Timing Sustainable Shareholder Proposals in Real Asset Investments*

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Abstract

Institutional investors increasingly file shareholder proposals to improve firms' environmental and social performance, yet evidence on their effectiveness remains limited. This paper shows that timing is critical: proposals only trigger sustainable investment in firms when they coincide with natural reinvestment cycles — periods when firms' long-lived assets are due for replacement. SEC filing restrictions, combined with the unpredictable timing of asset depreciation, generate quasi-random variation that allows us to identify the causal effect of proposal timing. Using novel microdata on retrofit activity across all U.S. publicly listed commercial real estate firms' properties from 1990 to 2022, we find that proposals filed during reinvestment cycles increase the share of sustainable retrofits by 21.5%; otherwise, they have no effect. We replicate these findings in the U.S. heavy manufacturing industry. Our results suggest that the effectiveness of sustainable finance depends not only on who investors target, but also when they do so.

Key words: Corporate Governance, Physical depreciation, Real assets, Socially Responsible Investing (SRI), Environmental Social Governance (ESG)

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1 Introduction

The United Nations estimates a $4 trillion annual funding gap in sustainable investments needed to achieve net-zero carbon emissions (UN, 2024). Over 5,000 institutional investors adopted sustainable financing strategies to meet this gap (UNPRI, 2022). A prevalent strategy is filing sustainable shareholder proposals, which are formal requests submitted by shareholders to a company's board of directors to initiate referendums on improvements in the company's environmental or social performance, utilizing their corporate governance rights.[1] While understanding their impact on firm behavior is crucial (Krueger, Sautner and Starks, 2020), evidence on their effectiveness and conditions for success remains limited.[2]

Assessing the impact of shareholder proposals on firm behavior is empirically challenging. Investors are likely to selectively file shareholder proposals with firms that appear more receptive or better equipped to implement proposed changes.[3] Prior strategies leveraged exogenous variation in investor pressure, such as shareholder proposals that narrowly pass voting thresholds (Flammer, 2013, 2015), bulk filing of near-identical proposals by institutional investors (Flammer et al., 2021), activist campaigns led by hedge funds and pension funds (Akey and Appel, 2019; Naaraayanan et al., 2021), and shifts in investor ideology induced by political cycles (Kahn et al., 2023). These papers examine the impact of shareholder proposals on aggregate outcomes, including financial and environmental pollution variables. They have not, however, addressed the question of how firms' decisions are influenced by shareholder intervention.

In this paper, we examine the role of timing as a moderator of the effectiveness of shareholder proposals in actions taken to improve real assets in the real estate, manufacturing, utility,

[1]Shareholder proposals are most common in the US but are a global phenomenon. In addition to proposals, investors also pursue screening strategies that evaluate investment opportunities based on environmental and social criteria, either excluding or including them from portfolios (Berk and van Binsbergen, 2021; Pástor et al., 2021; Edmans et al., 2022; Pástor et al., 2023; Oehmke and Opp, 2024). Certifications and labels provided by third-party entities often serve as (potentially noisy) signals for investors on the commitment, intentions, and performance in various social and environmental issues (Berg et al., 2022; Bams and van der Kroft, 2025).

[2]There is a broad literature that addresses governance proposals 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; Li et al., 2022; Lewellen and Lewellen, 2022; Meirowitz and Pi, 2022; Brav et al., 2024; Gao and Huang, 2025) For notable exceptions, on sustainable engagement see Azar et al. (2021) and Li et al. (2023) for shareholder proposal voting. For instance, He et al. (2023) highlight that sustainable proposals do frequently not make a majority vote, resulting in subsequent environmental and social controversies; Akey and Appel (2019), Naaraayanan et al. (2021), and Busch et al. (2023) find mixed evidence whether shareholder proposals initiate sustainable investments, or hinders firm growth by reducing the scope of production, and Broccardo et al. (2022) theoretically describe that the efficacy of proposals is strongly dependent on the share of sustainable versus conventional investors.

[3]For instance, investors often file shareholder proposals and privately 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, proposal success is higher when topics are financially material (Grewal et al., 2016; Bauer et al., 2023) or mitigate tail risk (Hoepner et al., 2021). One indicator of such selection is that Vanguard, BlackRock, and State Street Advisors, together, have 15, 24, and 10 employees managing all voting, initiating governance proposals, and filing sustainable proposals for the 13,000, 14,000, and 9,000 companies in their respective portfolios (Bebchuk et al., 2017). With such limited resources, firms pursuing low-hanging fruit would be optimal.

and petrochemical industries. Firms in these sectors operate long-lived assets — such as property, plants, and equipment — that physically depreciate over time. The capital adjustment cost literature suggests that, in this case, investment is lumpy and its timing is determined by an optimal stopping time (Mauer and Ott, 1995; Cooper and Haltiwanger, 2006; Livdan and Nezlobin, 2021). In the case of real estate, sustainable improvements often necessitate the replacement or upgrade of existing equipment or general building characteristics. For example, sustainably replacing prominent sources of emission, such as aging power transformers, industrial boilers, or building envelopes, takes place during periods of large capital expenditure, i.e., retrofit waves. Therefore, our hypothesis is that a shareholder proposal can alter the nature of the investment only if it aligns with the firm's investment decision. On the other hand, shareholder proposals outside of these reinvestment periods are less likely to be effective, as breaking open buildings for just sustainability purposes is cost-ineffective.

We focus on the public real estate market as it offers a unique setting because every capital investment is observable through retrofit permits. Using proprietary building-level microdata covering 359,022 retrofit permits for all buildings owned by US-listed real estate firms (N=61,870) from 1990 to 2022, we identify sustainable reinvestments - retrofits - decisions (e.g., solar panel installations, insulation upgrades, HVAC improvements) and distinguish them from conventional ones (e.g., plumbing or electrical work). This permit information is retrieved from municipality-level permit registries, to which contractors are mandated to report when performing renovations.[4]

One may argue that shareholders should be able to engage strategically to maximize the effectiveness of their proposals. The first possibility is to anticipate retrofit waves. After all, the filing of permits is public, and there are other public variables (such as interest rates) that could help shareholders predict the retrofit wave. Second, in the absence of proper anticipation, a possible strategy is to file a proposal in every meeting. We rule out both sources of endogeneity.

First, uncovering retrofit window timing ex ante is challenging, as listed real estate investment trusts (REITs) manage portfolios comprising up to thousands of properties across diverse locations and markets, each following its own depreciation trajectory. Shareholders lack access to on-the-ground property-level information across geographically and economically diverse real estate markets, making it impossible for them to detect potential clustering of retrofit windows for a large portfolio.[5] Although timing is critical for the effectiveness of shareholder proposals, shareholders themselves are often "blinded"—unable to observe or an-

[4]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) offices after correcting for baseline energy consumption and frequently used third-party energy certificates (Eichholtz et al., 2010). Furthermore, although requesting a permit does not guarantee an action will occur, we observe in the dataset that 99% of permits take place. Therefore, permits are a measure of both intentions and real actions.

[5]Public real estate firms manage portfolios comprising hundreds of properties across distinct local markets, each with unique conditions. This fragmentation creates information asymmetries that hinder investors from accurately predicting physical depreciation at the asset level. Consequently, investors struggle to foresee retrofit waves without a public signal.

ticipate the optimal moments for engagement. In fact, we show that the timing of sustainable proposals relative to retrofit waves is virtually random. The combined explanatory power of factors such as the costs and benefits of sustainable retrofits (e.g., construction material prices and energy costs), macroeconomic supply and demand conditions (e.g., construction spending index, house price returns, REIT returns), local market dynamics (e.g., surrounding vacancy rates), and broader economic indicators (e.g., NBER recessions, 10-year Treasury rates, S&P 500 returns, and real GDP growth) accounts for only 3% of retrofit wave timing. In other words, investors appear unable to predict retrofit waves: only 12% of their proposals align with retrofit waves, just one percentage point higher than the unconditional probability of retrofit wave occurrences (11%).

Investors appear to take timing into account, however. Investors can observe the retrofit waves ex-post by using the permit data we use in this paper. We find no instances of sustainable proposals filed two years after a retrofit wave. Suggesting that investors recognize the low likelihood of another wave occurring after one has already been implemented. In contrast, governance-related proposals continue to be filed during this period, indicating that investors remain vigilant in monitoring the firm.

Furthermore, investors cannot anticipate the retrofit wave by looking at public signals from the REITs - such as investment plan announcements. Legally, shareholder proposals need to be filed several months before the shareholder meeting. In particular, SEC Rule 14a-8 requires investors to file shareholder proposals at least 165 days before a vote (SEC, 2022). However, even when REITs publicly announce upcoming renovation waves and issue a capital call, permits for binding retrofit decisions are often filed within two months of the announcement.[6] Therefore, investors acting on public signals of renovations will be too late to be effective.

The second possible strategy, in the absence of anticipation, is for investors to file proposals at every shareholder meeting. However, SEC rules limit repeat filings and only allow proposals on the same topic at the same firm provided the proposal previously secured 5%, 10%, and 25% of favorable votes, for respectively the second, third, and fourth or onwards vote.[7] Attributed to these constraints, we only observe a single repeat shareholder proposal that is successful and timed during retrofit waves.[8] This, combined with detailed data on retrofit permits and SEC filing rules, allows us to mitigate endogeneity concerns between the timing of shareholder proposals and their effectiveness in shifting firms' sustainable investments.

[6] The retrofitting process in real estate follows a structured but swift sequence: firms first solicit bids from contractors, then select the best offer and finalize costs and timelines before publicly announcing their retrofitting plans. This rapid process allows firms to secure lower financing costs by ensuring they have precise funding requirements, enabling immediate payments to contractors. While this system introduces potential endogeneity in retrofit timing — since our measure of sustainable retrofit decisions, based on permits, inherently lags—this delay is minor compared to the SEC's filing restrictions.

[7] 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 proposal votes (He et al., 2023). Further, filing repeat proposals is also constrained when proposals are unsuccessful through omission by the SEC.

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

In summary, the timing of shareholder engagement and firms' retrofit windows can be treated as orthogonal: macroeconomic variables, and REIT's characteristics do not help predict the retrofit waves, the announcements can't be used due to the lead time the proposals are required to be filed, and filing repeated proposals is costly and constrained by the SEC.

We uncover the timing of retrofit windows using a jump-detection algorithm (Lee and Mykland, 2008). This approach identifies periods when a substantial share of properties within a firm's portfolio is sufficiently depreciated to trigger abnormal levels of permit applications. We then link these inferred retrofit windows to the universe of shareholder proposal events, using data 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 effectiveness of shareholder proposals in promoting firms' environmental and social performance hinges on timing: significant impacts occur only when proposals align with retrofit windows of real asset portfolios. When timing is not taken into account, shareholder proposals appear ineffective in triggering sustainable capital expenditures, as measured by the share of sustainable versus conventional permits. However, when proposals coincide with retrofit windows, sustainable proposals increase the share of sustainable permit issuances by 21.5%.

As robustness checks, we find that (1) the positive effect is driven exclusively by successful proposals—those approved by shareholders or preemptively adopted by firms—while unsuccessful proposals (excluded from the ballot or failing to pass a vote) show no effect or are negatively associated with sustainable permitting. (2) As a falsification test, governance-focused proposals (e.g., on remuneration, board structure, elections) do not affect sustainable investment outcomes, supporting the specificity of our results. (3) Increases in sustainable permits are additive: they do not come at the expense of conventional maintenance activity, whose volume and composition remain unchanged.[9] (4) Sustainable proposals operate on the intensive margin—they lead firms to invest more in sustainability within their portfolios, rather than by disposing of less sustainable assets.

