67, 13.95, and -6.80 for the event study specifications, respectively. These statistically and economically similar marginal effects show that our event-style two-way fixed effects analysis does not drive our results.

As a second step, we validate the robustness of our findings using property-level heterogeneity in sustainable investment demands. Successful sustainable engagements improve the sustainable investments of firms through increased sustainable permit issuance. Therefore, it

would not be unreasonable to assume that the extent to which REITs acquiesce to sustainable engagement demands varies with the external pressure their properties face to become more sustainable. Specifically, we anticipate that properties in states that impose more stringent commercial energy codes extensively comply with engagement demands since they face higher transition risks.[45] Similarly, we anticipate that properties in democratic voting states face a higher demand to issue sustainable permits and, therefore, will experience more sustainable permits for successful sustainable engagement during retrofit cycles.

In Columns (3) and (4), we validate our results by showing that REITs issue more sustainable permits during retrofit cycles under stringent energy requirements. In Panel A Columns (3) and (4), we find that the impact of sustainable engagement during retrofit cycles is significantly more positive when energy requirements are stringent. Specifically, where the aggregate effect for all properties in Column (2) increases sustainable permits by 2.82 percentage points, engagement increases sustainable permits by 6.08 percentage points under stringent energy requirements and even reduces the share by 5.05 percentage points for properties that face below median strict energy codes.

We find a similar pattern when we split this aggregate effect into successful and unsuccessful sustainable engagement. Specifically, successful sustainable engagement during retrofit cycles increases the share of sustainable permits by 19.50 percentage points in highly energy-regulated properties and reduces the share of sustainable permits by 9.43 percentage points in less stringently regulated environments. For unsuccessful sustainable engagement, we observe reductions of 7.31 for properties that face above-median energy code stringency and would otherwise receive sustainable retrofits and no statistically significant effect for below-median energy code stringency properties that would a priori be less likely to be sustainably retrofitted.

In Columns (5) and (6), we further validate our initial results by showing that REITs issue more sustainable permits during retrofit cycles in democratic states. Like the energy code analysis, we find significantly lower sustainable permit issuance for properties in red states during sustainable engagements. This effect is mirrored in successful and unsuccessful sustainable engagement during retrofit cycles, as the share of sustainable permits increases is approxi-

[45] See `https://www.energycodes.gov/state-portal` for a complete overview of the commercial and residential energy codes across states.

mately double for successful engagement in blue states as opposed to red states. Similarly, when engagement is unsuccessful, sustainable permit issuance more strongly declines in red compared to blue states. These two heterogeneity analyses align with the logic of our main results and support that successful sustainable engagement improves sustainable investments, while unsuccessful engagement increases externalities.

In a last validation analysis, we deviate the treatment duration of REITs after engagement. Following our identification strategy, we argue that sustainable engagement is primarily effective in reducing externalities during retrofit cycles. We accommodate this in our two-way fixed effects analysis by assuming that engaged REITs only remain treated for the duration of the retrofit cycle. However, it could be the case that once treated REITs remain treated across retrofit cycles or even outside of these cycles. To test whether this assumption drives our results, we replicate the full sample analysis while assuming that engaged REITs and engaged REITs during retrofit cycles remain treated throughout the end of the sample in Columns (7) and (8).

We observe a somewhat more grim representation of the impact of engagement on sustainable permits across treatment duration. In Columns (7) and (8) of Panel A, we find that sustainable engagement during retrofit cycles reduces the share of sustainable permits by 3.83 and 2.48 percentage points, contrasting the positive impact of engagement depicted in Table 4. For successful sustainable engagement during retrofit cycles, we observe 12.08 and 12.85 percentage points increases in the share of sustainable permits in Columns (7) and (8). These effects are reminiscent of the estimated added value of sustainable engagement on the share of sustainable 13.33 and 13.95 percentage points increases in Column (2) and Table 4. For unsuccessful sustainable engagements during retrofit cycles, we observe reductions in the share of sustainable permits of 10.51 and 11.48 percentage points in Columns (7) and (8) compared to 7.76 and 6.80 percentage points in Column (2) and Table 4. These results suggest that both the positive and negative consequences of (un)successful sustainable engagement on sustainable investments are long-lasting. Given the above persistence in our findings across event style and full sample two-way fixed effects analyses, property characteristics heterogeneity, and treatment effects duration, we argue that the methodological configurations that support

our identification strategy do not significantly drive our results.

