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Inside the Blackbox of Firm Environmental Efforts: Evidence from Emissions Reduction Initiatives

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Abstract

Using project-level data from the Carbon Disclosure Project, we demonstrate how firms actually reduce greenhouse gas emissions. Most firms mainly pursue projects with small investments (median $127,000) and short payback periods (maximum three years). Firms experiencing short-term performance pressure, smaller in size, and with shorter decarbonization horizons are more likely to implement such projects. Short-term projects focus on energy efficiency (e.g., LED upgrades) rather than involving transformative technology. They yield more expected annual carbon dioxide (CO2) and monetary savings and have greater NPVs than the average longer-term project, but exhibit lower total CO2 savings over the projects' lifetime. Firms with a greater share of short-term projects exhibit higher future environmental ratings, but it is a combination of short- and long-term projects that generates the most expected CO2 savings. Our evidence suggests that typical firm climate engagements are neither costly nor long-term oriented. In sum, firms tend to mitigate rather than adapt to climate change.

Keywords: Climate change; Corporate greenhouse gas emissions reduction initiatives; Environmental investment decisions; ESG ratings; Financial incentives; Investment horizon

JEL: D25; D62; G30; M41; Q54

1. INTRODUCTION

Climate change stands as a critical concern, posing an imminent threat to both global ecosystems and human societies. The primary drivers of climate change are greenhouse gas (GHG) emissions, largely stemming from industrial activities. As a result, firms are under escalating pressure to mitigate emissions and take an active role in combating climate change. Against this backdrop, a growing number of firms are actively committing to emissions reduction initiatives, such as Climate Action 100+ and the Science-based Targets Initiative. Concurrently, there is a notable uptick in participation in disclosure initiatives, including the Task Force on Climate-related Financial Disclosures (TCFD) and the Carbon Disclosure Project (CDP). The widespread adoption of these initiatives underscores a heightened awareness among both firm executives and investors regarding the far-reaching climate impacts of corporate decisions. However, despite this surge in awareness and commitment, there remains a notable gap in our understanding of the specific ways in which firms achieve reductions in GHG emissions and whether such initiatives are effective.

In this paper, we fill this gap and provide the first systematic and comprehensive evidence on what firms actually do to reduce GHG emissions. We examine project-level data sourced from firms' voluntary disclosure in the CDP that detail the spectrum of environmental projects involved—ranging from LED upgrades to transitions toward low-carbon energy production. This disclosure contains crucial information regarding the actual efforts that firms undertake to reduce emissions, including the investment amount, projected payback period, and expected carbon dioxide equivalent (henceforth "CO2") savings for each project. Our analysis centers on scrutinizing the nature of projects that firms choose for emissions reduction. Our particular focus and empirical strategy are on discerning whether firms exhibit a preference for short-term or long-term projects in their emissions reduction endeavors.

It is ex-ante unclear whether firms would prefer short-term emissions reduction projects (e.g., LED upgrades and process optimization) or long-term projects involving transformative actions (e.g., gradual machine replacements and transition to low-carbon energy production) that take time to fruition (Flammer, Hong, and Minor, 2019; Berrone and Gomez-Mejia, 2009). On the one hand, there are reasons to expect firms to gravitate towards short-term projects. First, managers typically have short horizons (i.e., the median CEO departs after 6 years) and face considerable risk of early turnover (e.g., Brochet, Limbach, Schmid, and Scholz-Daneshgari, 2021; Ali and Zhang, 2015; Allgood and Farrell, 2003). Thus, they are likely enticed by the prospect of quick financial and environmental results achievable with relatively modest amounts of investments. Market pressure to promptly generate earnings or improve ESG ratings may further amplify this inclination, and so may managers' reputational concerns (e.g., Hirshleifer, 1993; Narayanan, 1985). Second, managers claim that information available for them to make corporate investment plans is usually reliable only for a couple of years (Graham 2022). As a result, they may prefer projects with a short horizon, which exhibit less uncertainty. Third, given that managers frequently base capital budgeting decisions on the payback rule[1], which makes short-term projects overly attractive by ignoring more distant cash flows, firms may choose projects with quick returns. Lastly, firms may choose projects that yield short-term results to meet the decarbonization commitments they have made, especially if they already set forth ambitious goals and do not have much time left to meet their pledge. This is plausible given that 50% of corporate pledges specify target dates that are less than five years away (Aldy, Bolton, Kacperczyk, and Halem, 2023).

On the other hand, there are reasons to expect firms to invest in long-term oriented emissions reduction projects. First, long-term transformative actions are likely to achieve the most

[1] According to various studies (e.g., Graham, 2022; Graham and Harvey, 2001; Moore and Reichert, 1983), between 57% and 80% of U.S. firms' executives frequently use the payback rule.

emissions reductions needed for a proper transition (Paulson, 2015; United Nations, n.d.), thereby sustainably decreasing exposure to carbon-transition risk (Bolton and Kacperczyk, 2023). If so, managers who are committed to achieving the most reduction in emissions may choose longer term projects, even if they take time before showing any material results. Second and related, some of these long-term projects, such as investments in more efficient machines or solar energy, could significantly reduce firms' costs (e.g., for energy or carbon offsets), including potential costs of future environmental regulations. Third, embracing costly long-term projects may find favor among firms pursuing strategic environmental responsibility (Flammer and Bansal, 2017) as it reflects a proactive commitment to achieve long-term sustainability goals (Gillingham and Stock, 2018; Lys, Naughton and Wang, 2015). As a result, undertaking more long-term projects may improve firms' access to capital by attracting investors that incorporate climate risks in their investment decisions (Cheng, Ioannou, and Serafeim, 2014; Krueger, Sautner, and Starks, 2020), may constitute a credible response to investor engagement (Azar, Duro, Kadach, and Ormazabal, 2021), and enhance firms' reputation towards employees and customers that prefer the products of socially responsible businesses (Houston, Lin, Shan, and Shen, 2023).

Given the above tension, it is thus unclear how exactly and over which horizon firms invest to lower GHG emissions and improve their environmental performance. To test for this, we use the CDP data of 455 large public U.S. firms. Our interest is on the largest firms in the largest capital market in the world, because these firms are a significant contributor of global emissions.[2] The dataset covers 9,937 projects reported in the 2013-2022 CDP questionnaires for which information on payback periods as well as firms' reported emissions and targets are available.

[2] While precise percentage varies across the estimating entity, Standard & Poor's estimates S&P 500 companies' emissions to be equivalent to the total produced in France, Germany, and the U.K. combined, underscoring the significance of our sample (S&P Dow Jones Indices, 2016).

We examine project-year level panel data and show that the majority of firms choose projects that have payback periods of three years or less (henceforth "short-term projects") and that require small investments.[3] Particularly, 63% of all projects have a payback period of at most three years, while only 10% have payback periods exceeding ten years. A median of 67% of all projects that firms implement each year are short-term, and firms exclusively implement short-term projects in 34% of all firm-years. While a small group of firms make a sizable amount of investment, we find that most firms only take on a few projects that require a small amount of investment. For example, a median firm engages in three projects per year and invests a median amount of $127,000 per project. Firms' annual total investments in emissions reduction projects amount to about 1% of their concurrent capital expenditures and 0.2% of last year's net income. Furthermore, 74% of all projects target energy efficiency in buildings or production, while only 9% involve low-carbon energy consumption or generation.

We conduct cross-sectional tests to understand which firms are more or less likely to take on short-term projects. We find that firms subject to short-term performance pressure as well as those with a need to achieve GHG emissions reductions in the near term are more likely to choose short-term projects. In particular, firms are significantly more likely to implement short-term projects (1) if a greater fraction of their shares are held short or if they are less profitable, and (2) if they grant themselves less time to achieve their own emissions targets. We further find that firms subject to more environmental scrutiny and pressure to sustainably manage their climate risks to adapt to climate change are less likely to choose short-term projects. Specifically, large firms and

[3] We consider both projects' payback and NPV. However, we focus on payback for two reasons. First, Graham (2022) concludes that despite its deficiencies, many firms *"rely more heavily on payback than on NPV in capital allocation"* (p. 1979). Second, firms do not report NPVs in the CDP, and also data on overall project lifetime is not available for all projects. We thus have to make assumptions and estimate NPVs.

those listed in the S&P 500 index are significantly less likely to implement short-term projects. Azar et al. (2021) find that these firms are the primary targets of investors' climate engagement.

To understand the consequences of these short-term projects, we examine project-level outcomes of short-term relative to longer-term projects. We find that short-term projects are expected to generate more *annual* monetary and CO2 savings than longer-term projects (i.e., per year, during the projects' duration), both in absolute terms and relative to the initial investment. For example, short-term projects are expected to generate at least 11.5% more absolute CO2 savings per year than longer-term projects. However, short-term projects are more likely to target several CDP subcategories of energy efficiency and are significantly less likely to target low-carbon energy consumption or generation that involve new transformative technology. Specifically, the most common short-term projects belong to the subcategories "lighting" (e.g., LED upgrades), "process optimization" (e.g., reduction of running times), and "compressed air" (e.g., leak detection). Importantly, when examining the projects' lifetime outcomes, we find that an average short-term project yields a higher NPV and is 40% less likely to have a negative NPV, but expected to generate at least 25% less total lifetime CO2 savings than longer-term projects. Overall, firms appear to favor short-term results and financial benefits over long-term and sustainable emissions reduction.

We conduct additional analyses at the firm-year level to understand whether short-term projects are associated with firm outcomes. We find that the share of short-term projects that firms implement predicts better future environment-related ESG ratings. However, implementing more short-term projects is not associated with superior expected CO2 savings for the average firm. In fact, firms that have a mix of short- and longer-term projects save the most CO2, while firms that exclusively implement only short- or longer-term projects save significantly less. Our with-in sample estimates suggest that firms that have a 48:52 ratio of short- and longer-term projects exhibit the most expected reduction in CO2.

Lastly, we study how firms choose projects over time. We aggregate project variables at the firm-year level and calculate the mean and median values for those variables across all firms in their first, second, third, etc. years in the sample. We find that firms initially tend to invest small amounts to take on projects that mostly pay back quickly. Over time, firms invest more money in less profitable projects with longer time horizons, consistent with the idea that firms are first targeting easy-to-implement high-return projects, before they take on riskier ones. However, annual investments remain small, and, even after several years, the share of short-term projects on average never drops below 50%. Furthermore, the ratio of expected CO2 savings per US$ invested remains stable, indicating that firms do not choose more efficient projects over time. One may thus conclude that firms tend to mitigate rather than adapt to climate change, even after years.

Our study makes the following contributions to the literature. First, we contribute to a recently emerged literature on environmental policies, performance, and the specific integration of climate change in firms' decision-making. Bolton and Kacperczyk (2023) document that an increasing number of firms, especially those with lower emissions, make decarbonization commitments. In this regard, Aldy et al. (2023) find that more than 70% of the Russel 3,000 firms in their sample are behind their committed decarbonization trajectories. They conclude that firm commitments are not frequently accompanied by detailed plans on how to decarbonize but rather just serve as signals. Other studies show that firms tend to simply outsource "dirty assets." Duchin, Gao, and Xu (2022), for example, find that firms divest pollutive plants following scrutinized environmental risk incidents. However, little attention has been devoted to how firms actually reduce carbon emissions, which specific projects they select to do so, and whether these projects effectively and efficiently reduce emissions. In fact, to the best of our knowledge, we are the first to provide systematic evidence on this microeconomics of firms' emissions reduction and whether and which projects firms choose to reduce emissions.[4]

We also contribute to the debate on firm environmental efforts and long-term orientation. For example, Flammer and Bansal (2017) advocate for long-term orientation by highlighting that firm investments in long-term strategies create value. Flammer et al. (2019) advocate for CSR contracting to help induce managers to care more about the stakeholders as well as create financial value to the firm in the long run. In contrast, however, we document that firms on average take on projects that require small investments, which account for a negligible share of their earnings, and that have payback periods of at most three years. These short-term projects mostly target energy efficiency, often related to lighting and process optimization, and are not large nor long-term investments substantially changing firms' emissions profile. Further, while we cannot provide causal evidence on the optimal combination of projects needed to reduce the most emissions, we find that a combination of short- and longer-term projects is associated with more CO2 savings than choosing one or the other.[5] Overall, the evidence presented in this paper suggests that firms, at least on average, do not act according to the common view that investments in the environment are, or should be, long-term oriented, and at the same time presents evidence that adds to the debate on what firms "ought" to do to achieve greater emissions reductions.

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[4] While we provide primary evidence for large U.S. firms, and while the literature remains scarce, we note that we are not the first to examine whether energy efficiency investments pay off. Fowlie, Greenstone, and Wolfram (2018) address this question in their study of over 30,000 households in Michigan and find that upfront investment costs are about twice the realized energy savings.

[5] The evidence we provide questions the assumption, made in numerous studies, that firms' environmental engagement is particularly costly, pays off only in the long run, and thus necessitates a long-term perspective. For a summary of this view, see Cabolis, Lavanchy, and Schmedders (2023). While in theory this assumption might be valid, there is no systematic evidence to back it, and it is not even clear whether firms would at all make significant investments in clean technologies (e.g., Acemoglu, Akcigit, Hanley, and Kerr, 2016). Our results suggest that this assumption does not appear to reflect how firms actually invest to lower GHG emissions.

2. MOTIVATION AND INSTITUTIONAL SETTING

2.1 Motivation

There is an ongoing debate in both academia and practice on whether U.S. companies are too short-term oriented, i.e., whether they underinvest in capital expenditures and research and development (see, e.g., Kaplan, 2018; Roe, 2013). Survey evidence on how CEOs, CFOs and other executives make investment decisions support the notion that the leaders of U.S. companies may be too short-term oriented. This evidence suggests that the majority of executives would sacrifice long-term value to smooth earnings (Graham, Harvey, and Rajgopal, 2005), base investment decisions on the payback rule, which makes short-term projects overly attractive, and typically pursue projects with an expected lifetime of merely 3-7 years (Graham, 2022; Graham and Harvey, 2001). Still, Kaplan (2018) finds little long-term evidence to support the claim that U.S. companies are overly short-term oriented.