We do not differentiate between proposals that were accepted during the vote or preemptively accepted (withdrawn) by firms. The timing implied by our identification strategy occurs before firms decide on how to respond to a proposal. On the one hand, proposals could function as information provision to management or signal investors' willingness to pay for sustainability (see Pástor et al., 2021; Broccardo et al., 2022; Oehmke and Opp, 2024). On the other hand, proposals could be paired with investors directly willing to sacrifice returns and provide equity

[9]Except for electrical permits associated with installing sustainable HVAC systems.

or debt at lower capital costs to firms.[10] In other words, investors may strategically target firms with sustainable projects that have a positive NPV (Dimson et al., 2015; Busch et al., 2023; He et al., 2023). While our identification enables us to examine the role of timing in effective shareholder proposals, it does not allow us to investigate why firms adopt them.

We demonstrate the external validity of our results through two separate exercises, within and across industries. First, we test for selection in firms targeted by shareholder proposals in our sample, which covers the universe of REITs in the United States. Since not all REITs received shareholder proposals during the sample period, there is a risk that our observed economic magnitudes are subject to selection effects. The direction of this bias is theoretically ambiguous. On the one hand, investors select firms more likely to meet their demands (Dimson et al., 2015; Busch et al., 2023). On the other hand, proposals are often preceded by private engagement efforts, and the firms that ultimately receive proposals may be those that resisted these demands in private settings (McCahery et al., 2016; Levit, 2019). We observe that the characteristics of buildings managed by targeted and non-targeted REITs are ex ante statistically indistinguishable at the 5% level in terms of age, number of past retrofits, and size. These results suggest our findings appear representative of the industry, at least in the observables.

Second, we replicated our main results for US heavy manufacturing, petrochemical, and utility firms. Similar to REITs, Rule 14a-8 of the SEC constrains the timing of shareholder proposals for U.S. companies covered by the U.S. Environmental Protection Agency's (EPA) Toxic Release Inventory (TRI). We collect all sustainable shareholder proposals (N = 1,026) for the universe of the EPA sample, encompassing the 1,852 most polluting US-listed firms.[11] Even though real estate is not a core business for these heavy polluters, retrofits are often involved in pollution abatement efforts as they are required for the proper operation of their plans. Consistent with our primary analysis, we find heterogeneous treatment effects of shareholder proposals along depreciation cycles in the properties of US heavy polluters. In particular, only those proposals that coincide with the retrofit waves instigate sustainable retrofits. These retrofits are crucial for sustainable performance, as our data show that production processes in these firms lead to more operational pollution prevention activities and reduce (the magnitude of) environmental fines (e.g., installing scrubbers in power plants).

This paper makes two contributions. An expanding literature examines how investor pres-

[10]To provide the reader with some initial and far from complete indication of which mechanisms could play a role, we performed a rudimentary analysis of the correlation between successful proposals and capital costs. We computed firms' cost of equity by replicating the cost of equity measures of Gebhardt et al. (2001), Hou et al. (2012), Fama and French (2015), and Chattopadhyay et al. (2022), following Lee et al. (2021). We computed the cost of debt using firms' duration- and value-weighted bond yields and interest expenses. Further, we employed a 30% tax rate and Compustat book-value equity and total liability data to compute their cost of capital. Using an identical specification as when assessing how sustainable proposals affect firms' sustainable decision-making, we observe an insignificant 11 basis point reduction in the change in firms' capital costs for successful proposals, somewhat aligned with the cost of capital perspective. We leave a cleaner identification of the mechanism behind proposals to future research and thank Brooke Wang for suggesting this.

[11]EPA data is often used in economics and finance (Levinson, 1999; Bui and Mayer, 2003; Shapiro and Walker, 2018; Akey and Appel, 2019; Banzhaf et al., 2019; Naaraayanan et al., 2021; Xu and Kim, 2021; Dasgupta et al., 2023; Hsu et al., 2023).

sure influences firms' sustainable performance (Akey and Appel, 2019; Azar et al., 2021; Dimson et al., 2023; Naaraayanan et al., 2021; Kahn et al., 2023; Slager et al., 2023). However, prevailing empirical approaches often rely on broad, firm-level, and typically self-reported output-based indicators, such as ESG scores, greenhouse gas emissions, or toxic releases. While useful for reduced-form analyses, these measures offer limited insight into the decisions firms undertake in response to sustainability-oriented investor demands. We introduce new input-based retrofit metrics that directly capture firm-level decision-making. Our metrics allow researchers to trace how firms adjust their operational and investment choices in response to investor pressure, rather than inferring intent from lagging, path-dependent output indicators. Output-based metrics can take years to reflect internal behavioral changes, even after firms pivot toward more sustainable practices (Bams and van der Kroft, 2025).

Second, we emphasize for the first time the pivotal role of timing in sustainable finance. The importance of timing investor pressure on sustainability during pivotal investment decisions aligns with recent theoretical sustainable finance work, which models investors being able to push firms at the exact time they face a crucial decision to invest in producing a brown or green asset (Landier and Lovo, 2020; Pástor et al., 2021; Broccardo et al., 2022; Pástor et al., 2022; Oehmke and Opp, 2024; Berk and Van Binsbergen, 2025). However, the empirical literature relies on time-invariant identification strategies and provides estimates that overlook the dynamic nature of firms' sustainability decisions. Common strategies are comparisons across firms with narrowly passed vs failed shareholder proposal votes (Flammer, 2013, 2015), variation in firms targeted vs not targeted by bulk filings institutional investors (Flammer et al., 2021) or activist campaigns led by hedge funds and pension funds (Akey and Appel, 2019; Naaraayanan et al., 2021), and shifts in investor ideology induced by political cycles (Kahn et al., 2023). We find that sustainable proposals are only impactful when synchronized with investment decision periods, but are innocuous or even detrimental when unsynchronized with depreciation waves. This suggests that some findings of prior literature may be conservative lower-bound estimates, especially for firms with long-lived assets, where investments are irregular. Consequently, our results suggest that it is not only *who* sustainable investors engage, tilt, or file proposals 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 waves in our data. Section 5 explains our results and identification strategy. Section 6 analyzes internal and external validity. Section 7 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). 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 proposals 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 (American Tower Corporation, 2025; Boston Properties, 2025; CareTrust REIT, Inc., 2025; Prologis, 2025). 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.[12]

Listed real estate provides an ideal setting to study how the timing of sustainable shareholder proposals 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 proposals relative to the physical depreciation of assets on sustainable investments should generalize beyond our setting, albeit 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

[12]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.

permits from the local municipality.[13] 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).[14] Specifically, sustainably investing in a building involves improving its energy efficiency, changing the heating source from gas to electricity, installing solar panels, or making the property more comfortable for its tenants by providing better indoor air quality or an environment of amenities. Performing these retrofits simultaneously with conventional retrofits is economically warranted to reduce operational downtime (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 waves readily. To create a fair playing field between REITs and mutual 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 waves. This spiky pattern in physical depreciation allows us to assess whether the impact of proposals on sustainable investments varies over the depreciation wave of firms' real assets. For these reasons, real estate provides an ideal setting to investigate the effectiveness of sustainable proposals, even though our mechanism should generalize to other, less easily observable, real assets.

[13] 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`.

[14] 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).

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 proposals.

3.1 Real estate property characteristics

We collect building 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 buildings, 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 properties (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 waves 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.[15]

We connect BuildZoom permit information to REITs' properties by geospatially matching addresses and coordinate information in ArcGIS. This approach results in access to permitting information for more than 99% of REIT-owned properties at a 99% matching accuracy. For the 61,870 properties in our sample, we observe 359,022 permits with a combined value of approximately $43.79 billion, or $121,985 per permit.[16] This translates into 5.80 permits per property during our study period (1990 to 2021).

We utilize this comprehensive microdata to distinguish between sustainable and conventional retrofits at the property level. We implement the guidelines of Energy Star, LEED, WELL, and Fitwel to differentiate between environmental, social, and conventional retrofits. In particular, Energy Star and LEED are key authorities on environmental retrofitting, arguing that HVAC systems, heating and cooling, and building envelope retrofits are critical ways to reduce energy consumption and curb emissions (EnergyStar, 2023; LEED, 2024). We classify doors and windows, HVAC systems, retaining walls, roofing, and solar installations as sustainable retrofits that contribute to the property's environmental performance.

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.

[15]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.

[16]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. Further, BuildZoom traces the status of permits and provides information on whether permits are ongoing, finalized, or canceled. To ensure that failed retrofits do not drive our results, we solely consider the 359,022 non-canceled permits mentioned in this section. Canceled permits reflect roughly one percent of the sample, and including them does not affect our results.

WELL and Fitwell also include ventilation due to health benefits, already captured in the above HVAC retrofits. In Table 2, we display the frequency of all permits and their classification as conventional or sustainable based on the EnergyStar, WELL, and Fitwel guidelines. We observe 281,081 conventional permits with an average reported value of $109,241 per permit and 77,941 sustainable retrofit permits with an average value of $168,074 per permit.

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[17] 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 foot of different types of sustainable retrofits, 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 foot. This effect is economically relevant compared to an average emission intensity of 8.695 kilograms per square foot, 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 the overlap in the timing with social and conventional permits.

Environmental permits 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 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 shareholder proposal records

As a last step, we collect information on all (sustainable) proposals of S&P1500 firms from the Institutional Shareholder Services (ISS) 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

[17]We collect this data from the Local Law 87, BERDO, and BEUDO energy registry regulations (BERDO, 2024; BEUDO, 2024; NYC, 2024b). For further details on these laws, see Appendix A.

(Bebchuk et al., 2017; SEC, 2020).[18] The process of such proposals 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).[19] 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-up request or starting a legal procedure.

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" proposals 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" proposals 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 proposals (54.72%) are withdrawn or accepted by the firm before a vote, and 45.28% are omitted by the SEC or failed in a vote.[20] This distribution of successful and unsuccessful sustainable proposal events is

[18] Large institutional investors sometimes privately engage with firms as a first step in the proposal 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., 2023). When these private discussions are unsatisfactory, they can initiate a public shareholder proposal 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 proposals is likely to, if anything, underestimate the impact of shareholder proposals on sustainable investments because firms did not consent to stockholder demands in the private stage and thus oppose the proposal 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 shareholder proposal) 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). We thank Zacharias Sautner for pointing out this debate.

[19] 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).

[20] Withdrawn and omitted proposals never make it to the ballot as firms accept investor demands without the need to vote or fight it and successfully remove it from the ballot, preventing a vote.

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.[21]

4 Methods

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

4.1 Detecting Retrofit waves

There is no standardized way to determine when the intensity with which REITs retrofit their properties is classified as a retrofit wave. The thresholds for retrofit waves 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 waves 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 or intensity of retrofit waves. Since we do not attempt to predict when retrofit waves 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 waves 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 waves because we want to impose as little structure as possible on identifying retrofit waves while employing an objective and replicable method. The following paragraphs will describe how we choose both parameters and validate their adequacy.[22]

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

[22] 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 waves because BuildZoom's permit information records retrofit starting and completion dates for every property in our sample.