Table D1: Alternative two-way fixed effects specifications

This Table displays eight alternative specifications of Table 4. In Panels A, B, and C, we employ these specifications for all sustainable engagements, successful sustainable engagements, and unsuccessful sustainable engagements, respectively. In Column (1), we perform the principal analysis without the two-way fixed effects two-way fixed effects term on the whole sample to assess the aggregate effect of engagement on sustainable permits unconditional to retrofit cycles. In Column (2), we perform the same full-sample analysis with the two-way fixed effects component. In Columns (3) to (6), we perform full sample two-way fixed effects analyses that aggregate the share of sustainable permits by property-state characteristics. Columns (3) and (4) compute the percentage of sustainable permits by states with above and below median U.S. Department of Energy commercial property energy code stringency. Columns (5) and (6) aggregate sustainable permits by properties in blue and red states. Columns (7) and (8) adopt a specification in which we assume that REITs who experience sustainable engagement and REITs who experience sustainable engagements during retrofit cycles remain treated after the retrofit cycle until the end of the sample.

Panel A: All Sustainable Engagements

VARIABLES	(1) All	(2) All	(3) Stringent energy code	(4) Loose energy code	(5) Blue	(6) Red	(7) All	(8) All
Sustainable Engagement	-0.230	-0.777***	-3.029***	6.153***	-2.304***	9.916***	-5.691***	-6.188***
	(1.252)	(0.226)	(0.855)	(0.035)	(0.437)	(0.485)	(0.031)	(1.431)
Cycle X Sustainable Engagement		3.517***	8.042***	-10.520***	4.744***	-21.551***	1.911*	3.730***
		(0.661)	(0.055)	(1.660)	(0.196)	(0.812)	(1.041)	(0.458)
Cycle	0.097	0.078	1.081***	-0.680	-0.880***	1.197***	-0.050	-0.018
	(0.384)	(0.387)	(0.153)	(0.736)	(0.021)	(0.393)	(0.332)	(0.400)
Observations	8,009	8,009	6,981	5,972	6,775	5,974	8,009	8,009
Adjusted R-squared	0.121	0.121	0.118	0.101	0.128	0.081	0.123	0.122
REIT controls	YES	YES	YES	YES	YES	YES	YES	YES
Time FX	YES	YES	YES	YES	YES	YES	YES	YES
REIT FX	YES	YES	YES	YES	YES	YES	YES	YES

Table D1 – continued

Panel B: Successful Sustainable Engagements

VARIABLES	(1) All	(2) All	(3) Stringent energy code	(4) Loose energy code	(5) Blue	(6) Red	(7) All	(8) All
Sustainable Engagement successful	0.982	-1.000***	-7.589***	17.859***	-4.253***	4.196***	-3.286**	-1.322*
	(3.889)	(0.280)	(0.456)	(0.477)	(0.165)	(0.053)	(1.478)	(0.738)
Cycle X Sustainable Engagement successful		14.273***	26.040***	-26.613***	15.419***	-0.486	15.326***	14.117***
		(1.415)	(1.204)	(1.628)	(1.255)	(1.347)	(2.653)	(1.260)
Cycle	0.096	0.057	1.049***	-0.673	-0.899***	1.103***	0.043	0.053
	(0.385)	(0.388)	(0.151)	(0.731)	(0.023)	(0.397)	(0.397)	(0.386)
Observations	8,009	8,009	6,981	5,972	6,775	5,974	8,009	8,009
Adjusted R-squared	0.121	0.121	0.119	0.101	0.128	0.081	0.122	0.121
REIT controls	YES	YES	YES	YES	YES	YES	YES	YES
Time FX	YES	YES	YES	YES	YES	YES	YES	YES
REIT FX	YES	YES	YES	YES	YES	YES	YES	YES