There is however little evidence regarding firms' investments in sustainability, especially their "green" investments, although the question of how and over which horizon firms invest to combat global warming and mitigate climate risk is of a particular interest (Paulson, 2015). In this regard, extant studies documenting that firms do not generally underinvest in long-term projects or how managers choose some regular investment projects over others may not be informative about green investments because, as academics argue, such investments are "special." Specifically, in contrast to regular investments, green investments intend to reduce carbon emissions and other negative externalities that firms cause, but do not necessarily enhance firms' profitability or sales. Such investments may also necessitate relatively larger financial resources (e.g., Allcott and Greenstone, 2012). Thus, it is ex-ante unclear, and therefore is an empirical question, whether firms would at all make significant green investments. Acemoglu, Aghion, Bursztyn, and Hemous (2012) as well as Acemoglu, Akcigit, Hanley, and Kerr (2016) argue that, absent some form of government intervention, firms may not invest in clean technologies. Furthermore, since green investments may not primarily target financial returns, it remains unclear whether investment horizons or standard capital budgeting methods, such as the payback period or net present value, constitute first-order decision parameters.

A considerable issue in this regard is that data on how exactly managers invest is typically unavailable because firms do not disclose investment information at the project level. However, knowing whether and how firms invest to combat global warming and mitigate climate risk is important for various reasons, such as understanding the factors that hamper or benefit green investments or their efficacy. Currently, there is at best limited and indirect evidence on firms' investments in climate change and other environmental engagements.[6] Importantly, very little is known about how exactly firms invest to reduce greenhouse gas emissions, what determines firms' choice of investment horizons and profitability, and how much cash firms actually spend to lower their emissions. Existing literature on this (e.g., Aldy et al., 2023; Flammer, Hong, and Minor, 2019; Gillingham, 2019; Berrone and Gomez-Mejia, 2009) typically assumes that firms' environmental engagements are costly and have a long horizon, thus requiring a long-term perspective since they take time to materialize. We note with importance that there is no systematic evidence to back this assumption. In fact, the literature, at least to our knowledge, has been silent on a first-order question: *How do firms actually invest to achieve environmental performance, particularly reductions in greenhouse gas emissions?*

[6] Recent working papers attempt to approximate green investments. Studying the role of responsible institutional investors, Wiedemann (2023) approximates global firms' green investments via their green debt funding, while Accetturo, Barboni, Cascarano, Garcia-Appendini, and Tomasi (2024) identify green investments by applying a dictionary to financial statements of Italian firms to study the role of credit supply. Yet, these studies neither provide evidence on firms' actual efforts to become greener, nor on the efficiency of firms' green investments or their contribution to firm performance.

2.2 Forces that may shape the choice of project horizon

Both external market forces and within-firm forces related to emissions may affect the horizon of emissions reduction projects. The external market forces could be those that are related to the pressure to sustainably manage climate risk as well as pressure for short-term firm performance. Regarding the former, large firms, and especially S&P 500 index members, are subject to particular environmental scrutiny and pressure to adapt to climate change as induced by the media and professional investors who believe climate risks have implications for their portfolio (Krueger, Sautner, and Starks 2020). Especially the “Big Three” (i.e., BlackRock, State Street, and Vanguard), which are significantly invested in S&P 500 firms, would play an important role in forcing firms to respond to climate change (Azar et al. 2021). Direct investor engagement from such investors may force firms to credibly implement mid- to long-term initiatives that do not just mitigate climate risks but really help adapt to climate change.

Firms with better ESG ratings may be more likely to choose short-term projects because they face less pressure from both rating providers and investors to invest in longer-term projects that further help adapt to climate change. Better ESG ratings may also reflect that firms have already implemented meaningful long-term initiatives, leaving them with a relatively greater share of short-term low-investment projects to implement. Yet, better ratings may also reflect that firms have been able to successfully “manage” their ESG ratings by taking on various short-term projects, which is especially likely if rating providers follow some kind of “tick the box” approach. This may leave firms with a greater share of long-term projects to implement in the future, thereby decreasing the likelihood of short-term projects to be chosen.

Next, firms experiencing short-term performance pressure, i.e., less profitable firms and particularly those subject to short selling pressure, would also be more likely to take on short-term emissions reduction projects. There are at least two reasons. First, because such projects require significantly lower investments that will reduce free cash flow. Second, because short-term projects return invested capital quickly and yield almost immediate results that help signal managerial and financial strength.[7] Also, extant literature suggests that short-term performance pressure may cause corporate myopia. For example, Qian, Crilly, Lin, Zhang, and Zhang (2023) provide recent evidence suggesting that short-selling pressure induces firms to focus on current performance, neglecting critical investments that pay off only in the long run. Specifically, exploiting exogenous variation in firms' short-selling pressure due to Regulation SHO, they find that firms exhibit more employee injuries when they are subject to more short selling.

Lastly, we acknowledge with-in firm forces related to emissions. Particularly, firms with more emissions as well as those granting themselves less time to achieve their emissions targets, are more likely to take on short-term emissions reduction projects. Both high levels of firms' emissions as well as self-proclaimed commitment to achieve emissions reductions in the near term will increase a firm's need to curb emissions quickly. In this regard, Bolton and Kacperczyk (2023) show that an increasing number of firms make decarbonization commitments and indeed reduce their emissions upon making those commitments, even though the firms with the most ambitious commitments typically have lower emissions.

2.3 Institutional setting

Firms voluntarily file information about the projects that they take on to reduce GHG emissions with the CDP. The CDP is a non-profit organization that aims to increase transparency

[7] In this regard, Gao, He, and Wu (2023) argue that firms can use socially responsible activities, especially environmental engagement, to signal financial health in response to increased short-selling pressure. Consistently, they find that MSCI-KLD environment-related ESG ratings of Regulation SHO (RegSHO) pilot firms increase during the RegSHO implementation period. While the authors assume that environmental engagement may be particularly costly, and thus a credible signaling device, they do not provide evidence on the environmental activities that RegSHO pilot firms conduct. However, since RegSHO was only implemented for two years (2005 and 2006), increases in environmental ratings during that period likely stem from fast-to-implement initiatives.

regarding environmental disclosures. Each year, the organization sends out detailed questionnaires, which are filled out by companies and assessed by the CDP. Currently, the CDP database is the largest dataset on firms' responses to climate risk, providing detailed project-level data on how firms attempt to reduce their GHG emissions. Importantly, the information firms provide to the CDP is self-reported, and firms have the option to mark their responses as "private." Such responses are not available to the public but only to CDP signatory investors.[8]

The CDP questionnaire contains the question *"Did you have emissions reduction initiatives that were active within the reporting year?"* Firms particularly provide the following information in response to this question: (1) project category (e.g., energy efficiency in buildings or production processes, low-carbon energy consumption or generation, company policy or behavioral change, non-energy industrial process emissions reductions)[9] and subcategory,[10] (2) payback period (i.e., buckets for payback within <1, 1-3, 4-10, 11-15, 16-20, 21-25, >25 years), (3) the amount invested in the project, (4) annual monetary savings to be achieved via the project, (5) annual CO_2 savings to be achieved via the project, (6) the scope (i.e., scope 1, 2 or 3, or several scopes) to which the CO_2 savings refer to, and (7) the project's lifetime (i.e., buckets for lifetime of <1, 1-2, 3-5, 6-10, 11-15, 16-20, 21-30, >30 years, as well as ongoing projects).[11] CDP also asks about emissions reduction targets (*"Did you have an emissions reduction target that was active in the reporting*

[8] For a detailed overview of the CDP, see Cohen, Kadach, and Ormazabal (2023).

[9] For some years, the names of the project categories vary. In these cases, we update the names to the most recent questionnaire to ensure that these categories are available for all questionnaire years. We assign all categories that are not available as a separate response bucket for the entire questionnaire period to the category "Other."

[10] Subcategory information is only available from CDP questionnaire year 2018 onwards. For example, initiative subcategories include (1) compressed air, (2) heating, ventilation and air conditioning, (3) insulation, (4) lighting, (5) machine or equipment replacement, (6) solar photovoltaic and wind, and (7) vehicle replacement.

[11] Information on the lifetime of projects is only available from CDP questionnaire 2015 onwards and is sometimes missing or it is inconsistent or even wrong, especially since some firms interpret a project's lifetime as the time it needs to implement the project. For example, machine replacements are sometimes classified as projects with a lifetime of one year instead of a long-term lifetime. Importantly, however, in the CDP the relation between a project's payback period and its reported lifetime is generally meaningful. For example, 67% of all long-term projects with a payback period of more than ten years also have a lifetime of more than ten years, while 70% of all short-term projects with a payback period of three or less years have a lifetime of at most ten years or are ongoing projects.

year?"). This information is used to calculate the remaining time until the due date of targets set by the company.

3. DATA, VARIABLES, AND DESCRIPTIVE STATISTICS

3.1 Data

We match the CDP questionnaire years to firms' fiscal years. To do so, we rely on the reporting year that firms name in the questionnaire. The vast majority of questionnaire years refer to the previous fiscal year. Sometimes however firms respond for a specific year in successive CDP questionnaires. In this case, we rely on information from the most recent questionnaire. CDP only provides ISINs and tickers to identify firms. We bridge ISINs and CUSIPs by using historical GVKEYs. We then match CDP data to Compustat based on these GVKEYs to retrieve firms' accounting data as well as information on S&P 500 index membership and Standard Industry Classification (SIC) codes. We also retrieve data on the number of a firm's shares that are sold short from the Compustat Supplemental Short Interest file. Lastly, we match overall ESG ratings as well as environment-related ESG ratings from MSCI based on ISINs.[12] Appendix A presents the sample selection process, detailing the steps from the initial to final sample.

For our final project-level sample, we use all responses to the CDP questionnaire from public U.S. companies with an ESG rating that report data on their emissions as well as emissions reduction targets. This procedure results in 9,937 emissions reduction projects implemented by 455 firms over the fiscal years 2011 to 2021 (corresponding to 2,111 firm years).[13] Hence, firms on average implement 4.7 projects per year.

[12] We rely on MSCI ESG ratings because MSCI is by far the largest and most important provider in the ESG ratings market and because MSCI covers more firms than most other rating providers (Serafeim and Yoon, 2023).

[13] While the vast majority of observations relate to the fiscal years 2012 to 2021, there are a few observations for which the CDP questionnaire year 2013 refers to the fiscal year 2011.

3.2 Variables

In this section, we define the key project and firm variables that we use in our analyses (see Appendix B for more details). Our main variable of interest in all project-level analyses is the indicator *Short-term payback*, which equals one for projects with a payback period of at most three years (and zero otherwise). Similarly, *% short-term projects* is the variable of main interest in all firm-level analyses. It is defined as a firm's annual share of short-term emissions reduction projects with a payback period of at most three years relative to all of a firm's emissions reduction projects.

We use the following variables to measure project-level outcomes. *Annual CO2 savings/investment* is the ratio of a project's annual CO2 savings in tons relative to the US$ amount invested in the project. *Ln(Annual CO2 savings)* is the natural logarithm of a project's annual CO2 savings, while *Ln(Lifetime CO2 savings)* is the natural logarithm of a project's total lifetime CO2 savings. Both variables are in tons of CO2 savings. Since CDP provides information on project lifetimes only in buckets (e.g., 1-2, 3-5, 6-10 years), we use the midpoint of a bucket's interval to calculate lifetime outcome variables, multiplying a project's midpoint times its estimated annual (CO2 or monetary) savings.

Annual monetary savings/investment is the ratio of a project's annual monetary savings in US$ relative to the US$ amount invested in the project. *Ln(Annual monetary savings)* is the natural logarithm of a project's annual monetary savings, while *Ln(Lifetime monetary savings)* is the natural logarithm of a project's total lifetime monetary savings. *NPV* is the project's net present value, calculated by discounting a project's annual monetary savings with a discount rate of 11% (which equals the S&P 500's geometric average historical return over the last 50 years) and by subtracting the project's investment. The three aforementioned variables are all in US$. The indicator variable *Negative NPV* equals one for projects with a negative net present value (and zero otherwise). Furthermore, we use two indicator variables to examine firms' choice of initiative category. *Energy efficiency in buildings or production* equals one for initiatives targeting energy efficiency in buildings or production processes (and zero otherwise), and *Low-carbon energy consumption/generation* equals one for initiatives targeting the purchase or production of low-carbon energy (and zero otherwise).

Lastly, we use the following firm-level variables. *S&P 500* is an indicator variable that equals one for firms belonging to the S&P 500 stock index (and zero otherwise). *ESG rating* is a firm's ESG rating at the end of the last fiscal year as provided by MSCI. *Short selling* measures a firm's short interest, defined as the maximum number of shares held short in the last fiscal year standardized by the number of shares outstanding in the last fiscal year (following Rapach, Ringgenberg, and Zhou, 2016). This variable captures firms' short-term performance pressure as induced by short sellers. *# years to emissions target* is the timely distance in years from the current year *t* to a firm's self-proclaimed emissions reduction target year, which measures the commitment to achieve emissions reductions in the near term. If a firm has several emissions targets with different target years, we use the median of the timely distances. *Ln(Operations emissions market)* is the natural logarithm of the sum of a firm's scope 1 and 2 emissions. Scope 2 emissions are determined based on the market method (see World Resources Institute, 2015). Variables capturing firm fundamentals include *Capex/at* and *R&D/at* (i.e., capital expenditures and R&D to total assets), *Ln(total assets)*, *MTB* (i.e., the market-to-book ratio), *Net debt/at* (i.e., a firm's ratio of total liabilities minus cash to total assets), and *ROA* (i.e., net income to total assets).

3.3 Descriptive statistics

Table 1 presents the distribution of short-term emissions reduction projects across the ten most common industries in our sample. Although the average of the variable *Short-term payback* varies between 40% (SIC code 49) and 74% (SIC code 36), in eight of the ten main industries short-term projects account for at least 62% of all emissions reduction projects. Furthermore, the 10th and 90th percentiles of the within-industry firm-level values for *Short-term payback* vary between 0% and 100%. Yet, in seven of the ten industries, the 90th percentile is 100%, indicating that in most industries there are firms that exclusively take on short-term projects. Hence, while there is considerable variation in project horizons across and within industries, which is important for parameter identification, the majority of emissions reduction projects have a short horizon.

Table 2 provides descriptive statistics for the variables used in this study at both the project and firm level. Specifically, Panel A shows statistics at the project level based on our final sample of 9,937 emissions reduction projects. Panel B shows statistics at the firm level based on our final sample of 2,111 firm-years.