Duration of Retrofit waves: 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 filing date.[23] 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 waves 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.[24]

Threshold of Retrofit waves: We determine the threshold when a jump in retrofitting is identified as a retrofit wave through its magnitude and persistence. Since retrofit waves 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 waves.[25] Using this approach, we identify 417 retrofit waves out of 11,802 REIT-quarter observations, the average displayed in Figure 5. This is roughly one retrofit wave every 7.1 years. Linking this back to the previous example, Prologis has most retrofit waves (once every 5 years), followed by Boston Properties (once every 6.31 years), and American Towers (once every 12.13 years). Further, the time in between these retrofit waves significantly varies across and with firms, ranging from 2 to 10.75 years for just

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

[24]We replicate this analysis for all 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.

[25]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 wave to be identified as the start of a retrofit wave. Since retrofit waves are periods with abnormal retrofit levels, their starting points should reflect the most significant jump in retrofits within the span of the retrofit wave. Therefore, we remove all potential retrofit wave starting points three quarters before, during, or after the most significant retrofit increase. Subsequently, we repeat this process iteratively, moving from the potential retrofit wave 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.

Boston Properties.

Figure 5 shows the time series number of retrofits in the quarters before, during, and after a retrofit wave 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 waves in two ways. First, the jump is sizeable, exceeding three times the usual number of retrofits at the start of retrofitting waves. 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-wave increase in retrofitting and a negligibly higher number of retrofits just after retrofitting waves. This carefully suggests that we detect retrofitting waves' starting points and duration with reasonable precision. Given the above and a significant overlap in retrofit wave dates among 48 alternative specifications presented in Appendix C, we can detect retrofit waves reasonably well.[26]

4.2 Empirical specification

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

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

Sustainable retrofits $(\%)_{i,t} \equiv \frac{\text{Sustainable retrofits}_{i,t}}{\text{Total retrofits}_{i,t}}$ is measured as the sustainable investments of REIT i at quarter t as their share of sustainable over total retrofits, as assigned in Table 2. Since sustainable proposals should be most effective in improving sustainable investments surrounding the retrofit waves of REITs, we employ a two-way fixed effects setting with proposals and retrofit waves. Specifically, Sustainable proposal$_{i,t}$ is a dummy variable capturing whether REIT i receives a sustainable shareholder proposal at any day during quarter t. Further, the dummy variable Retrofit Wave$_{i,t}$ indicates whether REIT i experiences a retrofit wave at quarter t, lasting three quarters. The unit of analysis of this regression is REIT-quarter.

Since the effectiveness of sustainable proposals 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 av-

[26] 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 waves across these for 48 alternative specifications with similar coefficient estimates. Please note that we solely try to observe when REITs initiate retrofit waves in the sample with an objective measure rather than try to predict subsequent waves with the detection algorithm.

erage 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.[27]

5 Results

5.1 Sustainable proposals, sustainable investments, and depreciation waves

As a first step in analyzing the impact of sustainable proposals on sustainable investments, we plot the development of sustainable retrofits relative to retrofit waves and proposals using 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 wave. We split this by whether REITs experience no sustainable proposals, successful sustainable proposals, or unsuccessful sustainable proposals. The level of sustainable retrofits is demeaned with the average share of sustainable retrofits before the retrofit wave starts. Even in a setting without controls, REITs perform more sustainable investments when sustainable proposals are successful during retrofit waves, as indicated by the increase in sustainable retrofits relative to the no-proposal benchmark. In contrast, unsuccessful sustainable proposals appear to reduce the share of sustainable retrofits precisely when proposals coincide with retrofit waves. These initial results seem to suggest that sustainable proposals 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 proposals and retrofit waves following Equation 1. In aggregate, we do not observe a statistically significant effect of sustainable proposals on sustainable investments. Moreover, the effect is economically small and negative in sign. This estimate suggests that proposals are ineffective in improving firms' sustainable investments.

[27]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 waves), are transitory; and we have little power. To elaborate, a REIT is only engaged for one quarter, and retrofit waves 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 waves 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 waves where REITs experience events that are opposite to the proposals. Specifically, we omit the three quarters before, during, and after retrofit waves where REITs experience unsuccessful sustainable proposals when analyzing the impact of successful sustainable proposals and vice versa for unsuccessful sustainable proposals. 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 proposals, artificially increasing the magnitude of proposals on sustainable retrofits. In subsequent analyses, we also correct for overlap with governance proposals.

In Table 4 Column (2), we repeat the prior analysis while explicitly considering whether sustainable proposals occur during or outside retrofit waves. Unlike our preceding analysis, we find that sustainable proposals have the potential to impact firms' sustainable investments substantively. Proposals that occur during retrofit waves significantly increase the share of firms' sustainable retrofitting. In contrast, proposals significantly decrease sustainable retrofitting when it happens outside retrofit waves. In economic terms, sustainable proposals during physical depreciation waves increase 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 proposals outside retrofit waves. These opposing signs support that accurately timing sustainable proposals relative to real asset depreciation is pivotal in improving firms' sustainable investments.

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

Following our expectations, firms subject to successful sustainable proposals during their retrofit waves 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 proposals in general in Column (2). Furthermore, unsuccessful sustainable proposals reduce the share of sustainable retrofitting regardless of its timing relative to retrofit waves. Specifically, it jointly significantly reduces the share of sustainable retrofits by 6.80 percentage points, or 31.23%, during retrofit waves (see Table 4 Column (4)). This combination of increased sustainable investments for successful proposals and reductions for unsuccessful proposals further validates that timing sustainable proposals during the physical depreciation of real assets is central to steering firms' sustainable investment. However, it also signals that sustainable proposals are a high-stake decision with potentially harmful consequences when unsuccessful.[28]

[28]These findings are not driven by the detection of retrofit waves. Specifically, we replicated these analyses assuming retrofit waves take one quarter more or one quarter less in duration and find economically and statically comparable outcomes, with slightly higher standard errors as additional noise is introduced.

5.2 Institutional and regulatory barriers to timing optimization

In this section, we present several 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 proposals is unrelated to the timing of retrofit waves. First, we show that sustainable proposals do not align with retrofit waves, and public information has little predictive power over retrofit waves. Second, we show that investors cannot instigate retrofit waves. Third, we demonstrate that SEC law prevents investors from using REITs' announcements of retrofit waves to file proposals before the retrofit waves begin. Lastly, we demonstrate that investors cannot iteratively file sustainable proposals and achieve timing through brute force due to SEC legislation.

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

Sustainable proposals and retrofit waves do not align. As a first step in analyzing this question, we investigate the timing of sustainable proposals relative to the occurrence of retrofit waves. We find that sustainable proposals occur only 12.00% of the time during retrofit waves. This percentage is low compared to the 10.60% unconditional probability with which retrofit waves occur, suggesting sustainable proposals do not align with retrofit waves.[29]

Figure 4 displays event-study estimates when regressing the occurrence of retrofit waves on multiple leads and lags of (sustainable) proposals dummies, using the quarter before proposals as the reference category. In every instance, we find that a proposal does not correlate with the occurrence of retrofit waves. This suggests that investors appear not to purposefully align their sustainable proposals with retrofit waves.[30]

Next, we strive to provide a reason why investors appear unable to predict retrofit waves. Public REIT-specific accounting information and macroeconomic indicators are two prominent channels through which investors might be able to predict retrofit waves. However, capital and depreciation expenses on balance sheets are unlikely to aid investors in predicting retrofit waves

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

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

as physical depreciation is not mirrored in book depreciation because REITs linearly depreciate their properties for tax and accounting purposes.[31]

An alternative approach investors could take in identifying retrofit wave 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 waves.

In Table 5, we test whether a large set of macroeconomic conditions, retrofit profitability, and within-REIT variation in property characteristics can explain retrofit waves and sustainable proposals. In Columns (1) to (3), we regress the occurrence of retrofit waves 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 waves, they jointly only explain 3.3% of the *in sample* squared variation in retrofit waves. Furthermore, the timing of sustainable proposals 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 unable to use public information to predict when REITs initiate retrofit waves.

Information asymmetry: no initiation of retrofit waves Investors cannot influence retrofit waves with proposals because REITs retrofit a share of their portfolio of properties when these are physically depreciated. Even though the occurrence of sustainable proposals relative to retrofit waves appears nearly random, we explore the possibility that proposals initiate retrofit waves. 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 ex-

[31] The US G.A.A.P. linearly depreciates commercial properties in 39 years, 27.5 years for residential properties, and 15 years for land improvement costs. Land in itself cannot be depreciated.

pire. 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 waves as long as possible and are unlikely to be swayed by investor pressure to shift their timing.

Information asymmetry: no predictability of retrofit waves Investor statistically predicting retrofit waves is very challenging even for sophisticated investors as their occurrence follows a hazard model. Figure 6 Panel A plots the time between retrofit waves in quarters. The time between retrofit waves 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 waves 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 waves is 36.5 quarters and accounts for 55.19% of the observations. Therefore, the physical depreciation underlying retrofit waves indicate that predicting when REITs will announce and execute their retrofit waves is complex, hindering investors from statistically timing their sustainable proposals accurately,

On the other hand, investors are not agnostic of firms' retrofitting announcements as they refrain from filing sustainable proposals when these are undoubtedly ineffective. Figure 6 Panels A and B display the occurrence of retrofit waves and sustainable and governance proposals since the start of the prior retrofit wave. One clear pattern in retrofitting waves 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 wave and there will be no new retrofit wave for at least seven quarters, we should expect them to refrain from filing any sustainable proposals in the first seven quarters after the retrofit waves. This is precisely the pattern we observe in Panel B since investors only start filing sustainable proposals ten quarters after the start of a retrofit wave. In contrast, investors file governance proposals 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 proposals and physical depreciation.

SEC rule §240.14a-8: timing shareholder proposals with retrofit announcements For legal reasons, investors cannot time their sustainable proposals even when REITs publicly announce retrofit waves. 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, giving them a direct signal of retrofit waves. However, investors cannot use these signals to better align their sustainable proposals with retrofit waves due to a mismatch in timing.

According to SEC rule 14a8 (SEC, 2020), investors need to file their proposals (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 investors should file their proxy votes to the SEC 120 days before the day they receive their ballots. These 120 days allow the SEC to check the legal nature of the proposal and for firms to withdraw the proposal and acquiesce to investors' demands preemptively. This imposes a lag of at least four months, potentially up to 12 months, between the day proposals are filed and voted on.

On the one hand, the time between retrofit announcement and retrofitting is relatively 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.[32] Due to the short-lived nature of the public retrofitting announcements and the at least four-month response period of proposals, investors will be unable to affect retrofitting decisions once REITs' retrofitting intentions become public for legal reasons.

SEC rule §240.14a-8: iterative proposals One alternative way sustainable investors could ensure they timed their sustainable proposals correctly is by filing proposals en masse at every annual meeting and time their proposals correctly by brute force. However, filing multiple proposals is an unlikely strategy to achieve proposal success for four reasons.

First, the SEC does not allow proposals on specific topics to be submitted more than four times in a row and only under strict requirements. Specifically, proposals can only be resubmitted for a second, third, and fourth time when the firm does not omit them and they

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

reached a 5%, 10%, and 25% vote in favor of the proposals at the prior annual meeting, respectively.[33] Second, filing repeated proposals is risky as it increases the likelihood of firms requesting the SEC to omit the proposal under rule 14a8(i)(4). Third, when a proposal on a specific topic by a particular investor is omitted through a no-action request at the SEC, all other investors cannot initiate a proposal on the same subject under the duplication clause in SEC rule 14a8(i)(11), and that specific investor cannot initiate proposals 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 proposals on different topics not directly (but indirectly) related to the proposal. Since the benefits from constraining a repeat issuing shareholder are greater, shareholders who file multiple proposals could face higher litigation risks.