Table D1 – continued

Panel C: Unsuccessful Sustainable Engagements

VARIABLES	(1) All	(2) All	(3) Stringent energy code	(4) Loose energy code	(5) Blue	(6) Red	(7) All	(8) All
Sustainable Engagement unsuccessful	-1.778	-0.463***	2.468**	-10.175***	-0.218	22.680***	-6.491***	-10.260***
	(2.060)	(0.119)	(1.220)	(0.844)	(0.993)	(1.555)	(2.351)	(2.377)
Cycle X Sustainable Engagement unsuccessful		-7.414***	-10.934***	10.281***	-6.060***	-50.208***	-4.119***	-1.283
		(0.232)	(1.564)	(1.378)	(0.985)	(0.226)	(1.245)	(1.203)
Cycle	0.098	0.118	1.157***	-0.732	-0.834***	1.202***	0.108	0.064
	(0.380)	(0.380)	(0.163)	(0.739)	(0.014)	(0.387)	(0.381)	(0.381)
Observations	8,009	8,009	6,981	5,972	6,775	5,974	8,009	8,009
Adjusted R-squared	0.121	0.121	0.118	0.101	0.128	0.082	0.122	0.123
REIT controls	YES	YES	YES	YES	YES	YES	YES	YES
Time FX	YES	YES	YES	YES	YES	YES	YES	YES
REIT FX	YES	YES	YES	YES	YES	YES	YES	YES

Appendix E Predictability of retrofit cycles and engagement success

This Appendix displays the regression Tables of Figure 4 and analyzes whether engagement success is more likely when it occurs during retrofit cycles. In Table E1, we regress contemporaneous, lagged, and lead public engagement specifications on the occurrence of retrofit cycles. In Columns (1) to (3), we respectively consider all engagements, governance engagements, and sustainable engagements. The dependent variable is a dummy that indicates whether a retrofit cycle occurs at this point in time. The timestamps $_{t-4+}$ and $_{t+4+}$ indicate a dummy variable that captures engagements for all periods one year before or after the current point of time. Lagged quarterly total returns, log total assets, and the leverage ratio are considered in each regression as REIT characteristics. Similar to Figure 4, we find that all coefficients are statistically insignificantly different from zero, indicating that engagement has no predictive power over the timing of retrofit cycles.

Next, we analyze whether engagement, governance engagement, and sustainable engagement is more likely successful during retrofit cycles. One small concern for our empirical setting is that the effect of sustainable engagement is slightly overestimated if the likelihood of success is higher during retrofit cycles. Specifically, when more engagements are successful and such engagements have a positive impact, the net effect of successful over unsuccessful is more pronounced in the estimated coefficient. Even though we subsequently split the effect by successful and unsuccessful sustainable engagement in our main analysis, we provide evidence that sustainable engagement success is not become more likely to succeed during retrofit cycles in Figure E1 and Table E2.

Figure E1 graphically shows that retrofit cycles do not increase the likelihood of successful engagement of any type. Additionally, Table E2 employs a similar empirical setup as Table E1 and does not statistically finds that retrofit cycles affect the probability of engagement success for respectively engagements, governance engagements, and sustainable engagements in Columns (1) to (3). Given the above, engagement does not seem to be able to instigate retrofit cycles, and retrofit cycles are not more likely to trigger successful engagement.

Finally, one additional concern with this lack of predictability is that investors did not pay as much attention to sustainability in the initial years of our sample as they do right now (see Dyck et al., 2019; Krueger, Metzger and Wu, 2020). Therefore, we interact the engagement variable with two dummy variables capturing the later years of our sample (i.e., 2012 to 2017 and 2018 to 2022). Table E3 presents the results of this analysis, showing that there is no significant change in the explanatory power of engagements on retrofits over the years. This suggests that investors do not learn from the misalignment of sustainable engagements with firms' depreciation of real assets.

Table E1: Engagement does not predict retrofit cycles

This table regresses contemporaneous, lagged, and lead engagement specifications on the occurrence of retrofit cycles. In Columns (1) to (3), we respectively consider all engagements, governance engagements, and sustainable engagements. The dependent variable is a dummy that indicates whether a retrofit cycle occurs at this point in time. The timestamps $_{<q-3}$ and $_{>q+3}$ indicate all periods one year before or after the current point of time. REIT controls capture quarterly total returns, log total assets, and leverage. REIT-level clustered standard errors are given in parentheses. ***, **, and * denotes significance at the 1%, 5%, and 10% level.