First, the majority (63%) of all emissions reduction projects have a short-term payback period of at most three years.[14] Figure 1 provides a detailed overview of the distribution of all CDP project payback periods. About 28% and 35% of all projects have a payback period of 0-1 and 1-3 years, respectively. Regarding the remaining projects, only 10.5% have a long-term payback period of more than ten years, while more than 26% have a payback period of 6-10 years. The project short-termism we document does not simply reflect new firms that enter our sample over time and first take on projects that are easy and quick to implement. In fact, in untabulated analyses the above numbers remain virtually unchanged (e.g., 62% of all projects have a payback period of 0-3 years) when we examine only those firms that are part of the sample for the entire sample period. Consistently, the firm-level statistics in Panel B show that a median (mean) of 67% (61%)

[14] We find a similar share of short-term projects (63.5%) in our initial sample, which includes more than 15,000 projects with available payback data initiated by U.S. public firms. The high share of short-term projects in our final sample is thus not the result of focusing on potentially larger, more capital-market oriented firms with coverage in Compustat.

of all projects that firms take on per year have a payback period of at most three years. In 34% (18%) of all firm-years, firms exclusively implement (no) such short-term projects.

Second, most firms' investments in emissions reduction projects are very small. 16% of all projects necessitate no investment at all. For those projects that necessitate an investment, the median amount invested per project is only \$127,408. While the mean investment is \$9,084,193, this number is driven by a small share of projects as indicated by the 75th percentile, which amounts to one million dollars per project. Firms take on an average of 4.7 (median 3) projects each year. Hence, the vast majority of firms invest no more than five million dollars a year, with more than half of all firms investing even less than a million dollars. The firm-level statistics in Panel B put the above numbers into perspective: The median (mean) of a firm's average total investment in emissions reduction projects reported to the CDP amounts to 0.2% (6%) of last year's net income and to 0.5% (8%) of current capital expenditures.

Third, in terms of project categories (i.e., different ways of reducing CO2 emissions), the vast majority (74%) of projects belong to the category "energy efficiency in buildings or production." Figure 2 provides a detailed overview of the distribution of all CDP project categories. Almost half of all projects (48%) target energy efficiency in buildings, while ca. 26% are concerned with energy efficiency in production processes. Not surprisingly, five of the six main project subcategories target energy efficiency. Figure 3 shows the subcategories, their share within the "energy efficiency" category as well as the distribution of payback periods per subcategory. The most frequent subcategory is "lighting" (i.e., lighting efficiency in production facilities or buildings, such as LED upgrades or sensors), which accounts for 24% of energy efficiency projects, followed by "heating, ventilation and air conditioning (HVAC)" (14%), "process optimization" (10%), "compressed air" (6%), and "building energy management systems" (5%). All those subcategories have high shares of short-term payback periods, ranging from 49% (HVAC) to 79% (compressed air). In contrast, the most common long-term projects belong to arguably more sustainable and transformative subcategories, such as "machine replacement," "solar photovoltaic," and "insulation."

The only other notable category, accounting for more than 9% of all projects, is "low-carbon energy consumption/generation," i.e., producing (5.6%) or purchasing (3.8%) low-carbon energy. Lastly, we acknowledge that a concerningly low share (3%) of all projects belong to the category "company policy or behavioral change," which signals firms' willingness to effectively change their behavior for the benefit of nature and society. It includes subcategories such as "change in purchasing practices," "resource efficiency," "site consolidation or closure," "supplier and customer engagement," and "waste reduction."

Implementing the above projects, the median annual CO2 savings firms generate per project amount to 545 tons. As indicated by the mean and the 75th percentile of CO2 savings, which amount to 32,252 and 4,000 tons, respectively, the distribution of savings is skewed, with only few projects saving large amounts of CO2 equivalents.[15] The projects' median (mean) total lifetime CO2 savings amount to 4,318 (201,784) tons. Hence, while most firms' projects save only small amounts of CO2, both on an annual level and over their lifetime, some projects significantly help reduce emissions. Concerning financial figures, the projects generate median (mean) annual monetary savings of $71,059 ($1,728,766), while median (mean) total lifetime monetary savings amount to $664,000 ($12,697,134). In terms of project profitability, firms gain a median (mean) of $0.34 ($10.27) of annual savings for each dollar invested per project. Consistent with the short

[15] The sum of CO2 savings of all projects per firm-year accounts for a median (mean) of 0.9% (3.7%) of a firm's emissions reported for the previous year. Yet, based on Scope 1 and 2 only, median (mean) annual savings of 2.3% (11.5%) of the previous year's emissions are generated.

payback periods we document, most projects not only pay off, but they do so considerably fast. Furthermore, projects' median (mean) net present value (NPV) is $83,985 ($1,767,322), with 24% of all projects being NPV negative.

Concerning the firms in our sample, Panel B shows that 81% belong to the S&P 500 stock index. Thus, our evidence is on many of America's largest and most important companies that experience massive scrutiny regarding their environmental policies and that are responsible for a significant share of overall greenhouse gas emissions. The firms have a median MSCI ESG rating of 5 (on a 0-10 scale), and they grant themselves a median of 5 years to achieve their self-proclaimed emissions targets. In terms of accounting data, the average numbers for our sample firms compare well to extant studies.

4. RESEARCH DESIGN AND RESULTS

4.1 Determinants of choosing short-term payback projects

So far, we documented that the majority of projects firms take on to reduce GHG emissions have a short-term horizon (i.e., payback period of at most three years) and necessitate small investments. This result appears inconsistent with the common view that firms' environmental engagements are, or should be, costly and long-term oriented. In this section, we examine which firms are more or less likely to take on short-term projects to shed light on the potential forces that relate to corporate short-termism in managing climate risk. We refer to the forces that may shape a firm's project horizon discussed in Section 2.2.

To examine firms' choice of project horizon, we conduct the OLS regression model shown in equation (1):

$$\textit{Short-term payback}_{i,j,t} = \textit{External market forces} + \textit{Emissions-related firm forces} + \textit{Firm controls} + \textit{FE} \quad (1)$$

The dependent variable is *Short-term payback*, i.e., we compare the choice of short-term vs. mid- to long-term payback periods. Regressions are at the project level, i.e., for project *j* taken on by firm *i* in fiscal year *t*. We are particularly interested in two sets of explanatory variables relating to external market forces and emissions-related firm forces.

External market forces is a vector of variables capturing market forces at firm-level that may affect project payback periods. It includes the *S&P 500* indicator and the variable *ESG rating*, which enters the regression with one period lag. These variables capture a firm's pressure – from investors (especially the "Big Three") and ESG rating providers – to reduce their GHG emissions. We additionally rely on the variable *Ln(total assets)* as a measure of pressure from investors and ESG rating providers since the former engage significantly more with larger firms and the latter are more likely to issue ratings for such firms. The vector also includes the variable *Short selling*, which also enters the regression with one period lag, as a measure of a firm's short-term performance pressure as induced by short sellers. We additionally use the variable *ROA* as a measure of realized firm performance.

Emissions-related firm forces is a vector of variables capturing firms' needs to reduce GHG emissions in the near term. *# years to emissions target* measures a firm's commitment to achieve emissions reductions in the near term, with larger values of this variable indicating less pressure to achieve targets soon. *Ln(Operations emissions market)* captures the need to achieve emissions reductions. We assume that firms with more scope 1 and 2 emissions in the last year have a greater need to reduce their emissions in the near term.

The vector *Firm controls* includes the variables *Capex/at*, *MTB*, *Net debt/at*, and *R&D/at* (beyond the controls for firm size and profitability). All variables capturing firm fundamentals enter the regressions with one period lag to mitigate concerns of simultaneity bias. All regressions include fiscal year fixed effects. We additionally include different combinations of industry, scope, and U.S. state fixed effects or, alternatively, firm fixed effects. This allows us to lower the concerns of omitted variable bias by comparing projects within different groups, exploiting variation across industries and states or within firms. We cluster standard errors at the firm level to allow for serial correlation in firms' environmental strategies and performance.[16]

The results are presented in Table 3, Panel A. We find that both external market forces as well as emissions-related firm forces explain firms' likelihood of taking on short-term emissions reduction initiatives. In particular, while the coefficient on *ESG rating* is statistically insignificant, we find that the coefficient on *S&P 500* is negative and significant at least at the 5% level in all four columns. The estimates indicate that, orthogonal to firm size, S&P 500 firms that are subject to heightened pressure to sustainably adapt to climate change are 10-12% less likely to choose projects with short payback periods. We also find larger firms to be less likely to choose short-term projects. The coefficient on *Ln(total assets)* is negative and statistically significant in all columns omitting firm fixed effects (which arguably remove necessary variation in firm size).

Regarding short-term performance pressure, we find the coefficient on *Short selling* to be positive and significant at least at the 5% level in columns (1) to (3). In addition, the coefficient on *ROA* is negative and statistically significant throughout all four columns. These results support the notion that firms with more performance pressure are more likely to implement short-term emissions reduction projects.

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[16] Appendix C provides correlations for the main variables we use in this study. *Short-term payback* exhibits moderate correlations with firm characteristics, indicating that multicollinearity is unlikely to be an issue for statistical inference. In particular, consistent with the potential forces shaping the choice of project horizon (discussed in Section 2.2), we find that *Short-term payback* correlates negatively with firm size (-11.5%), the S&P 500 indicator (-10.9%), and the number of years to achieve decarbonization targets (-10.6%), whereas it correlates positively with the variable *Short selling* (10.2%). These correlations are significant at the 1% level.

Turning to emissions-related firm forces, we find the coefficient on *# years to emissions target* to be negative and statistically significant in all four columns, while the coefficient on *Ln(Operations emissions market)* is positive and significant at the 1% level in columns (1) to (3). Thus, firms that grant themselves less time to achieve their self-proclaimed emissions targets and those with higher emissions levels are more likely to take on short-term projects.

We further find that growth firms are significantly less likely to choose short-term projects, as indicated by the significantly negative coefficient on *MTB*. We find some marginal evidence that firms with less financial flexibility (*Net debt/at*) prefer short payback periods. Firms' investments in tangible (*Capex/at*) and intangible assets (*R&D/at*) do not seem to determine firms' preference for short-term projects.

To complement the above analysis, we study the role of CEOs' career and monetary incentives. We re-estimate the regressions shown in Panel A, additionally including the following five variables: *CEO age* and *CEO tenure*, which capture career concerns, *Ln(TDC1)* as a control for total CEO compensation, and *Option awards/TDC1* (i.e., the standardized grant date fair value of options granted to the CEO) as well as *Shares owned* (i.e., the percentage of a firm's shares outstanding held by its CEO) to measure monetary incentives. Younger CEOs and those early in their tenure have stronger career concerns that entail incentives to signal their effort and quickly resolve uncertainty about their quality (e.g., Hirshleifer, 1993). We thus expect them to prefer short-term initiatives that yield fast results and pay-offs. Regarding financial incentives, we expect CEOs with more option awards to prefer initiatives that pay off fast, while CEO ownership may provide incentives for long-termism.

Panel B of Table 3 presents the regression results. While the coefficients on *CEO tenure* and *Shares owned* have the expected sign, they are statistically insignificant in all columns. The coefficient on *Option awards* is positive, as expected, but only significantly so in column (2). Only the coefficient on *CEO age* shows some consistent results. It is negative and significant at least at the 10% level in columns (1), (2) and (3), indicating that firms run by younger CEOs tend to be more likely to implement short-term projects. Overall, the evidence suggests that CEO incentives, particularly monetary incentives, play at best a minor role for short-termism in emissions reduction. The lack of significant results for CEOs' monetary incentives may be attributed to the fact that most projects involve only small investments and thus will only have limited effects on firm performance, consistent with the evidence we present in the following subsection.

4.2 Outcomes of short-term projects

4.2.1 Annual monetary and CO2 savings

In this subsection, we analyze how short-term and long-term projects differ with regard to several project-level outcomes. We use the OLS regression model shown in equation (2):

$$\textit{Project outcome}_{i,j,t} = \textit{Short-term payback}_{i,j,t} + \textit{External market forces} + \textit{Emissions-related firm forces} + \textit{Firm controls} + \textit{FE} \qquad (2)$$

Project outcome$_{i,j,t}$ stands for different dependent variables for project *j* taken on by firm *i* in fiscal year *t*. We regress project outcome variables on the indicator *Short-term payback* along with the same explanatory variables and combinations of fixed effects as in equation (1).

Table 4, Panel A, presents results on the profitability of initiatives. Columns (1) to (4) of Panel A show the results from regressions explaining the dependent variable *Annual monetary savings/investment*. In all four columns, the coefficient on *Short-term payback* is positive and significant at the 1% level, indicating that short-term projects are expected to generate greater monetary savings per dollar invested than more long-term oriented projects.[17] In untabulated regressions, we find that short-term projects are at least 36% more likely to generate monetary savings in the top quartile (≥ 75th percentile) of the distribution of annual monetary savings to investment. In columns (5) and (6), we use *Ln(Annual monetary savings)*, i.e., the logarithm of absolute monetary savings, as the dependent variable. We find results consistent with the previous columns.

The above results indicate that short-term projects are significantly more financially sensible. Firms can thus have monetary incentives to focus on the short term and potentially neglect longer-term projects that may help adapt to climate change. Therefore, in Panel B of Table 4, we examine whether the monetary benefits of short-term projects come at the cost of achieving lower CO2 savings. In columns (1) to (4), we use *Annual CO2 savings/investment* as the dependent variable. Except for column (3), we find that the coefficient on *Short-term payback* is positive and statistically significant, suggesting that short-term projects actually are expected to save more CO2 per dollar invested. For example, the estimate in column (4) where we use firm fixed effects indicates that short-term initiatives are expected to save 0.085 more tons of CO2 per dollar invested.

In untabulated regressions, we find that short-term initiatives are at least 23% more likely to generate annual expected CO2 savings per dollar invested in the top quartile (≥ 75th percentile) of the distribution. In columns (5) and (6), we use *Ln(Annual CO2 savings)*, i.e., the logarithm of absolute CO2 savings, as the dependent variable. We find results consistent with the previous

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[17] The coefficient estimates indicate that short-term projects, on average, generate between $9 and $11 more annual monetary savings for each 1$ invested per initiative. Although we winsorize continuous variables at the 1st and 99th percentiles, these estimates appear large and may still reflect outliers. Therefore, we exclude all observations for which *Annual monetary savings/investment* takes on values larger than the 95th percentile and re-estimate the regressions. The coefficient on *Short-term payback* remains positive and significant at the 1% level, and the estimates indicate monetary savings of $0.85 for each 1$ invested.

columns. Specifically, the estimates indicate that short-term projects are expected to generate between 11.5% and 13.5% more CO2 savings per year. Collectively, the above results suggest that short-term projects, on average, likely generate more CO2 savings per year than projects with longer payback periods. To this extent, we find no evidence that the monetary benefits of short-term projects that accrue to firms come at the cost of lower CO2 savings, which would be borne by external parties.