Further, we observe a similar pattern in our data, where only 20% of engaged firms experience sustainable proposals in consecutive years. These proposals 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 proposals in a REIT are effective. Specifically, solely one REIT is successfully sustainably engaged during a retrofit wave on the fourth year of consecutive proposals (by different investors). Conversely, two REITs are repeat engaged (by different investors) and experience unsuccessful sustainable proposals during retrofit waves. For these reasons, we argue that investors are legally and practically constrained in using consecutive proposals as a strategy to time their proposals with retrofit waves through brute force.

Given the above, we argue that the timing of sustainable proposals relative to retrofit waves is random as sustainable proposals do not coincide above moderately often with retrofit waves, predicting retrofit waves is complicated due to their hazard-style occurrence, public accounting and macroeconomic variation providing little insights in retrofit timing, investors cannot act on retrofit wave announcements by REITs due to the timing of SEC shareholder proposal law and contractor agreements, investors cannot consecutively file proposals according to SEC law, and investors are unlikely to shift the timing of retrofit waves due to high costs. However, we argue the impact of proposals on retrofit waves 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 waves. 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).

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

6 Robustness checks

Now that we have shown that the timing of sustainable shareholder proposals is unrelated to the timing of retrofit waves, we further verify the validity of our results by studying property sales, conventional retrofitting activities, and REIT selection. Moreover, we replicate our entire paper and obtain similar results for manufacturing, petrochemical, and utility plants in the US, thereby generalizing our findings beyond the REIT setting. Last, Appendix F finds no effect of sustainable shareholder proposals on governance engagements as a falsification test.

6.1 Intensive or extensive margin of sustainable proposals: Property sales

We analyze whether the impact of sustainable proposals 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.[34] For this reason, we analyze whether successful sustainable proposals 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 proposals on sustainable performance. Table 6 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 proposals, respectively. We do not observe that sustainable proposals or successful sustainable proposals induce abnormal property sales regardless of retrofit waves. However, unsuccessful proposals during retrofit waves reduce 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 proposals and potentially worsen its negative consequences when proposals are unsuccessful .[35]

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

[34]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.

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

omitting the interaction terms for outside and during retrofit waves 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 proposals. Given the absence of abnormal property sales due to proposals, the low baseline level of property sales, and the persistence in sustainable retrofits after the sale, we rule out the impact of property sales on the efficacy of successful sustainable proposals in sustainable investments.

6.2 Conventional retrofits

In addition to property liquidation, the extent to which REITs alter their conventional retrofitting activities is relevant for the "additionality" of sustainable proposals in improving sustainable performance. We previously argued that proposals are exogenous of retrofit waves because these waves are driven by depreciation in the physical characteristics of properties. One consequence of physical property depreciation is that properties must be improved regardless of pressure from sustainable proposals. Therefore, if sustainable proposals 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 proposals 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 proposals during retrofit waves. However, the number of electrical retrofits could marginally increase as performing major retrofits to HVAC systems requires REITs to file additional conventional electrical retrofits. Therefore, increasing the share of sustainable retrofits in conjunction with no decrease in non-electrical conventional retrofits would provide direct evidence of the additionality of sustainable proposals in increasing sustainable investments.

Table 7 follows Equation 1 using the number of conventional retrofits as the dependent variable in Columns (1) to (3). We find that sustainable proposals increase the number of conventional retrofits by 4.79, 6.62, and 3.28 for all, successful, and unsuccessful sustainable proposals during retrofit waves, 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 proposals during retrofit waves. However, unsuccessful sustainable proposals 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 proposals on non-electrical conventional retrofits during retrofit waves. These results validate that sustainable proposals do not substantively harm REITs' conventional retrofitting efforts.

6.3 REIT selection

Where our findings show that the timing of sustainable proposals within firms matters for its impact on sustainable investments, prior studies focus on variation in the effectiveness of proposals 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., 2023).

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 proposal) 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 proposal 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 those outside 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.

6.4 Replication for US Heavily Polluting Plants

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 proposals 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 proposal datasets. Our final sample includes 692 firms, 2,295 plants, and 170,539 plant-year-chemical observations, 31,890 of which have sustainable proposals. This means that we compare the environmental impact at the level of the individual plant, assessing the yearly pollution of every chemical separately. This is equivalent to 1,818 firm-year shareholder proposals, with 1,026 sustainable proposals, 44.99% of which are successful and sustainable, and 55.01% of which are unsuccessful and sustainable.

We also employ a jump-detection algorithm to uncover retrofit waves in our TRI sample. For REITs, we have access to quarterly data and can detect jumps where the average over two quarters is higher than the average of the two quarters before plus one standard deviation. For our TRI sample, data is reported on a yearly frequency, preventing us from using the same methodology. To maintain consistency with our prior approach, we assume that retrofit waves occur within a year and adopt a two-standard-deviation threshold. This resembles the two times one standard deviation requirement we adopted using quarterly data. Furthermore, manufacturing, utility, and petrochemical plans are generally less well-maintained than the average sample of properties operated by REITs (including offices, hotels, multi-family, healthcare, and retail spaces), resulting in lower baseline permitting and larger jumps during retrofit cycles.

We replicate our main results in Table 4 for TRI plants. Table 8 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 proposals improve the sustainable property investments of manufacturing firms when being agnostic about physical depreciation waves (Column (1) in Table 8). We find that the aggregate effect of sustainable proposals on sustainable retrofits is negative when we analyze their impact during retrofit waves in Column (2). This effect combines the impact of successful and unsuccessful proposals. Since the benefits in terms of tenant satisfaction for sustainable retrofits in this sample are likely lower than for the property types operated by REITs, the consequences of unsuccessful proposals are likely pronounced, explaining the aggregate negative coefficient.[36]

In line with our primary analysis, we find that successful sustainable proposals only increase the share of sustainable retrofits during retrofit waves. 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 8). In contrast, unsuccessful sustainable proposals reduce the share of sustainable retrofits by 1.09 percentage points, or 21.41%, during retrofit waves in Column (4). Finding that stainable proposals spur sustainable investments in the heavily polluting manufacturing sector during retrofit waves 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 perfromance. 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

[36]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.

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 9.

In Column (1), we utilize EPA pollution prevention data to demonstrate that sustainable retrofits are associated with a higher number of pollution prevention activities. These activities suggest that sustainable proposals catalyze investments substantial enough to be reported to the EPA. However, some of these reported actions may reflect abatement efforts unrelated to real estate, such as changes tied to firms' production processes or chemical use. Examples include redesigned chemical packaging, leak-detection systems, enhanced labeling and shelf-life controls, preventive maintenance protocols, and operator certification programs.

We address this concern with two falsification analyses. The EPA distinguishes between three types of prevention activities: chemical use or process improvements that should be unrelated to sustainable retrofitting, and the handling of materials, which are more closely aligned with how firms operate their properties. Per this intuition, material handling pollution prevention activities are positively associated with sustainable retrofitting (Column (2)), whereas chemical use or process improvements are not (Column (3 and 4)).

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 proposals during retrofit waves decrease the likelihood of EPA penalties by 1.49% through initiating sustainable retrofits, see the footnote for a detailed computation of this effect.[37] With pollution prevention being costly and fines averaging 2.1 million dollars, sustainable proposals positively influence the sustainable investments of even the heaviest polluters in the US.[38]

These analyses demonstrate that our results extend beyond the listed real estate setting to other assets, such as heavy manufacturing plants. In theory, accurately timing sustainable proposals plays a critical role in any physical long-lived asset due to the occurrence of depreciation cycles and the real-option structure associated with delaying renovations (Mauer and Ott, 1995; Cooper and Haltiwanger, 2006; Livdan and Nezlobin, 2021). Therefore, our results suggest that accurately timing sustainable proposals to coincide with the physical depreciation waves of real assets can play an essential role in steering sustainable investments.

[37] Sustainable proposals increase the share of sustainable retrofits by 7.59 percentage points (Table 8, 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.

[38] 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.

7 Conclusion

This paper provides evidence that sustainable proposals improve firms' sustainable investments only when their 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 proposals reduce the intensive margin of sustainable investments through sustainable retrofits when their timing aligns with the physical deprecation of assets. In contrast, unsuccessful sustainable proposals curtail firms' sustainable investments. These results persist when correcting for governance proposals, 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 proposals pose an effective tool to improve firms' sustainable investments when accurately aligned with the depreciation waves of their physical assets.

These results should extend to other long-term assets. The extent to which the timing of investors' pressure matters for engagement effectiveness in the real estate market arises from the costs associated with replacing or retrofitting a non-depreciated asset. This pattern exists beyond the real estate market and directly relates to asset lifespan. When assets have a long duration, such as intangible assets, equipment, or vehicles, timing is similarly critical.

Furthermore, our results should also apply to other forms of investor engagement given their transitory nature. Alongside shareholder proposals, investors can privately engage with management or try to attain board seats. For private engagement, timing is similarly critical when assuming imperfect managerial memory, and its ability to shift decisions is short-lived. However, there are fewer timing constraints on private engagement, making it easier to align timing with depreciation cycles. Our mechanism is present but less potent for attaining board seats. Board members often serve for multiple years as directors. Even though their expected term might be shorter than asset lifespans, the likelihood of a board member aligning with an extensive retrofit or investment event is more likely, as they are less transient.

Last, our results suggest that the literature likely underestimates the impact of sustainable financing mechanisms by being agnostic on their synchronization with depreciation waves. Without controlling for depreciation waves, we do not observe an effect of shareholder proposals on sustainable permit issuance. By omitting information on when firms face pivotal sustainability decisions, the prior literature on sustainable financing mechanisms, such as divestment, portfolio tilting, engagement, or shareholder proposals, is likely to similarly underestimate its impact (Akey and Appel, 2019; Krueger, Sautner and Starks, 2020; Azar et al., 2021; Naaraayanan et al., 2021; Busch et al., 2023; Gantchev et al., 2022; Gibson Brandon et al., 2022; Heath et al., 2023; Li et al., 2023; Bams and van der Kroft, 2025). This effect is likely pronounced as theoretical models studying these mechanisms almost exclusively assume such a pivotal sustainable investment decision (Pástor et al., 2021; Broccardo et al., 2022; Edmans et al., 2022; Pástor et al., 2023; Oehmke and Opp, 2024).

Continuing this thought, accurately timing sustainable investment pressure as investors can similarly amplify its impact. For instance, 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). Getting this timing right is of first-order importance in attaining net-zero emissions by 2050, as missed opportunities 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).

One area for future research is uncovering the mechanisms behind the impact of shareholder proposals on sustainable performance. On the one hand, proposals could function as information provision to management or signal investors' willingness to pay for sustainability (see Pástor et al., 2021; Broccardo et al., 2022; Oehmke and Opp, 2024). On the other hand, proposals could be paired with investors directly willing to sacrifice returns and provide equity or debt at lower capital costs to firms.[39] In other words, investors may strategically target firms with sustainable projects that have a positive NPV (Dimson et al., 2015; Busch et al., 2023; He et al., 2023). Are engaging investors not having an effect, but just following sustainable improvements that would have happened anyway? Do they provide crucial information on the profitability of sustainable initiatives that trigger firms to adopt additional projects by shifting managerial attention or aggregating information during voting? Do proposals signal the extent to which sustainable investors are willing to reduce capital costs for sustainability reasons, enabling firms to take on previously negative NPV projects? Are proposals a concealed threat of exit, and do firms feel compelled to implement sustainable projects? Do investors credibly signal that they can instigate reputational damage when firms do not comply? Validating any of the above mechanisms might help explain the effectiveness of proposals and further our understanding of how sustainable investors can use their capital to improve firms' environmental and social performance. Unfortunately, our identification strategy is not suited to disentangle the capital cost mechanism from the information provision one.