VARIABLES	(1)	(2)	(3)
$Engagement_{<q-3}$	-0.001	-0.024	0.007
	(0.021)	(0.035)	(0.019)
$Engagement_{q-3}$	0.028	-0.002	0.027
	(0.035)	(0.055)	(0.031)
$Engagement_{q-2}$	-0.006	0.003	-0.021
	(0.029)	(0.046)	(0.027)
$Engagement_{q}$	-0.010	0.020	-0.029
	(0.023)	(0.047)	(0.026)
$Engagement_{q+1}$	0.030	0.014	0.037
	(0.031)	(0.050)	(0.034)
$Engagement_{q+2}$	0.021	-0.022	0.034
	(0.033)	(0.047)	(0.041)
$Engagement_{q+3}$	0.023	-0.049	0.050
	(0.027)	(0.030)	(0.032)
$Engagement_{>q+3}$	0.021	-0.007	0.037*
	(0.021)	(0.024)	(0.022)
Engagement type	All	Governance	Sustainable
Observations	10,641	10,641	10,641
Adjusted R-squared	0.040	0.040	0.041
REIT controls	YES	YES	YES
Time FX	YES	YES	YES
REIT FX	YES	YES	YES

Figure E1: Are Engagements during Retrofit Cycles more Successful?

Figure E1 shows that engagements during retrofit cycles are not more successful. The x-axis represents lags and leads in retrofit cycles relative to the current time q. Spikes represent the 90% and 95% confidence intervals around the estimated coefficients. The periods $< q-3$ and $> q+3$ represent a categorical variable that indicates whether a REIT had retrofitting cycles at any point in time more than a year ago or more than a year after the engagement. Period $q-1$ is removed as a reference category. The y-axis represents the probability of successful engagement.