4.2.2 Project categories

Next, we study the choice of project categories to examine whether short-term projects differ with regard to how they achieve CO2 savings. Since it is by far the most frequent category, Panel A of Table 5 shows regressions explaining the dependent variable *Energy efficiency in buildings or production*. The coefficient on our variable of interest, *Short-term payback*, is positive but only significant in columns (3) and (4), which include more granular fixed effects. We thus conclude that short-term projects at the very least are more targeted towards energy efficiency. This result is likely explained by the fact that three out of four projects target energy efficiency anyway. However, in untabulated regressions, we find that short-term projects are significantly more likely to target energy efficiency subcategories related to building energy management systems, compressed air, and process optimization. We note that these projects rarely involve new transformative technologies.[18] These results are in line with the evidence in Figure 3.

Further, Panel B of Table 5 shows the results from regressions explaining *Low-carbon energy consumption/generation*, the second most frequent category. In all columns, the coefficient on *Short-term payback* is negative and significant at the 1% level, indicating that short-term

[18] Because data on initiative subcategories is only available from CDP questionnaire 2018 onwards, regressions at the subcategory level are based on a limited number of (less than 4,900) observations. For that reasons, and for sake of brevity, we do not tabulate those results.

projects are less likely to target the production or purchase of low-carbon energy, one of the most sustainable project categories that involves investments in new transformative technologies. Hence, while most projects generally target energy efficiency, short-term projects differ with regard to how they save CO2.

4.2.3 Project lifetime results

So far, we have focused on annual project level outcomes. We now examine projects' overall lifetime outcomes, particularly expected total CO2 and monetary savings as well as the net present value (NPV) of projects. This analysis allows us to shed light on two important questions. First, whether firms favor quick CO2 savings and financial results over total CO2 reductions. Second, whether firms' investments in emissions reductions initiatives are positive-NPV projects, and especially so if they are short-term oriented. To address these questions, we estimate regression model (2) using several project lifetime outcome variables. Table 6 presents the results.

In Panel A, we show regressions explaining the variable *Ln(Lifetime CO2 savings)*, i.e., the natural logarithm of total amount of a project's estimated CO2 savings over its lifetime. In columns (1) to (4), our variable of interest is *Short-term payback*. The coefficient on this variable is negative and significant at the 1% level in all four regressions, indicating that short-term projects are expected to generate significantly less CO2 savings over their lifetime. Specifically, we find that such projects are associated with at least 25% less expected CO2 savings, which is an economically meaningful number. Since we know that short-term projects are less likely to target the production or purchase of low-carbon energy, we consider the variable *Low-carbon energy consumption/generation* in columns (5) and (6). We find that projects involving low-carbon energy save considerably more CO2 over their lifetime, which provides an explanation for why short-term payback projects are associated with less total lifetime emissions reduction.

Panel B shows the results from analyses of projects' lifetime financial results. Again, variable of interest is *Short-term payback*. In columns (1) and (2), we find that short-term payback projects do not differ from longer-term projects in terms of total lifetime monetary savings. However, as shown in columns (3) and (4), short-term payback projects yield significantly greater NPVs. On average, a short-term project's NPV is about $3.5 million higher.[19] Further, as suggested by the estimates in columns (5) and (6), short-term payback projects are at least 40% less likely to be negative-NPV projects. In sum, firms, and also their shareholders, may thus likely have financial incentives to take on low-investment short-term projects.

Taken together, the evidence presented in subsection 4.2 suggests that, on annual level, emissions reduction projects with short-term horizon are expected to be more profitable and save more CO2 than projects with a longer horizon that are supposed to reduce emissions within the same scopes conducted either by the same firm or by firms in the same industry and U.S. state at the same time. Put differently, short-term payback projects yield relatively quick results, both in terms of CO2 savings and financially. This can in part be explained by the finding that these projects only rarely target new transformative technology, such as low-carbon generation, which typically needs more time until initial investments pay off. In this regard, we further show that short-term payback projects yield greater NPVs and are significantly less likely to be NPV negative. However, these projects generate at least 25% less total CO2 savings over their lifetime.

[19] In untabulated regressions, we winsorize the variable *NPV* at the 5th and 95th percentiles (instead of the 1st and 99th) and find that the average short-term project's NPV is at least one million USD higher. We also find that our results do not hinge on whether we use a lifetime of 31 years for projects with a reported lifetime of 31 or more years or whether we use 40 years instead.

4.3 Firm-level outcomes

4.3.1 Environmental performance

Lastly, we examine whether taking on more low-investment short-term projects is associated with firms' environmental performance. Since the majority of firms take on mostly short-term projects (see Table 2B, median *% short-term projects* = 67%), it appears unlikely that (in equilibrium) this short-termism has considerable negative consequences for the average firm. To examine the relation between firms' short-term projects and firm outcomes related to environmental and financial performance, we use the firm-level regression model in equation (3):

$$\textit{Firm outcome}_{j,t+1} = \textit{\% short-term initiatives}_{j,t} + \textit{External market forces} + \textit{Emissions-related firm forces} + \textit{Firm controls} + \textit{FE} \quad (3)$$

The placeholder *Firm outcome*$_{j,t+1}$ stands for dependent variables measuring firm-level outcomes for firm *i*, namely environment-related ratings from MSCI and firm-level expected CO2 savings. Our independent variable of interest is *% short-term projects*$_{j,t}$, which is defined as a firm's annual share of short-term emissions reduction projects that have a payback period of at most three years out of all of its emissions reduction projects in the fiscal year. This variable measures a firm's short-term orientation in addressing climate risk at the annual level. We use the same control variables as in regression equations (1) and (2). All regressions include fiscal year fixed effects, which we combine with (4-digit SIC) industry or firm fixed effects. Firm fixed effects allow us to infer whether deviations from a firm's time series mean with regard to its short-termism in emissions reduction projects explains firms' environmental performance. As before, we cluster standard errors at the firm level to allow for serial correlation in firm performance.

Regarding firms' environment-related ESG ratings, conducting more short-term projects, which yield more near-term results, may benefit the ratings. First, firms can report about more projects they implement to manage climate risk and thus rating providers may be able to "tick more boxes." Second, short-term projects are expected to save more CO_2 in the near future. However, a high share of short-term projects may also harm firms' environment-related ratings if rating providers take on the (common) view that firms should make long-term investments in the environment to successfully and sustainably manage climate risk. Regarding overall expected annual CO_2 savings at the firm level, it is unclear whether conducting more short-term projects reduces more overall emissions than combining short-term projects with more longer-term projects that potentially yield more emissions reductions than the marginal short-term project. Overall, the relation between the share of a firm's short-term emissions reduction projects and its environmental performance is ex ante unclear and thus an empirical question.

Table 7 presents the results of regressions examining the link between firms' share of short-term projects and their environmental performance. We use *Environmental rating*$_{t+1}$, which is a firm's year-end numerical environment-related ESG rating assigned by MSCI in year t+1, as the dependent variable in Panel A. In all four columns, the coefficient on *% short-term projects* is positive and statistically significant, mostly at the 5% level, independent of whether we control for firms' past environment-related ratings or not. The estimates suggest that a greater share of a firm's short-term emissions reduction projects predict better future environment-related ESG ratings. In untabulated regressions, we find no significant evidence for a non-linear relationship between the variables *Environmental rating*$_{t+1}$ and *% short-term projects*. The results provide another rationale for why many firms focus on the short term.

In Panel B, we examine firms' aggregate annual emissions reduction by using *Ln(Sum CO2 savings),* which is the sum of annual CO_2 savings that would be generated by all the emissions reduction projects a firm takes on in year t (as reported to the CDP), as the dependent variable. In columns (1) and (2), we find no evidence that the relationship between the share of a firm's short-term emissions reduction projects and its expected CO2 savings is linear. The coefficient on *% short-term projects* is insignificant, both statistically and economically. Firms with a greater share of short-term projects thus do not exhibit superior expected CO2 savings.

To test for a non-linear relationship, we augment our regression model with the squared term of the variable *% short-term projects* in columns (3) and (4). We find evidence for a non-linear relationship, indicating that firms can take on too many and too few short-term projects. Specifically, the coefficient on *% short-term projects* is positive, whereas that on *% short-term projects squared* is negative, while all coefficients are significant at least at the 5% level. Using the test for non-linear estimates proposed Lind and Mehlum (2010), we find that the hump-shaped relationship between *Ln(Sum CO2 savings)* and the share of short-term projects is indeed statistically significant and that its turning point corresponds to a share of short-term projects of about 48% in column (3). Additionally, in columns (5) and (6), we replace the variable *% short-term projects* and its squared term by the two indicator variables *% short-term initiatives = 0%* and *% short-term initiatives = 100%*, which equal one for years in which a firm implements no or only short-term projects, respectively. The coefficients on both indicators are negative and significant, indicating that firms focusing exclusively on short-term projects as well as those that do not undertake any short-term projects generate significantly less expected CO2 savings.

Collectively, we find that implementing more short-term projects is not associated with superior CO2 savings for the average firm. In fact, firms that exhibit the most expected CO2 savings have a mix of short- and long-term projects, while firms that exclusively implement only short- or long-term initiatives save significantly less. However, as a caveat, we note that we document the relationship between short-term emissions reduction projects and CO_2 savings for the firms in our sample, but cannot test whether our findings hold out of sample.[20]

4.3.2 Time series analysis

In this last subsection, we provide additional evidence on how the firms in our sample manage climate risk over time. To conduct the firm-level time series analysis, we aggregate project-level variables per firm-year, similar to aggregating all of firms' project payback periods to derive the firm-year variable *% short-term projects*. We then calculate mean and median values for those variables (all winsorized at the 5% and 95% level) for all firm-years that are the first, second, third, etc. year that a firm is part of the sample.[21] This approach allows us to illustrate how initiative variables vary in the time series from firms' first to tenth year in the sample. While the number of firms (technically) declines over time, this analysis enables us to document trends in how firms attempt to reduce emissions over time. The results are shown in Figures 4A to 4D.

We start with how the variable *% short-term projects* evolves over time. As Figure 4A illustrates, firms are particularly likely to take on projects with a short payback period in their first year in the sample – the median and mean of *% short-term projects* amounts to 80% and 66.5%, respectively. Both the median and mean decline over time. Yet, even in the sample's last years, the share of short-term projects remains at 50%.[22]

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[20] In an untabulated analysis, we examine the consequences on firms' financial performance. We use firms' EBIT and sales of t+1 relative their total assets as well as their buy-and-hold stock return (calculated as the difference between the firm's year-end market capitalization in year t+1 and t, divided by the market capitalization in year t) as dependent variables but find no evidence that implementing more short-term projects is associated with superior future accounting nor stock performance.

[21] We only use firms for which data on all projects in a year is available. Thus, the number of firms per year can be less than 455, the total number of unique firms in our sample. We also acknowledge that firms may have reported to the CDP – and hence may have taken on emissions reduction projects – way before.

[22] According to our non-linear estimates for the relationship between firms' aggregate annual CO_2 savings and their share of short-term projects, a mix of 48% short-term and 52% longer-term projects is associated with the largest CO_2 savings. In that sense, Figure 4A suggests that firms may move towards the optimal project mix over time.

Regarding firms' total investments over time, as shown in Figure 4B, the annual US$ amount of expected investment that would be spent on emissions reduction projects is considerably smaller in the first year. The median amount is about $1.1 million. The median amount invested per year however not only doubles in the second year but increases almost steadily over time. Still, even the amount of $5.5 million, which is the median for the sample's final year, only amounts to 0.2% of firms' lagged earnings. Nonetheless, it is worth noting that a small number of firms in our sample invest significantly larger amounts to implement projects that reduce GHG emissions. Accordingly, the mean annual US$ amount spent on such projects amounts to about $15 million dollars in the first year and stabilizes at around $23-26 million in later years.

Together, Figures 4A and 4B suggest that firms in their first years typically invest small amounts to take on projects that payback fast. Over time, firms tend to invest more money over longer horizons. This pattern is consistent with firms first targeting easy-to-implement initiatives before they take on riskier ones, which may reflect learning. Yet, since the average total investment remains small over time and since the majority of firms keep implementing projects with a short horizon, one may conclude that most firms tend to mitigate rather than adapt to climate change.

To better understand whether firms learn, we further analyze the carbon efficiency and profitability of firm projects over time. Figure 4C shows the time series for firms' total annual expected CO2 savings relative to total annual investments in emissions reduction projects. Median expected CO2 savings in tons per US$ invested remain stable from the first to the tenth sample year, indicating that firms do not (or cannot) choose more efficient projects over time. As the time series of mean values for expected CO2 savings per US$ invested shows, even those firms managing to save large amounts of CO2 do not implement more efficient projects over time. Finally, in terms of monetary savings, Figure 4D reveals that the ratio of total annual monetary savings to total annual investments in emissions reduction projects declines over time. In their first year, firms choose the initiatives that yield the largest mean and median monetary savings per dollar investment (e.g., median = 41 cents/ dollar invested). As investments gradually increase over time, we find profitability to decline.

5. CONCLUSION

This study uses granular data at the firm's project level, provided by the CDP, to present the first evidence on what large U.S. firms actually do to reduce greenhouse gas emissions. We establish two major descriptive results. First, the majority of emissions reduction projects require small investments – the median investment per project is $127,000, with the median of firms' total annual investment in such projects amounting to only 0.2% of net income. Second, 63% of all projects have payback periods of at most three years, while just about 10% of all projects pay off after more than ten years. These short-term projects mostly target energy efficiency in buildings or production, and typically do not involve new transformative technology and low-carbon energy. However, there is a small group of firms that invest significantly larger amounts and undertake longer-term projects.