[39] To provide the reader with some initial and far from complete indication of which mechanisms could play a role, we performed a rudimentary analysis of the correlation between successful proposals and capital costs. We computed firms' cost of equity by replicating the cost of equity measures of Gebhardt et al. (2001), Hou et al. (2012), Fama and French (2015), and Chattopadhyay et al. (2022), following Lee et al. (2021). We computed the cost of debt using firms' duration- and value-weighted bond yields and interest expenses. Further, we employed a 30% tax rate and Compustat book-value equity and total liability data to compute their cost of capital. Using an identical specification as when assessing how sustainable proposals affect firms' sustainable decision-making, we observe an insignificant 11 basis point reduction in the change in firms' capital costs for successful proposals, somewhat aligned with the cost of capital perspective. We leave a cleaner identification of the mechanism behind proposals to future research and thank Brooke Wang for suggesting this.

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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 multi-family), 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 proposals, sustainable investments, and physical depreciation

This table regresses the impact of sustainable proposals 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. Wave represents a dummy variable equal to 1 in the three quarters during which REITs experience retrofit waves and 0 in the three quarters before or after these waves. Sustainable proposal is a dummy variable that indicates whether a REIT experiences a sustainable proposal. In Columns (2) to (4), we estimate the impact of sustainable proposals, successful sustainable proposals, and unsuccessful sustainable proposals conditional on the occurrence of retrofit waves. Observations with unsuccessful and successful proposals have been removed from Columns (3) and (4) to allow for a fair comparison of the impact of successful and unsuccessful sustainable proposals. 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 wave 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 proposals during retrofit waves compared to no proposals outside retrofit waves. This equates to adding the estimated coefficients of the wave, sustainable proposals, and interaction terms. Standard errors clustered at retrofit wave level in parentheses. ***, **, and * denotes significance at the 1%, 5%, and 10% level.

	Share sustainable permits (%)			
VARIABLES	(1)	(2)	(3)	(4)
Sustainable Proposal	-1.223	-4.992***		
	(4.781)	(0.656)		
Wave X Sustainable Proposal		9.902***		
		(1.323)		
Sustainable Proposal successful			-3.191***	
			(0.919)	
Wave X Sustainable Proposal successful			17.528***	
			(1.136)	
Sustainable Proposal unsuccessful				-5.631***
				(0.661)
Wave X Sustainable Proposal unsuccessful				-0.961
				(4.671)
Wave	-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 Proposal during wave (%)	-	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 waves with public information

This table regresses indicators of property depreciation, vacancy rates, and macroeconomic conditions on retrofit waves and sustainable proposals. 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 waves, and the dependent variable in Columns (4) to (6) indicates sustainable proposals 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 waves			Sustainable proposals		
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: The extensive margin of sustainable proposals

This table analyzes the impact of sustainable proposals 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 wave level in parentheses. ***, **, and * denotes significance at the 1%, 5%, and 10% level.

	Sold (%)			Sustainable retrofits after sale (%)
VARIABLES	(1)	(2)	(3)	(4)
Sustainable Proposal	0.843*			
	(0.468)			
Wave X Sustainable Proposal	-0.153			
	(0.692)			
Sustainable Proposal successful		1.837		-7.339
		(2.838)		(13.703)
Wave X Sust. Proposal successful		-0.141		
		(2.926)		
Sustainable Proposal unsuccessful			0.625***	-10.321
			(0.092)	(6.865)
Wave X Sust. Proposal unsuccessful			-0.991***	
			(0.271)	
Wave	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 7: Conventional retrofitting during sustainable proposals

This table regresses all, successful, and unsuccessful sustainable proposals specifications during and outside retrofit waves 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 proposals 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 wave 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 Proposal	-4.128***			-3.002**			-1.126***		
	(0.925)			(1.321)			(0.397)		
Wave X Sustainable Proposal	8.922***			6.098***			2.824*		
	(1.635)			(0.123)			(1.512)		
Sustainable Proposal successful		-4.122***			-3.964**			-0.158	
		(0.541)			(1.736)			(1.195)	
Wave X Sustainable Proposal successful		10.740***			9.410***			1.330	
		(2.118)			(0.271)			(2.389)	
Sustainable Proposal unsuccessful			-4.094***			-2.801			-1.293
			(1.083)			(1.815)			(0.733)
Wave X Sustainable Proposal unsuccessful			7.376***			3.835**			3.541*
			(0.130)			(1.821)			(1.951)
Wave	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 8: Heavy polluters, sustainable proposals, retrofit waves, 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. Wave represents a dummy variable equal to 1 in the year during which plants experience retrofits two standard deviations above their firms' mean. Sustainable proposals is a dummy variable that indicates whether firms operating production facilities experience sustainable proposals. Periods with both unsuccessful and successful proposals 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 Proposal	0.041	0.193		
	(0.270)	(0.281)		
Wave X Sustainable Proposal		-2.655***		
		(0.712)		
Sustainable Proposal successful			0.259	
			(0.372)	
Wave X Sustainable Proposal successful			5.160***	
			(1.903)	
Sustainable Proposal failed				-0.713*
				(0.402)
Wave X Sustainable Proposal failed				-2.725***
				(0.935)
Wave	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 Proposal during wave (%)	-	-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 9: 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.

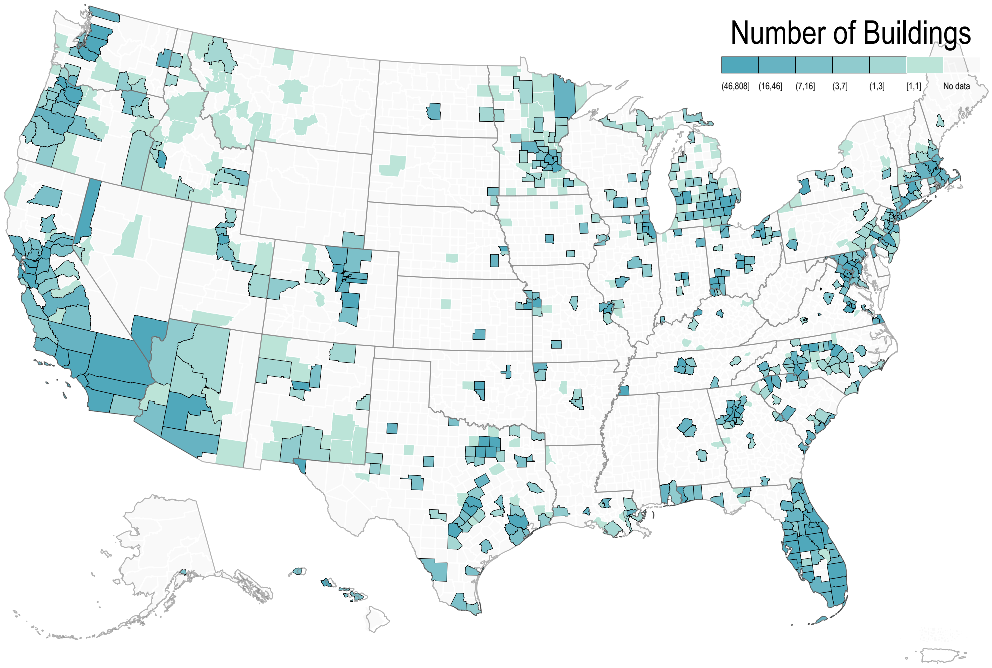


Figure 2: Duration of retrofit waves

Figure 2 shows the average time between when a permit is filed 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.

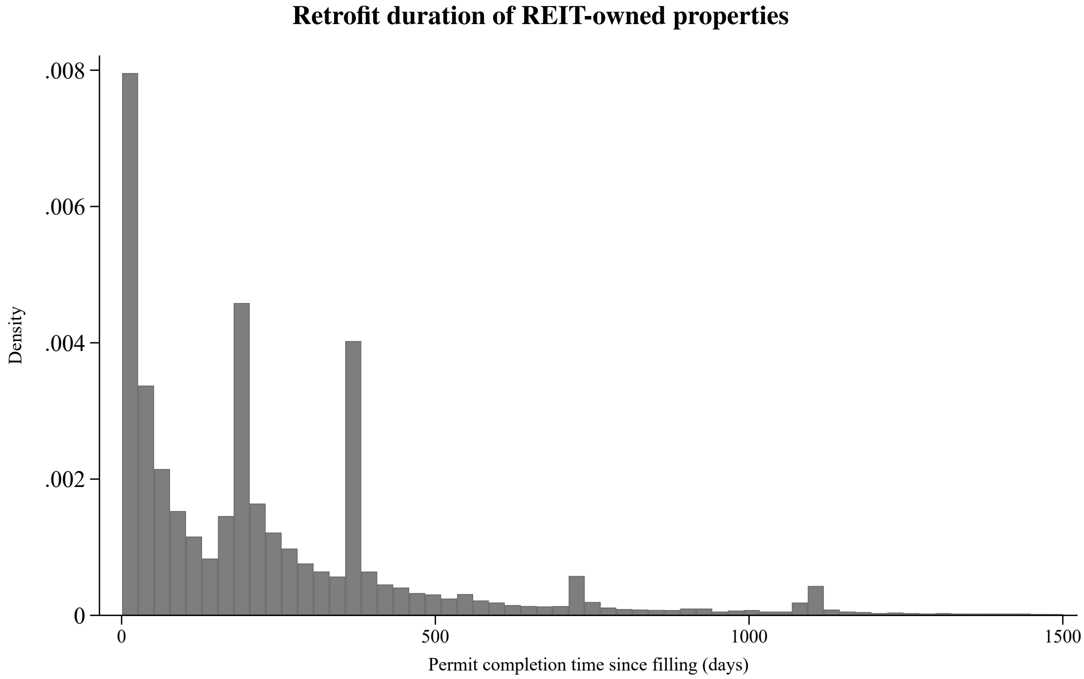


Figure 3: Sustainable proposals, sustainable investments, and retrofit waves

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

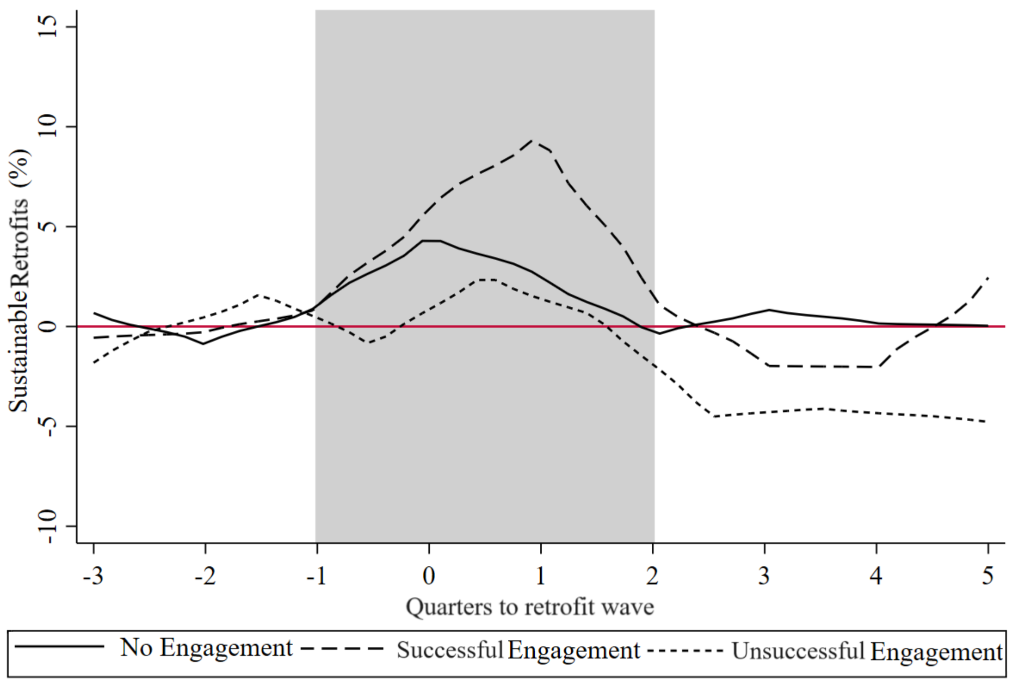


Figure 4: Do proposals predict retrofit waves?