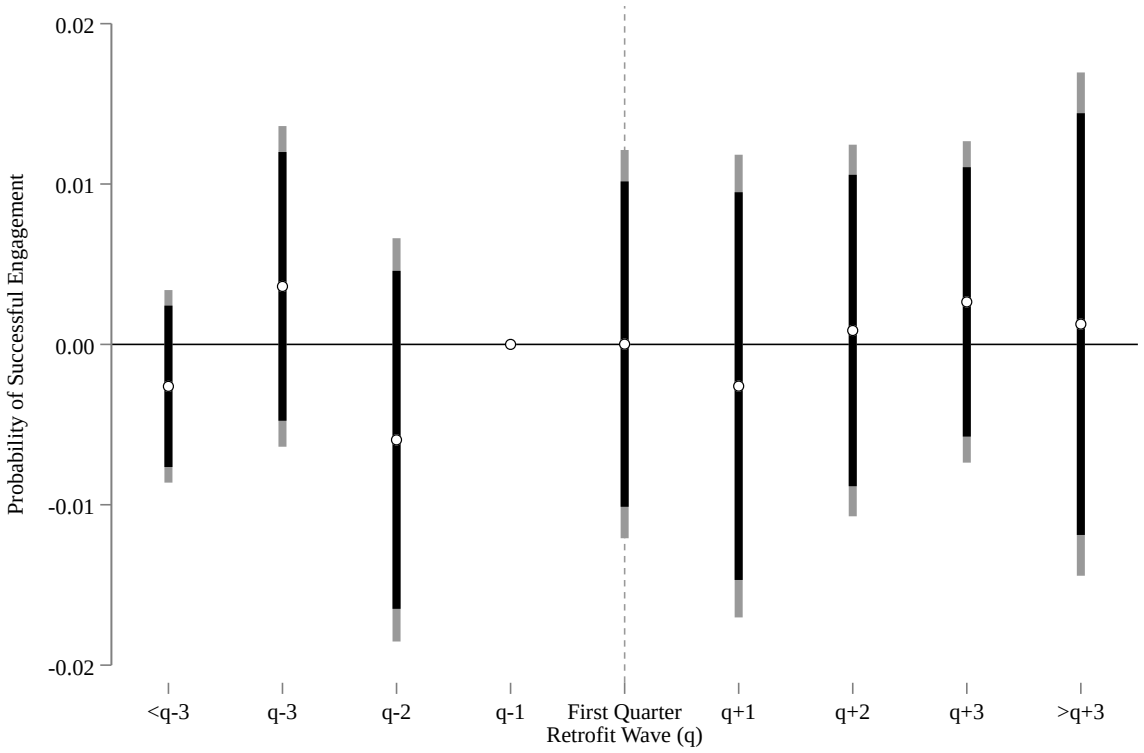


Table E2: Engagement success and retrofit cycles

This table regresses contemporaneous, lagged, and lead retrofit cycle indicators on successful engagement activities. In Columns (1) to (3), we respectively consider the probability of a REIT experiencing successful engagements, successful governance engagements, and successful sustainable engagements. The timestamps $_{<q-3}$ and $_{>q+3}$ indicate all periods one year before or after the current point of time. REIT controls capture quarterly total returns, log total assets, and leverage. REIT-level clustered standard errors are given in parentheses. ***, **, and * denotes significance at the 1%, 5%, and 10% level.

VARIABLES	(1)	(2)	(3)
$Cycle_{<q-3}$	-0.002	0.001	-0.002
	(0.003)	(0.003)	(0.002)
$Cycle_{q-3}$	0.006	0.007	-0.001
	(0.005)	(0.005)	(0.001)
$Cycle_{q-2}$	-0.003	-0.001	-0.002
	(0.007)	(0.007)	(0.002)
$Cycle_{q}$	-0.000	-0.000	-0.000
	(0.006)	(0.006)	(0.002)
$Cycle_{q+1}$	-0.000	-0.000	-0.000
	(0.007)	(0.006)	(0.003)
$Cycle_{q+2}$	-0.003	-0.003	0.000
	(0.006)	(0.005)	(0.003)
$Cycle_{q+3}$	0.005	0.006	-0.000
	(0.006)	(0.005)	(0.001)
$Cycle_{>q+3}$	0.004	0.004	-0.000
	(0.006)	(0.005)	(0.002)
Engagement type	All	Governance	Sustainable
Observations	10,641	10,641	10,641
Adjusted R-squared	0.072	0.063	0.011
REIT controls	YES	YES	YES
Time FX	YES	YES	YES
REIT FX	YES	YES	YES

Table E3: Timing engagements and retrofit cycles

This table verifies whether sustainable engagement coincides with retrofit cycles more frequently over time. We do so by regressing contemporaneous engagement dummies interacted with time dummies for periods from 2012 to 2017, and 2018 to 2022. The dependent variable is a dummy that indicates whether a retrofit cycle is happening at this point in time. REIT controls capture lagged quarterly total returns, log total assets, and the leverage ratio. In Columns (1) to (3), we respectively consider all engagements, governance engagements, and sustainable engagements. We explicitly remove time fixed effects to allow our model to better capture investors' ability to file sustainable engagements that coincide with retrofit cycles over time. REIT-level clustered standard errors are given in parentheses. ***, **, and * denotes significance at the 1%, 5%, and 10% level.

VARIABLES	(1) Cycle	(2) Cycle	(3) Cycle
$year = 2006 - 2011$	-0.037	-0.038	-0.039
	(0.053)	(0.055)	(0.056)
$year = 2012 - 2017$	-0.139	-0.140	-0.140
	(0.217)	(0.219)	(0.218)
$year = 2018 - 2022$	-0.069	-0.070	-0.069
	(0.101)	(0.103)	(0.102)
$Engagement_t$	0.013	-0.028	-0.003
	(0.020)	(0.043)	(0.004)
$Engagement_t$ X $year = 2012 - 2017$	-0.036	0.005	0.102
	(0.056)	(0.007)	(0.127)
$Engagement_t$ X $year = 2018 - 2022$	-0.051	-0.002	-0.021
	(0.092)	(0.012)	(0.047)
Engagement type	All	Governance	Sustainable
Observations	11,802	11,802	11,802
Adjusted R-squared	0.035	0.035	0.035
REIT controls	YES	YES	YES
Time FX	NO	NO	NO
REIT FX	YES	YES	YES