Importantly, our results suggest that short-term emissions reduction projects are expected to generate more CO2 and monetary savings per year, yield greater NPVs, and predict higher environment-related ESG ratings in the near future. However, total expected CO2 savings over the projects' lifetime are at least 25% lower for short-term payback projects. Firms that exhibit the most expected CO2 savings have a mix of short- and longer-term projects, while firms exclusively implementing only short-term or longer-term projects expect to save significantly less CO2. We also study how characteristics of firms' emissions reduction projects, such as their payback period and efficiency in expected CO_2 saving, evolve over time and show which firms implement more short-term projects.

Collectively, the evidence presented in this paper suggests that the majority of large U.S. firms do not act according to the common view that firms' environmental engagements are, or should be, long-term oriented. Particularly, frequent statements that firms' investments in environmental performance are costly and only pay off in the long-term are not backed by the results of our study. In fact, it appears that firms, at least on average, tend to mitigate rather than adapt to climate change. On the bright side, however, the short-term projects that firms take on are expected to generate fast CO_2 savings in a time when immediate responses to climate change are needed. In this regard, our evidence suggests that firms combining short- and longer-term projects exhibit the most expected CO_2 savings.

This study is not without limitations. First, firms can choose whether CDP makes their responses public. To the extent that firms are arguably more likely to mark their responses as private if their environmental performance is weak, we may tend to draw a too friendly picture of the current state of U.S. firms' actions to manage climate risks and combat global warming. Second, we only observe the emissions reduction projects that firms actually take on, not their set of potential projects. While this is a common issue in research on corporate investment, it tends to limit our ability to use counterfactuals. Lastly, CDP provides data based on their questionnaires, which are filled out by the companies themselves and which include the CO_2 and monetary savings that firms expect. To the best of our knowledge, CDP does not consistently check the accuracy of the information that firms provide. At least with regard to our regression estimates, data inaccuracy would however likely run against us finding significant results.

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Figure 1: Payback period of GHG emissions reduction projects

This figure presents the share of payback periods for greenhouse gas emissions reduction projects actively pursued by U.S. stock-listed firms publicly reporting to the Carbon Disclosure Project (CDP) over the period 2013-2022. Payback period buckets are directly taken from the CDP questionnaire.

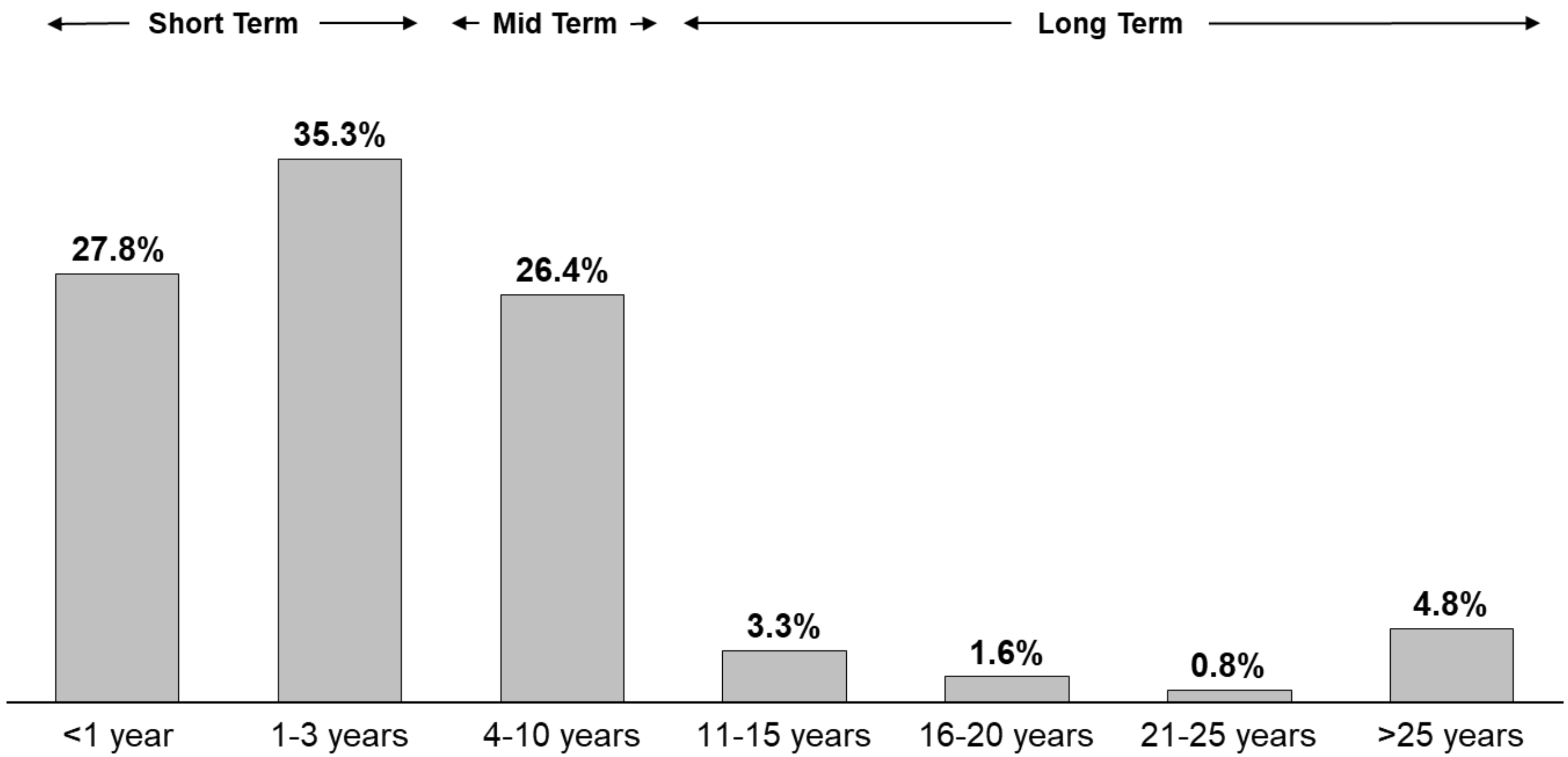

Figure 2: Categories of GHG emissions reduction projects

This figure presents the share of different categories of greenhouse gas emissions reduction projects actively pursued by U.S. stock-listed firms publicly reporting to the Carbon Disclosure Project (CDP) over the period 2013-2022. Project categories are directly taken from the CDP questionnaire.

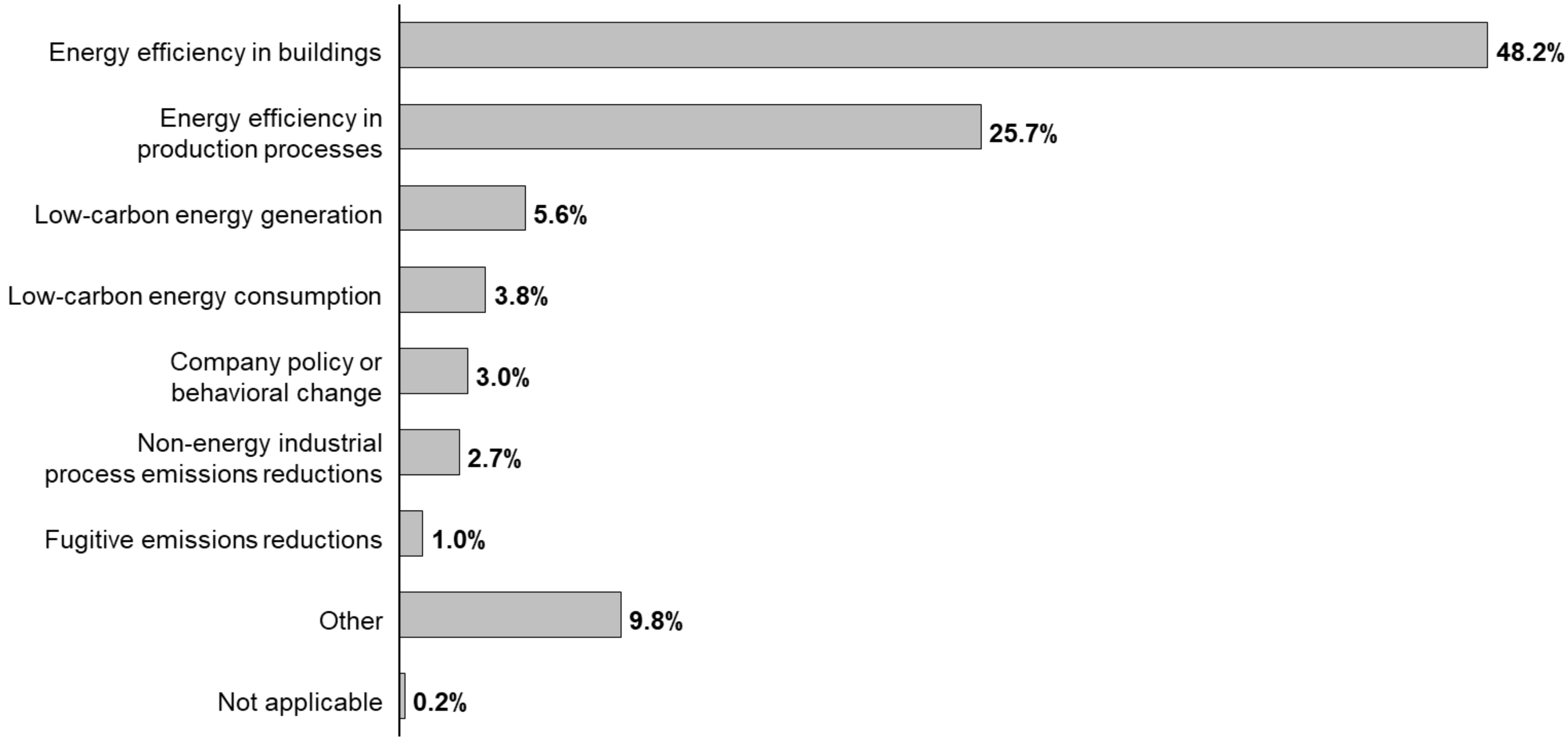

Figure 3: Top 5 subcategories of projects targeting energy efficiency in buildings and production processes

This figure presents the five most frequent subcategories of projects targeting energy efficiency in buildings and production processes actively pursued by U.S. stock-listed firms publicly reporting to the Carbon Disclosure Project (CDP) over the period 2013-2022. Project subcategories are directly taken from the CDP questionnaire. The share of each subcategory within the main category "energy efficiency" is shown in parentheses below the subcategory name. Light and dark grey bars illustrate the average share of short-and long-term payback periods (i.e., ≤ 3 years vs. >10 years) per subcategory.

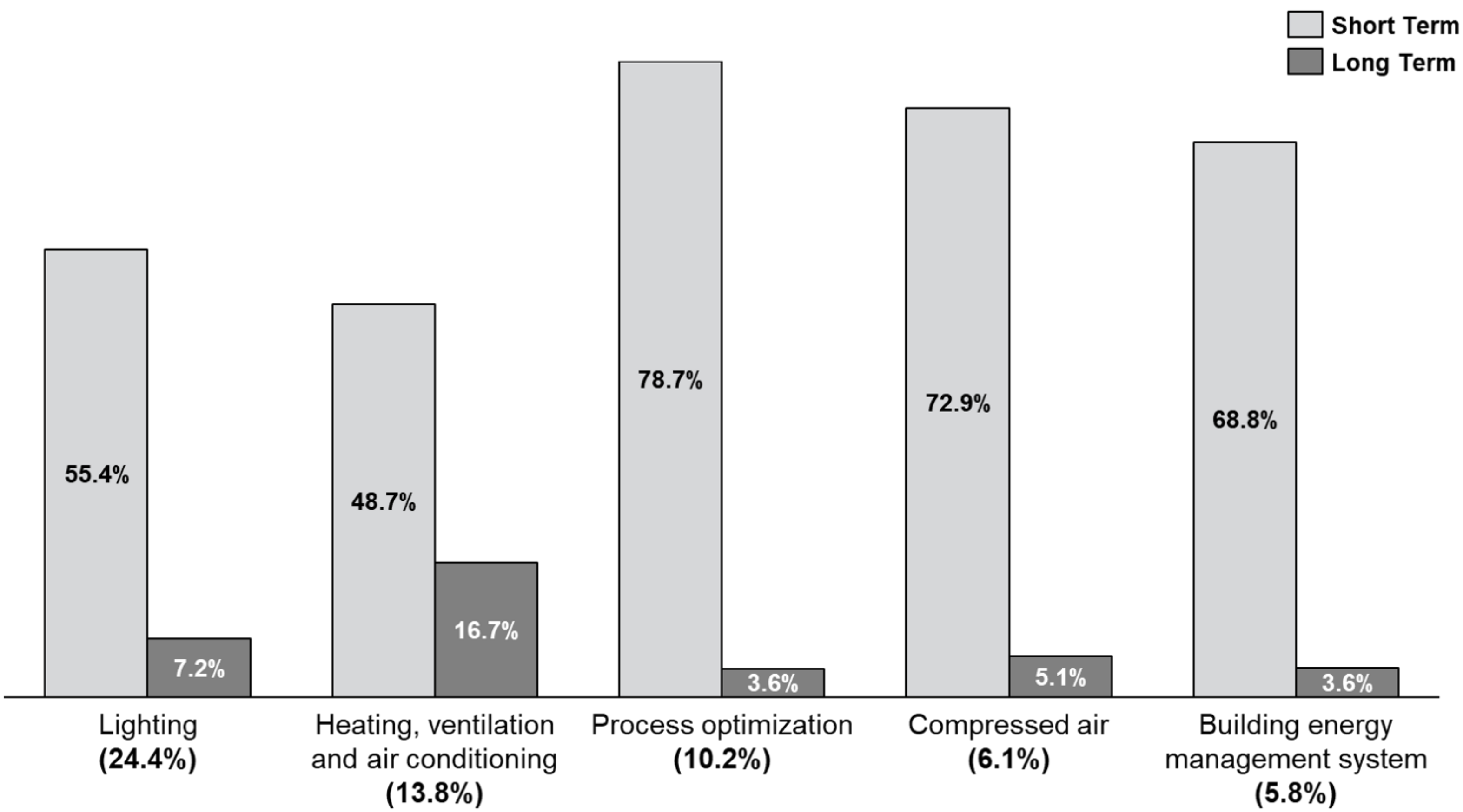

Figure 4A: Firm-level time series analysis – Share of short-term projects in %

This figure presents the share of short-term GHG emissions reduction projects actively pursued by U.S. stock-listed firms publicly reporting to the Carbon Disclosure Project (CDP) over the period 2013-2022. Short-term projects are those with a payback period of at most three years. The figure shows the mean and median share of short-term projects for firms in their first, second, third, etc. year in the sample. Firms may have reported to the CDP before 2013.