Figure 4 shows that proposals have no predictive power over the timing of retrofit waves. The x-axis represents lags and leads in proposals 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 proposal. Period $q-1$ is removed as a reference category. The y-axis represents the probability of retrofit waves.

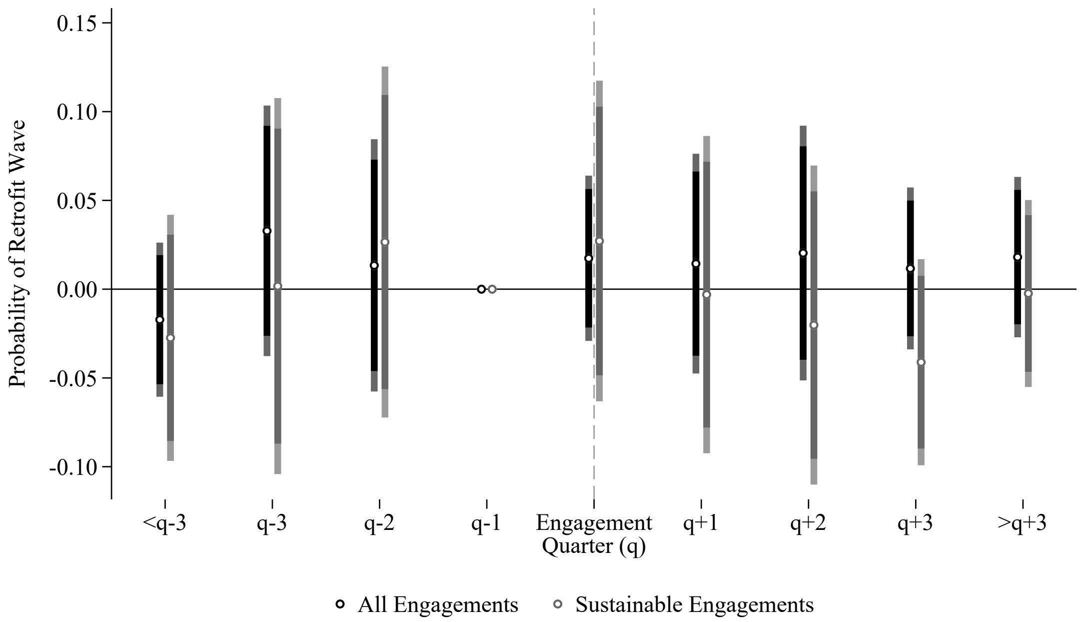


Figure 5: Timing of retrofit waves

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

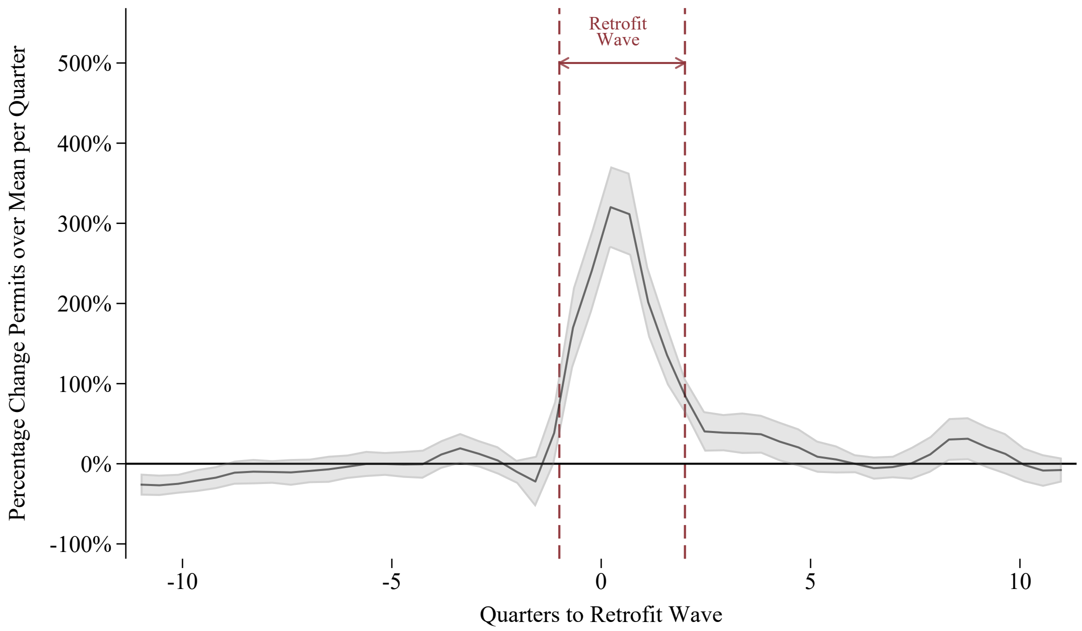
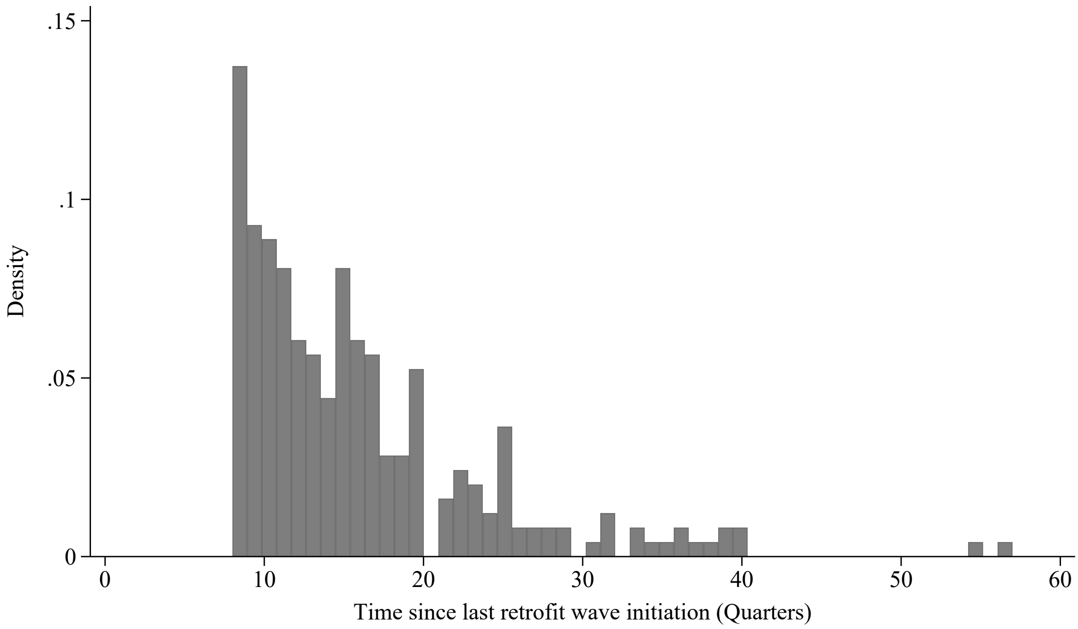


Figure 6: (Lack of) predictability in retrofit waves

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

Panel A: Time between retrofit waves



Panel B: proposals after retrofit waves

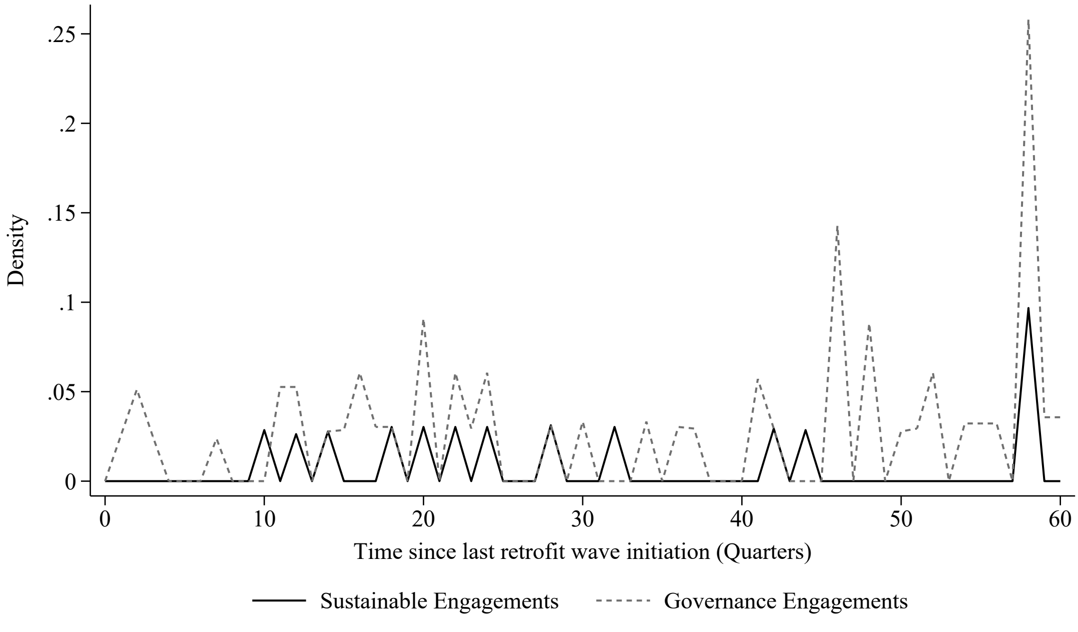
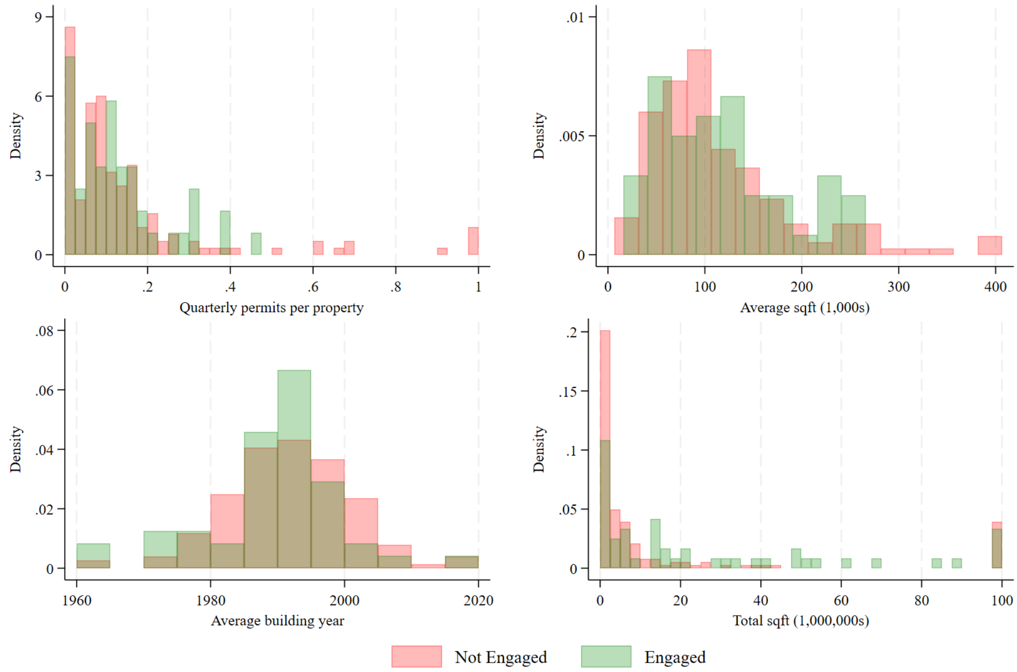