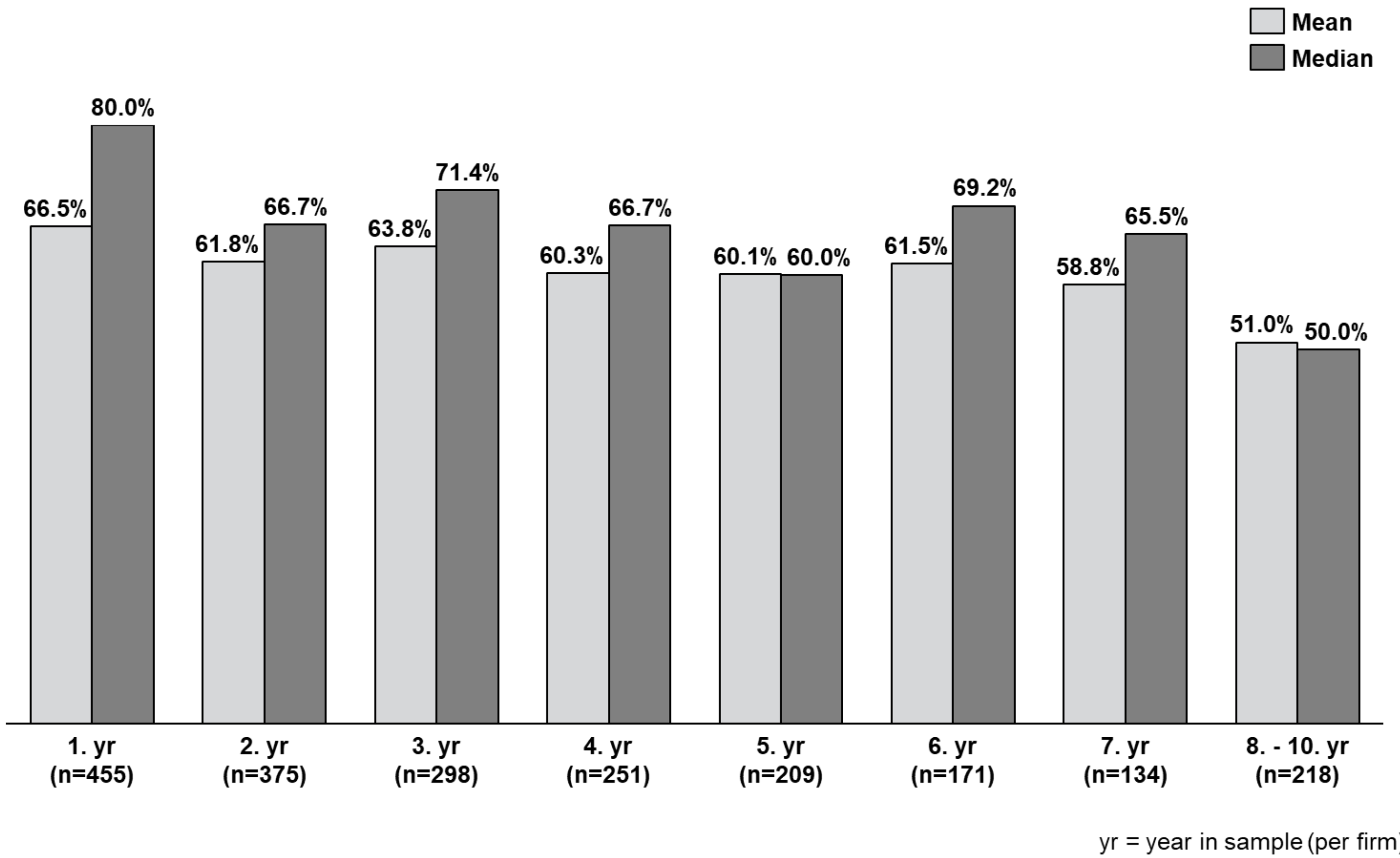

Figure 4B: Firm-level time series analysis – Investments (in US$)

This figure presents the US$ amount invested in GHG emissions reduction projects actively pursued by U.S. stock-listed firms publicly reporting to the Carbon Disclosure Project (CDP) over the period 2013-2022. The figure shows the mean and median US$ amount invested per project for firms in their first, second, third, etc. year in the sample. Firms may have reported to the CDP before 2013.

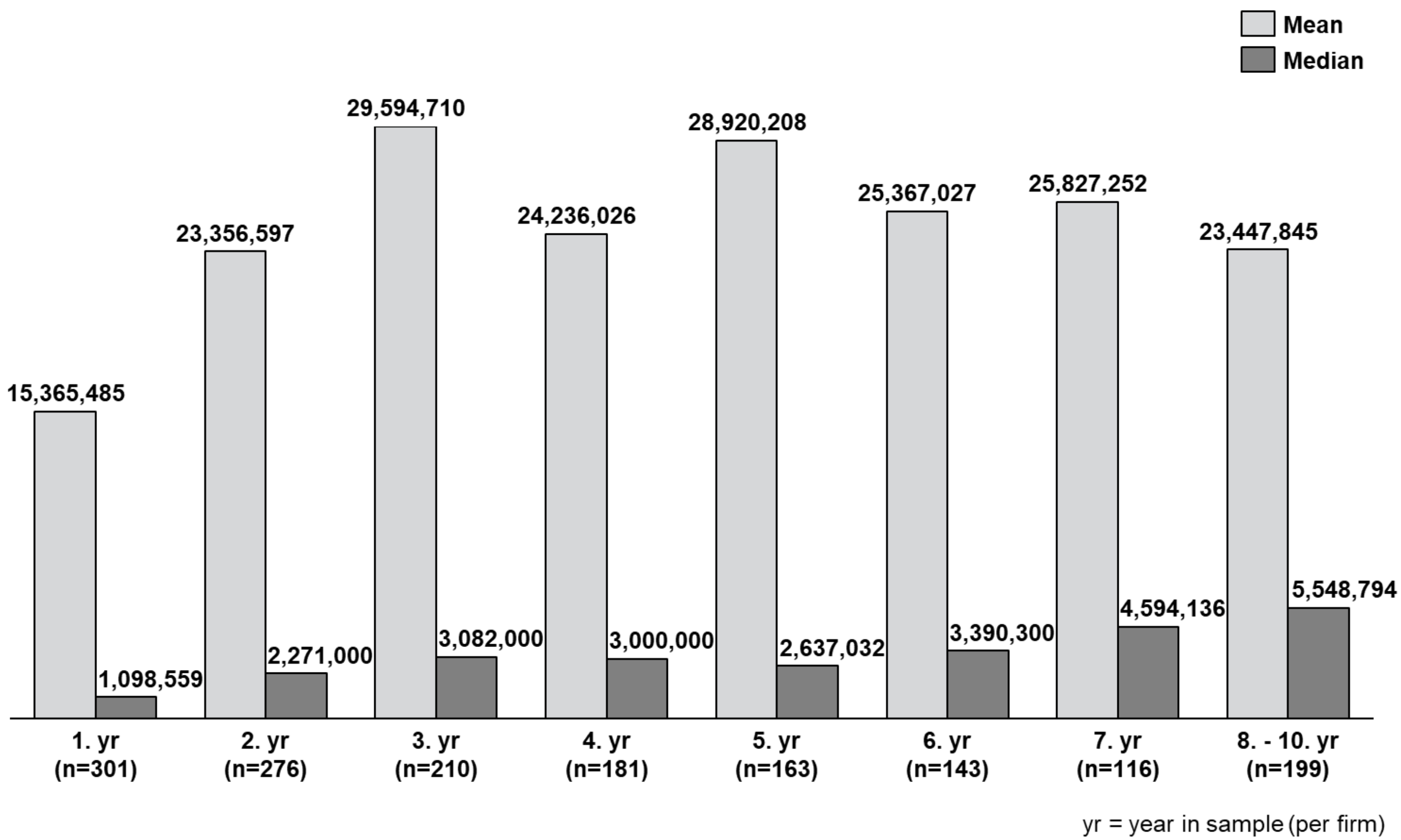

Figure 4C: Firm-level time series analysis – Annual CO2 savings (in tons)/investments (in US$)

This figure presents the ratio of annual CO2 savings in tons relative to the US$ amount invested in GHG emissions reduction projects actively pursued by U.S. stock-listed firms publicly reporting to the Carbon Disclosure Project (CDP) over the period 2013-2022. The figure shows the mean and median ratio of annual CO2 savings in tons relative to the US$ amount invested per project for firms in their first, second, third, etc. year in the sample. Firms may have reported to the CDP before 2013.

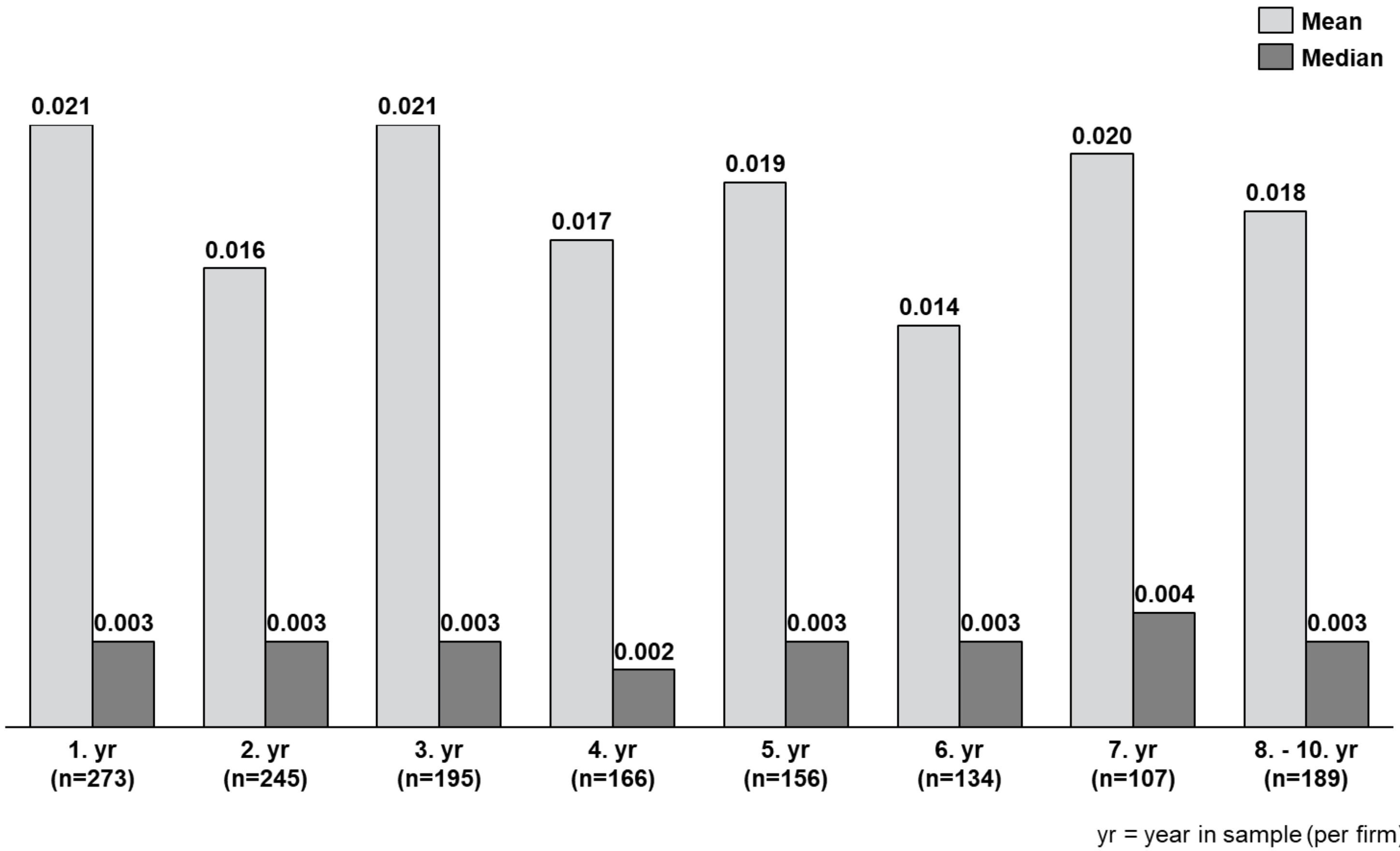

Figure 4D: Firm-level time series analysis – Annual monetary savings/investments (in US$)

This figure presents the ratio of annual monetary savings in US$ relative to the US$ amount invested in GHG emissions reduction projects actively pursued by U.S. stock-listed firms publicly reporting to the Carbon Disclosure Project (CDP) over the period 2013-2022. The figure shows the mean and median ratio of annual monetary savings in USD relative to the USD amount invested per project for firms in their first, second, third, etc. year in the sample. Firms may have reported to the CDP before 2013.

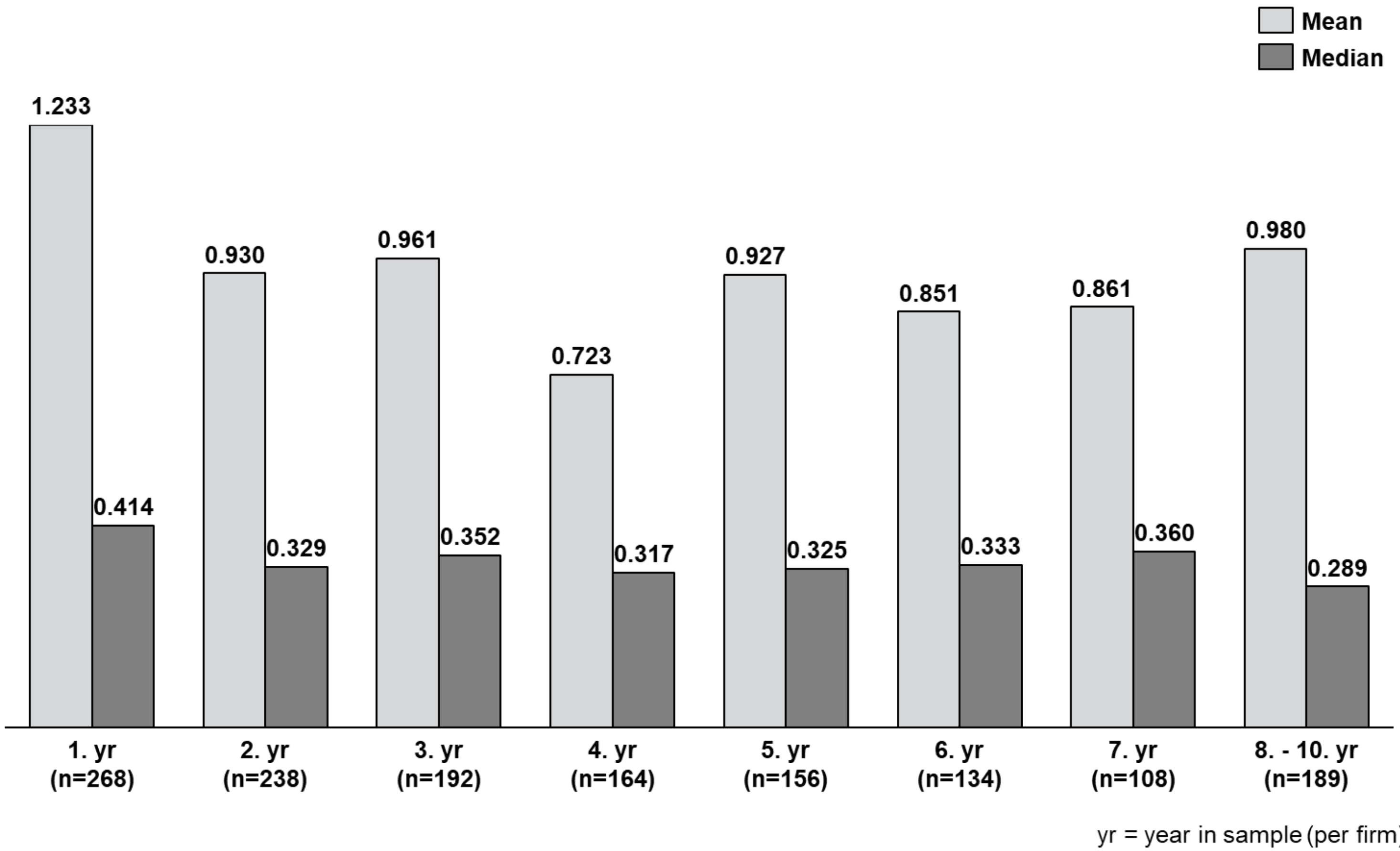

Table 1: Distribution of short-term GHG emissions reduction projects across industries

This table shows the share of short-term projects, i.e., projects with a payback period of at most three years, across the ten most common two-digit SIC industries in the sample. The sample covers U.S. stock-listed firms publicly reporting to the Carbon Disclosure Project (CDP) between 2013 and 2022. The table also shows the 10th and 90th percentiles of the within-industry firm-level values for the variable *Short-term payback*.

			Short-term payback		
Industry	**SIC**	**# projects**	***Mean***	***p10 firm level***	***p90 firm level***
Chemicals & Allied Products	28	1,407	62%	21%	100%
Food & Kindred Products	20	905	62%	23%	100%
Industrial & Commercial Machinery, Computer Equipm.	35	730	66%	48%	100%
Electronic & Other Electrical Equipment & Components	36	608	74%	30%	100%
Business Services	73	599	69%	25%	100%
Electric, Gas & Sanitary Services	49	543	40%	0%	88%
Transportation Equipment	37	434	65%	4%	100%
Depository Institutions	60	399	49%	0%	76%
Measuring, Photogr., Medical, Optical Goods, Clocks	38	372	63%	40%	97%
Other	-	3,940	65%	8%	100%
Total		**9,937**	**63%**		

Table 2: Descriptive statistics

Panel A: At the project level

This table presents project-level summary statistics for both emissions reduction projects and firm characteristics. The sample covers U.S. stock-listed firms publicly reporting to the Carbon Disclosure Project (CDP) between 2013 and 2022. All continuous non-logarithmized variables are winsorized at the 1st and 99th percentiles. Appendix B provides variable definitions.

	N	Mean	P25	Median	P75	StD
Project characteristics:						
Short-term payback	9,937	0.63				0.48
Investment (in $)	9,032	9,084,193	8,003	127,048	1,000,000	47,214,956
No investment required	9,032	0.16				0.37
Annual CO2 savings (in tons)	9,589	32,252	85	545	4,000	157,230
Annual CO2 savings/investment	7,474	0.18	0.001	0.002	0.006	1.30
Annual monetary savings (in $)	9,091	1,728,766	11,274	71,059	438,000	7,158,569
Annual monetary savings/investment	7,385	10.27	0.15	0.34	0.78	74.21
Energy efficiency in buildings or production	9,913	0.74				0.44
Lifetime CO2 savings (in tons)	7,084	210,784	670	4,318	28,016	1,054,916
Lifetime monetary savings (in $)	6,775	12,697,134	105,105	664,000	3,782,000	51,002,286
Low-carbon energy consumption/generation	9,913	0.09				0.29
Net present value (NPV) (in $)	6,643	1,767,322	0	83,985	736,309	16,998,666
Negative NPV	6,643	0.24				0.43
Firm characteristics:						
# years to emissions target	9,937	6.09	2.00	5.00	9.00	5.42
Capex/at $_{t-1}$	9,937	0.04	0.02	0.03	0.05	0.03
ESG rating $_{t-1}$	9,937	5.41	3.90	5.50	7.00	2.24
Ln(operations emissions market) $_{t-1}$	9,937	13.24	11.83	13.35	14.35	1.99
Ln(total assets) $_{t-1}$	9,937	10.04	9.00	9.84	11.01	1.52
MTB $_{t-1}$	9,937	3.59	1.65	3.00	5.01	13.64
Net debt/at $_{t-1}$	9,937	0.19	0.06	0.18	0.31	0.18
R&D/at $_{t-1}$	9,937	0.02	0	0.01	0.03	0.04
ROA $_{t-1}$	9,937	0.06	0.03	0.06	0.10	0.06
S&P 500	9,937	0.82				0.38
Short selling $_{t-1}$	9,937	0.04	0.02	0.03	0.05	0.04

Panel B: At the firm level

This table presents firm-level summary statistics for both emissions reduction projects and firm characteristics. The sample covers U.S. stock-listed firms publicly reporting to the Carbon Disclosure Project (CDP) between 2013 and 2022. Unless only fewer observations are available, the statistics refer to the 2,111 firm-years in the final sample. All continuous non-logarithmized variables are winsorized at the 1st and 99th percentiles. *% short-term projects* is the share of a firm's projects with short-term payback relative to all of the firms projects in a calendar year. *Investment (in $)* is the sum of all USD investment amounts of all projects a firm takes on in a calendar year, i.e., a firm's overall USD amount invested in GHG emissions reduction projects per year. Appendix B provides variable definitions.

	N	Mean	P25	Median	P75	StD
Project characteristics:						
% short-term projects	2,111	0.61	0.33	0.67	1.00	0.37
Investment (in $)	1,589	72,815,357	464,963	2,835,140	14,600,000	326,725,105
Investment/capex	1,492	0.08	0.00	0.01	0.02	0.37
Investment $_t$ /net income $_{t-1}$	1,589	0.06	0.00	0.002	0.01	0.31
Firm characteristics:						
# years to emissions target	2,111	6.18	2.50	5.00	9.00	5.46
Capex/at $_{t-1}$	2,111	0.04	0.01	0.03	0.05	0.03
Environmental rating $_{t+1}$	2,106	6.06	4.40	5.80	7.40	2.19
ESG rating $_{t-1}$	2,111	5.29	3.80	5.40	6.84	2.14
Ln(operations emissions market) $_{t-1}$	2,111	13.09	11.54	12.94	14.52	2.23
Ln(total assets) $_{t-1}$	2,111	9.99	8.92	9.86	10.88	1.54
MTB $_{t-1}$	2,111	4.12	1.60	2.80	4.95	11.05
Net debt/at $_{t-1}$	2,111	0.19	0.05	0.18	0.32	0.18
R&D/at $_{t-1}$	2,111	0.02	0	0.003	0.03	0.04
ROA $_{t-1}$	2,111	0.06	0.02	0.05	0.09	0.06
S&P 500	2,111	0.81				0.39
Short selling $_{t-1}$	2,111	0.05	0.02	0.03	0.06	0.04

Table 3: Which firms are more/less likely to take on short-term payback projects?

Panel A: External market forces and emissions-related firm forces

This table presents results from project-level OLS regressions of *Short-term payback* on two sets of variables capturing external market forces and emissions-related firm forces along with control variables and varying combinations of fixed effects (FE). *Short-term payback* is an indicator that equals one if the project's payback period is ≤ 3 years. S*&P 500*, *Short selling*, and *ESG score* capture external market forces, i.e., pressure from (Big Three) investors, short sellers, and ESG rating agencies. The variables *# years to emission target* and *Ln(operations emissions market)* capture emissions-related firm forces (i.e., firm commitments and the need to achieve CO2 reductions). The regression in column (1) includes fiscal year and (4-digit SIC) industry FE, that in column (2) additionally includes scope (CO2 saving scopes 1, 2 and 3 as well as combinations thereof) and U.S. state FE, the regression in column (3) includes industry*fiscal year, scope and U.S. state FE, and that in column (4) includes fiscal year, firm and scope FE. Standard errors are clustered at the firm level. t-statistics are reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively. All variables are defined in Appendix B.

	Short-term payback			
	(1)	(2)	(3)	(4)
External market forces:				
S&P 500	-0.097***	-0.120***	-0.103**	-0.105**
	(-2.759)	(-3.654)	(-2.441)	(-2.044)
ESG rating $_{t-1}$	0.003	0.006	0.009	0.004
	(0.481)	(0.985)	(1.144)	(0.580)
Short selling $_{t-1}$	0.638***	0.591**	0.814**	0.187
	(2.730)	(2.336)	(2.366)	(0.709)
Emissions-related firm forces:				
# years to emissions target	-0.005**	-0.004**	-0.005**	-0.003*
	(-2.397)	(-2.093)	(-2.059)	(-1.809)
Ln(operations emissions market) $_{t-1}$	0.044***	0.050***	0.060***	-0.017
	(3.438)	(3.715)	(3.768)	(-1.006)
Firm controls:				
Net debt/at $_{t-1}$	0.162*	0.144*	0.138	0.151
	(1.768)	(1.652)	(1.419)	(1.237)
Ln(total assets) $_{t-1}$	-0.032*	-0.036**	-0.054***	0.009
	(-1.879)	(-2.354)	(-2.999)	(0.247)
ROA $_{t-1}$	-0.364**	-0.471***	-0.514**	-0.367**
	(-2.081)	(-2.680)	(-2.079)	(-2.211)
Capex/at $_{t-1}$	0.502	-0.026	-0.530	0.385
	(0.834)	(-0.042)	(-0.586)	(0.703)
R&D/at $_{t-1}$	-0.411	-0.711	-0.920*	-0.555
	(-0.760)	(-1.599)	(-1.936)	(-0.565)
MTB $_{t-1}$	-0.001***	-0.001***	-0.003***	-0.001***
	(-3.768)	(-3.398)	(-4.822)	(-2.622)
Fiscal year FE	YES	YES	NO	YES
Scope FE	NO	YES	YES	YES
Industry FE	YES	YES	NO	NO
Firm FE	NO	NO	NO	YES
Industry*Fiscal year FE	NO	NO	YES	NO
U.S. state FE	NO	YES	YES	NO
Observations	9,937	9,899	9,731	9,914
Adjusted R-squared	0.145	0.164	0.201	0.223

Panel B: CEO incentives

This table presents results from re-estimating the OLS regressions presented in Panel A, including additional variables measuring CEO incentives. CEO incentive measures are *CEO age*, *CEO tenure*, *Option awards / TDC1*, *Ln(TDC1)* and *Shares owned*. All CEO data is from ExecuComp. The regressions include fewer observations than those in Panel A because CEO data is not available for all firm-years. Standard errors are clustered at the firm level. t-statistics are reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively. All variables are defined in Appendix B.

	Short-term payback			
	(1)	(2)	(3)	(4)
CEO incentives:				
CEO age	-0.004*	-0.005**	-0.007***	-0.002
	(-1.691)	(-2.526)	(-2.603)	(-0.671)
CEO tenure	0.002	0.001	-0.000	0.002
	(0.858)	(0.521)	(-0.139)	(0.849)
Option awards/TDC 1	0.076	0.098*	0.192**	0.005
	(1.293)	(1.664)	(2.318)	(0.080)
Ln(TDC 1)	0.003	0.000	0.002	-0.001
	(0.426)	(0.051)	(0.175)	(-0.110)
Shares owned	0.000	0.002	-0.010	0.018
	(0.000)	(0.223)	(-0.725)	(1.320)
Variables from Panel A:				
S&P 500	-0.106***	-0.137***	-0.130***	-0.111**
	(-2.677)	(-3.882)	(-2.876)	(-2.210)
ESG rating $_{t-1}$	0.004	0.006	0.009	0.004
	(0.628)	(1.072)	(1.097)	(0.582)
Short selling $_{t-1}$	0.570**	0.487*	0.853**	0.168
	(2.303)	(1.859)	(2.251)	(0.629)
# years to emissions target	-0.006***	-0.004**	-0.006**	-0.003*
	(-2.773)	(-2.467)	(-2.283)	(-1.922)
Ln(operations emissions market) $_{t-1}$	0.042***	0.048***	0.059***	-0.020
	(3.078)	(3.472)	(3.491)	(-1.153)
Net debt/at $_{t-1}$	0.153	0.131	0.103	0.177
	(1.595)	(1.429)	(1.030)	(1.388)
Ln(total assets) $_{t-1}$	-0.026	-0.027*	-0.044**	0.006
	(-1.444)	(-1.692)	(-2.384)	(0.142)
ROA $_{t-1}$	-0.327*	-0.434**	-0.436	-0.321*
	(-1.742)	(-2.295)	(-1.642)	(-1.800)
Capex/at $_{t-1}$	0.492	-0.024	-0.553	0.415
	(0.775)	(-0.037)	(-0.594)	(0.733)
R&D/at $_{t-1}$	-0.395	-0.649	-0.846*	-0.698
	(-0.675)	(-1.437)	(-1.799)	(-0.696)
MTB $_{t-1}$	-0.001***	-0.001***	-0.003***	-0.001**
	(-3.739)	(-3.309)	(-4.526)	(-2.448)
Fiscal year FE	YES	YES	NO	YES
Scope FE	NO	YES	YES	YES
Industry FE	YES	YES	NO	NO
Firm FE	NO	NO	NO	YES
Industry*Fiscal year FE	NO	NO	YES	NO
U.S. state FE	NO	YES	YES	NO
Observations	9,533	9,495	9,342	9,517
Adjusted R-squared	0.142	0.164	0.202	0.219

Table 4: Outcomes of short-term projects – Annual monetary and CO2 savings

Panel A: Annual monetary savings per dollar invested

This table presents results from project-level OLS regressions of *Annual monetary savings/investment* on *Short-term payback* along with control variables and varying combinations of fixed effects (FE). The regressions include fewer observations because all projects that do not necessitate investments must be excluded. *Annual monetary savings/investment* measures a project's annual monetary savings in USD relative to the USD amount invested in the project. *Short-term payback* is an indicator that equals one if the project's payback period is ≤ 3 years. The regression in column (1) includes fiscal year and industry FE, that in column (2) additionally includes scope (CO2 saving scopes 1, 2 and 3 as well as combinations thereof) and U.S. state FE, the regression in column (3) includes industry*fiscal year, scope and U.S. state FE, and that in column (4) includes fiscal year, firm and scope FE. Standard errors are clustered at the firm level. t-statistics are reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively. All variables are defined in Appendix B.