Figure 7: No proposals selection of REITs

Figure 7 shows that there is little selection across engaged and non-engaged REITs. We display multiple property characteristics before the first proposal 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

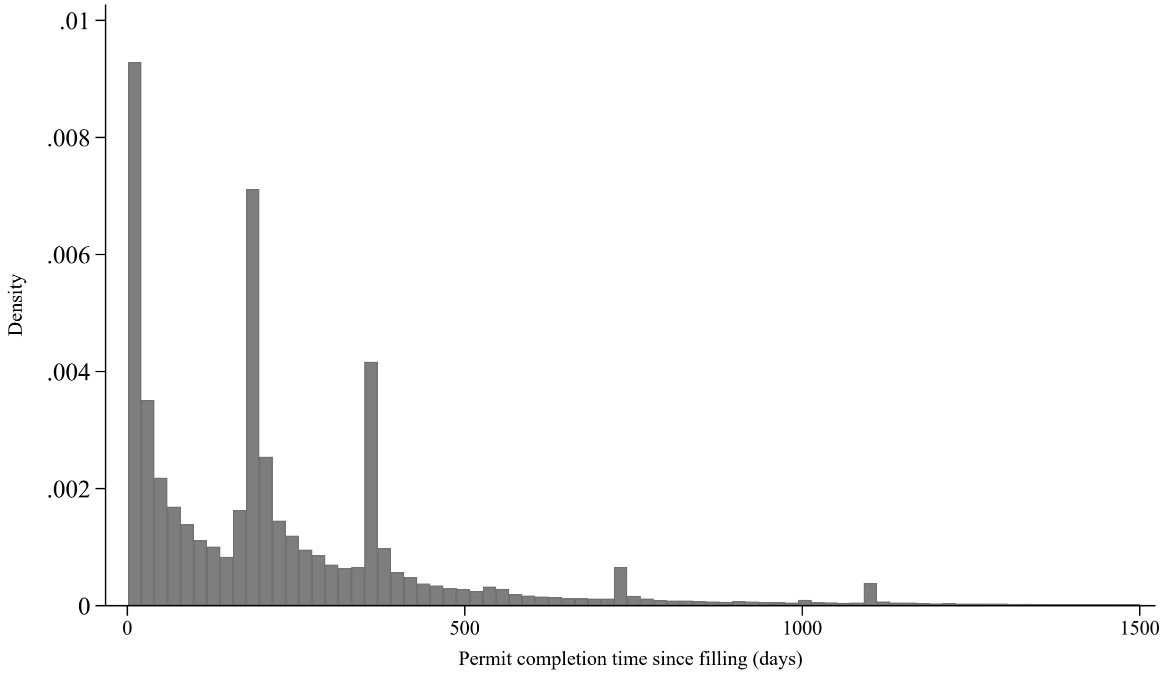
In this Appendix, we provide further information on the permit completion time. It could be the case that permit completion times differ for the REIT sample from the entire US population. On the one hand, REITs perform much more extensive retrofits on a significantly larger scale, such as improving the 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.

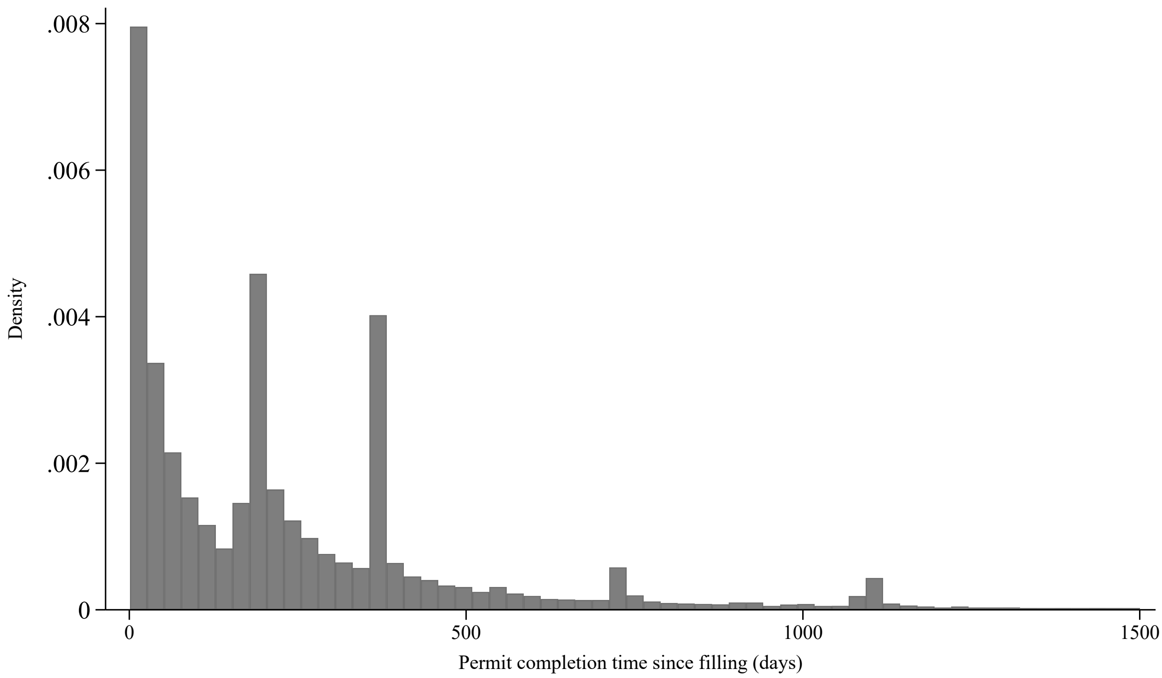
Figure B1: Duration of retrofit waves

Figure B1 Panels A and B show the average time between when a permit is filed 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 waves is paramount for the reliability of our findings, as we use the timing of these waves to detect the impact of sustainable proposals on sustainable investments. We strive to be as accurate as possible in detecting retrofit waves 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 waves, as there is no pre-defined approach in the literature. To alleviate concerns that the choice of retrofit wave detection algorithm drives our results, we provide 35 alternative retrofit wave detection approaches and validate our findings. This Appendix shows that substantial deviations in our retrofit wave detection algorithm result in limited differences in detected retrofit waves across REITs. Moreover, we reproduce Table 5 and find that different wave detection strategies produce similar results.

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

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

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 wave starting point. The retrofit wave algorithm that best fits our data uses three-quarter retrofit wave lengths, a two-lag identification period (q=2), and a one standard deviation jump threshold ($Threshold_i = \sigma$). To validate robustness, we deviate our detection by varying the retrofit wave length, the number of lags used to observe jumps in permits, and the threshold that classifies jumps in permits as initiations of retrofit waves.

The first way in which we deviate our detection strategy is by employing retrofit wave lengths of two, three, and four quarters. The length of retrofit waves 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 waves are relatively short, as fewer quarters are classified as retrofit waves. However, having shorter retrofit wave windows increases the odds of type one errors in correctly identifying retrofit waves. The inverse is true for using broader retrofit wave lengths. Incorrectly detecting the start of retrofit waves could affect our results as we would classify during retrofit proposals as outside retrofit wave proposals and vice versa. We use retrofit wave 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 waves. Since we argue that retrofit waves represent sharp increases in the number of permits and using one lag ($q = 1$) overidentifies insufficiently persistent permit jumps as retrofit waves, 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 wave 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 waves. 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 waves. Introducing these false positives would underestimate the true impact of sustainable proposals during retrofit waves on sustainable permits. In contrast, thresholds that are too stringent might detect only the most prominent retrofit waves and could lead to overestimated and selective results. To validate the persistence of detected retrofit waves 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 wave 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 wave 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 wave 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 waves. Since sudden jumps in permits characterize retrofit waves, 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 waves. Last, the 35 robustness specifications are also strongly correlated with each other, indicating at least a common trend in the detection of retrofit waves regardless of specification.

Table C1: Correlation matrix of alternative retrofit wave 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 waves 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 waves 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 proposals are primarily effective in promoting sustainable retrofitting during retrofit waves. To accommodate this, we choose a relatively constrictive event window to measure the effects of proposals surrounding retrofit waves. 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 proposals 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 proposals on the share of sustainable permits. These analyses indicate that the timing of successful sustainable proposals 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 proposals during retrofit waves on the share of sustainable permits. For all, successful and unsuccessful proposals during retrofit waves, 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 proposals 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 proposals 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 proposal demands since they face higher transition risks.[40] 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 proposals during retrofit waves.

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

In Columns (3) and (4), we validate our results by showing that REITs issue more sustainable permits during retrofit waves under stringent energy requirements. In Panel A Columns (3) and (4), we find that the impact of sustainable proposals during retrofit waves 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, proposals increase sustainable permits by 6.08 percentage points under stringent energy requirements and even reduce 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 proposals. Specifically, successful sustainable proposals during retrofit waves increase the share of sustainable permits by 19.50 percentage points in highly energy-regulated properties and reduce the share of sustainable permits by 9.43 percentage points in less stringently regulated environments. For unsuccessful sustainable proposals, 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 waves in democratic states. Like the energy code analysis, we find significantly lower sustainable permit issuance for properties in red states during sustainable proposals. This effect is mirrored in successful and unsuccessful sustainable proposals during retrofit waves, as the share of sustainable permits increases is approximately double for successful proposals in blue states as opposed to red states. Similarly, when proposals are unsuccessful, sustainable permit issuance declines more strongly in red states than in blue states. These two heterogeneity analyses align with the logic of our main results and support that successful sustainable proposals improve sustainable investments, while unsuccessful proposals increase externalities.

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

We observe a somewhat more grim representation of the impact of proposals on sustainable permits across treatment duration. In Columns (7) and (8) of Panel A, we find that sustainable proposals during retrofit waves reduce the share of sustainable permits by 3.83 and 2.48 percentage points, contrasting the positive impact of proposals depicted in Table 4. For successful sustainable proposals during retrofit waves, 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 proposals on the share of sustainable 13.33 and 13.95 percentage points increases in Column (2) and Table 4. For unsuccessful sustainable proposals during retrofit waves, 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 proposals 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 proposals, successful sustainable proposals, and unsuccessful sustainable proposals, 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 proposals on sustainable permits unconditional to retrofit waves. 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 proposals and REITs who experience sustainable proposals during retrofit waves remain treated after the retrofit wave until the end of the sample.

Panel A: All Sustainable Proposals

VARIABLES	(1) All	(2) All	(3) Stringent energy code	(4) Loose energy code	(5) Blue	(6) Red	(7) All	(8) All
Sustainable Proposal	-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)
wave X Sustainable Proposal		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)
wave	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 Proposals

VARIABLES	(1) All	(2) All	(3) Stringent energy code	(4) Loose energy code	(5) Blue	(6) Red	(7) All	(8) All
Sustainable Proposal 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)
wave X Sustainable Proposal 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)
wave	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 Proposals

VARIABLES	(1) All	(2) All	(3) Stringent energy code	(4) Loose energy code	(5) Blue	(6) Red	(7) All	(8) All
Sustainable Proposal 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)
wave X Sustainable Proposal 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)
wave	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 waves and proposal success

This Appendix displays the regression Tables of Figure 4 and analyzes whether proposal success is more likely when it occurs during retrofit waves. In Table E1, we regress contemporaneous, lagged, and lead public proposals specifications on the occurrence of retrofit waves. In Columns (1) to (3), we respectively consider all proposals, governance proposals, and sustainable proposals. The dependent variable is a dummy that indicates whether a retrofit wave occurs at this point in time. The timestamps $_{t-4+}$ and $_{t+4+}$ indicate a dummy variable that captures proposals 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 proposals has no predictive power over the timing of retrofit waves.

Next, we analyze whether proposals, governance proposals, and sustainable proposals are more likely successful during retrofit waves. One small concern for our empirical setting is that the effect of sustainable proposals are slightly overestimated if the likelihood of success is higher during retrofit waves. Specifically, when more proposals are successful and such proposals 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 proposals in our main analysis, we provide evidence that sustainable proposals are not more likely to succeed during retrofit waves in Figure E1 and Table E2.

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

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 proposal 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 proposals on retrofits over the years. This suggests that investors do not learn from the misalignment of sustainable proposals with firms' depreciation of real assets.

Table E1: proposals do not predict retrofit waves

This table regresses contemporaneous, lagged, and lead proposals specifications on the occurrence of retrofit waves. In Columns (1) to (3), we respectively consider all proposals, governance proposals, and sustainable proposals. The dependent variable is a dummy that indicates whether a retrofit wave 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)
$Proposal_{<q-3}$	-0.001	-0.024	0.007
	(0.021)	(0.035)	(0.019)
$Proposal_{q-3}$	0.028	-0.002	0.027
	(0.035)	(0.055)	(0.031)
$Proposal_{q-2}$	-0.006	0.003	-0.021
	(0.029)	(0.046)	(0.027)
$Proposal_{q}$	-0.010	0.020	-0.029
	(0.023)	(0.047)	(0.026)
$Proposal_{q+1}$	0.030	0.014	0.037
	(0.031)	(0.050)	(0.034)
$Proposal_{q+2}$	0.021	-0.022	0.034
	(0.033)	(0.047)	(0.041)
$Proposal_{q+3}$	0.023	-0.049	0.050
	(0.027)	(0.030)	(0.032)
$Proposal_{>q+3}$	0.021	-0.007	0.037*
	(0.021)	(0.024)	(0.022)
Proposal 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 Proposals during Retrofit waves more Successful?

Figure E1 shows that proposals during retrofit waves are not more successful. The x-axis represents lags and leads in retrofit waves 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 waves at any point in time more than a year ago or more than a year after the proposal. Period $q-1$ is removed as a reference category. The y-axis represents the probability of successful proposals.

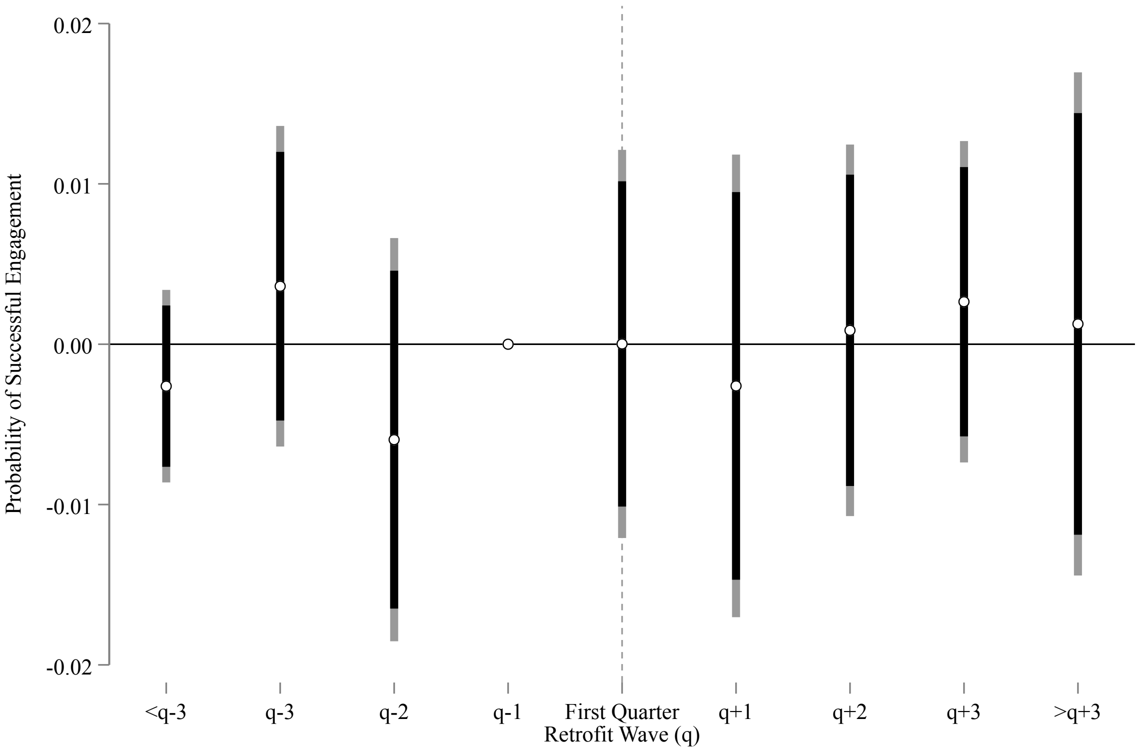


Table E2: Proposals success and retrofit waves

This table regresses contemporaneous, lagged, and lead retrofit wave indicators on successful proposals. In Columns (1) to (3), we respectively consider the probability of a REIT experiencing successful proposals, successful governance proposals, and successful sustainable proposals. 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)
$Wave_{<q-3}$	-0.002	0.001	-0.002
	(0.003)	(0.003)	(0.002)
$Wave_{q-3}$	0.006	0.007	-0.001
	(0.005)	(0.005)	(0.001)
$Wave_{q-2}$	-0.003	-0.001	-0.002
	(0.007)	(0.007)	(0.002)
$Wave_{q}$	-0.000	-0.000	-0.000
	(0.006)	(0.006)	(0.002)
$Wave_{q+1}$	-0.000	-0.000	-0.000
	(0.007)	(0.006)	(0.003)
$Wave_{q+2}$	-0.003	-0.003	0.000
	(0.006)	(0.005)	(0.003)
$Wave_{q+3}$	0.005	0.006	-0.000
	(0.006)	(0.005)	(0.001)
$Wave_{>q+3}$	0.004	0.004	-0.000
	(0.006)	(0.005)	(0.002)
Proposal 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 proposals and retrofit waves

This table verifies whether sustainable proposals coincide with retrofit waves more frequently over time. We do so by regressing contemporaneous proposals 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 wave 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 proposals, governance proposals, and sustainable proposals. We explicitly remove time fixed effects to allow our model to better capture investors' ability to file sustainable proposals that coincide with retrofit waves over time. REIT-level clustered standard errors are given in parentheses. ***, **, and * denotes significance at the 1%, 5%, and 10% level.

VARIABLES	(1) Wave	(2) Wave	(3) Wave
$Year = 2006-2011$	-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)
$Proposal_t$	0.013	-0.028	-0.003
	(0.020)	(0.043)	(0.004)
$Proposal_t$ X $Year = 2012-2017$	-0.036	0.005	0.102
	(0.056)	(0.007)	(0.127)
$Proposal_t$ X $Year = 2018-2022$	-0.051	-0.002	-0.021
	(0.092)	(0.012)	(0.047)
Proposal 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

Appendix F Governance Proposals

In addition to sustainable proposals, 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 proposals should have a significantly lower impact than sustainable proposals on sustainable retrofitting as they address different issues.[41] Therefore, governance proposals pose a falsification test for the impact of sustainable proposals on sustainable investments during retrofit waves.

Table F1 presents the estimated impact of governance proposals on sustainable retrofits. Column (1) estimates the effect of governance proposals 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 governance proposals outside retrofit waves. Further, we see an insignificant decrease in sustainable retrofits when governance proposals coincide with retrofit waves. Since governance proposals 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 proposals during retrofit waves. Even though the impact of governance proposals are negligible, we explicitly test whether introducing outside and during retrofit wave governance proposals in Columns (2) to (5) affects our results. Across these specifications, we observe a random pattern in the estimated coefficient of governance proposals during or outside retrofit waves, indicating that its effect is highly unstable (as is desirable for a falsification analysis).

However, we still observe that sustainable proposals do not significantly affect REITs' share of sustainable retrofits unconditionally on the occurrence of retrofit waves after controlling the impact of governance proposals in Column (3). Further, the impact of sustainable proposals conditional on retrofit waves 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 waves for successful and unsuccessful sustainable proposals, 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 proposals on sustainable retrofits is not driven by investors steering on sustainability through governance proposals.

[41]The economic impact of governance proposals 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 proposals.

Table F1: Governance vs sustainable proposals

This table provides a falsification analysis of the impact of sustainable proposals on sustainable retrofitting by considering the impact of governance proposals. In Column (1), we regress governance proposals outside and during retrofit waves on the share of sustainable retrofits. In Columns (2) to (5), we replicate the results of Table 4 when explicitly correcting for governance proposals. 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 proposals during retrofit waves compared to no proposals outside retrofit waves. This equates to adding the estimated coefficients of the wave, sustainable proposals, and interaction terms. Standard errors clustered at retrofit wave level in parentheses. ***, **, and * denotes significance at the 1%, 5%, and 10% level.

	Share sustainable permits (%)				
VARIABLES	(1)	(2)	(3)	(4)	(5)
Governance Proposal	-0.835**	-0.792***	-0.199	-0.793*	-0.408
	(0.345)	(0.201)	(0.425)	(0.465)	(0.341)
Wave X Governance Proposal	-0.503	-0.539	-1.310***	-1.029***	-0.023
	(0.326)	(0.126)	(0.320)	(0.349)	(0.582)
Sustainable Proposal		-0.350	-4.710***		
		(4.411)	(0.164)		
Wave X Sustainable Proposal			9.788***		
			(0.535)		
Sustainable Proposal successful				-2.737***	
				(0.534)	
Wave X Sustainable Proposal successful				17.435***	
				(1.565)	
Sustainable Proposal unsuccessful					-4.822***
					(0.024)
Wave X Sust. Proposal unsuccessful					0.129
					(3.992)
Wave	-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 Proposal during wave (%)	-	-	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