	Annual monetary savings/investment				**Ln(Annual monetary savings)**	
	(1)	(2)	(3)	(4)	(5)	(6)
Short-term payback	**10.892*** **	**10.716*** **	**8.974*** **	**9.950*** **	**0.457*** **	**0.482*** **
	(3.073)	**(3.081)**	**(2.931)**	**(2.819)**	**(6.031)**	**(6.462)**
S&P 500	-23.506	-28.476*	-19.326**	-53.483	0.182	0.087
	(-1.562)	(-1.657)	(-2.205)	(-1.075)	(0.691)	(0.320)
ESG rating $_{t-1}$	3.720*	3.152**	4.410**	0.546	0.026	-0.012
	(1.821)	(2.010)	(2.137)	(0.375)	(0.753)	(-0.352)
Short selling $_{t-1}$	-106.173	-102.546	-144.284	-81.341	1.049	0.567
	(-1.423)	(-1.339)	(-1.202)	(-1.188)	(0.656)	(0.410)
# years to emissions target	-0.215	0.115	0.276	-0.077	-0.022*	-0.001
	(-0.537)	(0.367)	(0.532)	(-0.372)	(-1.881)	(-0.061)
Ln(operations emissions market) $_{t-1}$	7.928	7.143	7.660	-2.379	0.217***	-0.038
	(1.522)	(1.608)	(1.119)	(-0.910)	(2.670)	(-0.431)
Net debt/at $_{t-1}$	45.222	37.240	47.078	32.557	0.305	0.392
	(1.640)	(1.363)	(1.437)	(0.919)	(0.524)	(0.719)
Ln(total assets) $_{t-1}$	5.486	8.376	8.071	-2.703	0.181*	0.319
	(1.041)	(1.256)	(1.454)	(-0.502)	(1.828)	(1.186)
ROA $_{t-1}$	84.143	110.203	99.792	96.564	2.853**	1.098
	(1.373)	(1.597)	(1.622)	(1.112)	(2.207)	(1.002)
Capex/at $_{t-1}$	-344.142*	-293.484*	-215.577	-43.919	13.511***	-3.162
	(-1.840)	(-1.756)	(-0.951)	(-0.328)	(3.882)	(-0.679)
R&D/at $_{t-1}$	183.453	168.605	184.379	18.096	-4.498	-2.425
	(1.339)	(1.176)	(1.049)	(0.120)	(-1.344)	(-0.359)
MTB $_{t-1}$	0.121*	0.112**	0.229**	0.030	-0.004	-0.001
	(1.701)	(1.984)	(2.216)	(0.838)	(-1.532)	(-0.536)
Fiscal year FE	YES	YES	NO	YES	NO	YES
Scope FE	NO	YES	YES	YES	YES	YES
Industry FE	YES	YES	NO	NO	NO	NO
Firm FE	NO	NO	NO	YES	NO	YES
Industry*Fiscal year FE	NO	NO	YES	NO	YES	NO
U.S. state FE	NO	YES	YES	NO	YES	NO
Observations	7,381	7,350	7,153	7,358	8,188	8,382
Adjusted R-squared	0.240	0.275	0.355	0.500	0.477	0.477

Panel B: Annual CO2 savings

This table presents results from project-level OLS regressions of *Annual CO2 savings/investment* on *Short-term payback* along with control variables and varying combinations of fixed effects (FE). *Annual CO2 savings/ investment* measures a project's annual CO2 equivalent savings in tons relative to the USD amount invested in the project. *Short-term payback* is an indicator that equals one if the project's payback period is ≤ 3 years. The regression in column (1) includes fiscal year and industry FE, that in column (2) additionally includes scope (CO2 saving scopes 1, 2 and 3 as well as combinations thereof) and U.S. state FE, the regression in column (3) includes industry*fiscal year, scope and U.S. state FE, and that in column (4) includes fiscal year, firm and scope FE. Standard errors are clustered at the firm level. t-statistics are reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively. All variables are defined in Appendix B.

	Annual CO2 savings/investment				**Ln(annual CO2 savings)**	
	(1)	(2)	(3)	(4)	(5)	(6)
Short-term payback	**0.101****	**0.100****	**0.048**	**0.085****	**0.115***	**0.135****
	(2.315)	**(2.237)**	**(1.545)**	**(1.998)**	**(1.660)**	**(2.085)**
S&P 500	-0.426*	-0.513*	-0.410**	-0.696	0.152	0.315
	(-1.699)	(-1.795)	(-2.210)	(-0.877)	(0.646)	(1.258)
ESG rating $_{t-1}$	0.069*	0.062**	0.073**	0.020	0.073*	0.016
	(1.759)	(2.133)	(1.973)	(0.780)	(1.868)	(0.446)
Short selling $_{t-1}$	-1.926	-1.750	-2.319	-1.027	-0.360	0.071
	(-1.447)	(-1.327)	(-1.150)	(-1.146)	(-0.198)	(0.051)
# years to emissions target	-0.004	0.002	0.005	0.001	-0.017	0.002
	(-0.495)	(0.359)	(0.470)	(0.430)	(-1.185)	(0.199)
Ln(operations	0.163	0.138	0.125	-0.006	0.407***	0.180**
emissions market) $_{t-1}$	(1.565)	(1.575)	(1.004)	(-0.146)	(3.633)	(2.013)
Net debt/at $_{t-1}$	0.642	0.409	0.815	0.368	0.759	0.951
	(1.281)	(0.866)	(1.429)	(0.649)	(1.228)	(1.453)
Ln(total assets) $_{t-1}$	0.112	0.177	0.209*	-0.086	0.073	0.207
	(1.083)	(1.390)	(1.895)	(-0.918)	(0.617)	(0.708)
ROA $_{t-1}$	1.289	1.767	1.489	1.109	0.733	-0.953
	(1.321)	(1.618)	(1.530)	(0.808)	(0.479)	(-0.542)
Capex/at $_{t-1}$	-7.136*	-6.908**	-5.417	-1.519	13.750***	-11.491**
	(-1.954)	(-2.063)	(-1.266)	(-0.632)	(3.770)	(-2.229)
R&D/at $_{t-1}$	3.039	2.885	3.989	2.029	-0.983	8.396
	(1.134)	(1.042)	(1.192)	(0.893)	(-0.287)	(1.074)
MTB $_{t-1}$	0.002	0.002*	0.004**	0.001	-0.003	-0.001
	(1.599)	(1.696)	(2.109)	(1.130)	(-0.881)	(-0.222)
Fiscal year FE	YES	YES	NO	YES	NO	YES
Scope FE	NO	YES	YES	YES	YES	YES
Industry FE	YES	YES	NO	NO	NO	NO
Firm FE	NO	NO	NO	YES	NO	YES
Industry*Fiscal year FE	NO	NO	YES	NO	YES	NO
U.S. state FE	NO	YES	YES	NO	YES	NO
Observations	7,469	7,439	7,242	7,444	9,248	9,440
Adjusted R-squared	0.248	0.294	0.397	0.566	0.519	0.537

Table 5: Outcomes of short-term projects – Project categories

Panel A: Energy efficiency in buildings or production processes

This table presents results from project-level OLS regressions of *Energy efficiency in buildings or production* on *Short-term payback* along with control variables and varying combinations of fixed effects (FE). *Energy efficiency in buildings or production* is an indicator that equals one if a project targets energy efficiency in buildings or production processes to save CO2 emissions. *Short-term payback* is an indicator that equals one if the project's payback period is ≤ 3 years. The regression in column (1) includes fiscal year and industry FE, that in column (2) additionally includes scope (CO2 saving scopes 1, 2 and 3 as well as combinations thereof) and U.S. state FE, the regression in column (3) includes industry*fiscal year, scope and U.S. state FE, and that in column (4) includes fiscal year, firm and scope FE. Standard errors are clustered at the firm level. t-statistics are reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively. All variables are defined in Appendix B.

	Energy efficiency in buildings or production			
	(1)	(2)	(3)	(4)
Short-term payback	**0.009**	**0.022**	**0.027***	**0.029***
	(0.524)	**(1.458)**	**(1.784)**	**(1.934)**
S&P 500	0.034	0.025	0.038	-0.013
	(1.293)	(0.949)	(1.073)	(-0.373)
ESG rating $_{t-1}$	-0.001	-0.001	-0.003	0.000
	(-0.189)	(-0.234)	(-0.600)	(0.012)
Short selling $_{t-1}$	0.276	0.249	0.237	0.218
	(1.314)	(1.308)	(0.918)	(1.040)
# years to emissions target	-0.001	-0.001	0.001	-0.003*
	(-0.697)	(-0.637)	(0.763)	(-1.876)
Ln(operations emissions market) $_{t-1}$	0.000	-0.020	-0.014	-0.003
	(0.024)	(-1.577)	(-0.973)	(-0.162)
Net debt/at $_{t-1}$	0.019	0.028	-0.026	0.178**
	(0.240)	(0.433)	(-0.301)	(2.056)
Ln(total assets) $_{t-1}$	-0.007	0.009	0.010	-0.039
	(-0.414)	(0.583)	(0.564)	(-1.053)
ROA $_{t-1}$	0.046	0.132	0.021	0.269*
	(0.263)	(0.853)	(0.112)	(1.679)
Capex/at $_{t-1}$	-0.325	0.073	-0.391	1.107*
	(-0.728)	(0.157)	(-0.696)	(1.761)
R&D/at $_{t-1}$	-0.289	0.087	0.147	-0.758
	(-0.667)	(0.191)	(0.280)	(-1.287)
MTB $_{t-1}$	0.000	0.000	-0.000	0.000
	(0.645)	(0.178)	(-0.895)	(0.295)
Fiscal year FE	YES	YES	NO	YES
Scope FE	NO	YES	YES	YES
Industry FE	YES	YES	NO	NO
Firm FE	NO	NO	NO	YES
Industry*Fiscal year FE	NO	NO	YES	NO
U.S. state FE	NO	YES	YES	NO
Observations	9,912	9,874	9,708	9,892
Adjusted R-squared	0.179	0.249	0.276	0.293

Panel B: Low carbon energy consumption and generation

This table presents results from project-level OLS regressions of *Low carbon energy consumption/generation* on *Short-term payback* along with control variables and varying combinations of fixed effects (FE). *Low carbon energy consumption/generation* is an indicator that equals one if a project targets low carbon energy efficiency consumption and generation to save CO_2 emissions. *Short-term payback* is an indicator that equals one if the project's payback period is ≤ 3 years. The regression in column (1) includes fiscal year and industry FE, that in column (2) additionally includes scope (CO_2 saving scopes 1, 2 and 3 as well as combinations thereof) and U.S. state FE, the regression in column (3) includes industry*fiscal year, scope and U.S. state FE, and that in column (4) includes fiscal year, firm and scope FE. Standard errors are clustered at the firm level. t-statistics are reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively. All variables are defined in Appendix B.

	Low carbon energy consumption/generation			
	(1)	(2)	(3)	(4)
Short-term payback	**-0.097*** **	**-0.094*** **	**-0.094*** **	**-0.092*** **
	(-7.983)	**(-7.796)**	**(-7.395)**	**(-7.492)**
S&P 500	-0.015	-0.019	-0.028	-0.016
	(-0.796)	(-0.952)	(-1.150)	(-0.373)
ESG rating $_{t-1}$	0.002	0.004	0.005	-0.001
	(0.884)	(1.370)	(1.321)	(-0.476)
Short selling $_{t-1}$	-0.197*	-0.247**	-0.273	-0.036
	(-1.864)	(-2.040)	(-1.573)	(-0.233)
# years to emissions target	0.001	0.000	0.000	0.001
	(0.674)	(0.357)	(0.186)	(1.051)
Ln(operations emissions market) $_{t-1}$	0.005	0.012*	0.008	0.016
	(0.816)	(1.662)	(0.899)	(1.610)
Net debt/at $_{t-1}$	-0.001	-0.001	-0.048	0.006
	(-0.022)	(-0.019)	(-0.900)	(0.098)
Ln(total assets) $_{t-1}$	-0.000	-0.006	-0.002	0.019
	(-0.024)	(-0.565)	(-0.137)	(0.942)
ROA $_{t-1}$	-0.152	-0.142	-0.125	-0.195*
	(-1.514)	(-1.471)	(-1.039)	(-1.798)
Capex/at $_{t-1}$	0.035	-0.043	0.260	-0.979***
	(0.161)	(-0.174)	(0.781)	(-3.057)
R&D/at $_{t-1}$	0.126	-0.120	-0.164	1.008**
	(0.505)	(-0.500)	(-0.573)	(2.583)
MTB $_{t-1}$	0.000	0.000	0.001***	0.000
	(1.065)	(0.830)	(2.847)	(0.903)
Fiscal year FE	YES	YES	NO	YES
Scope FE	NO	YES	YES	YES
Industry FE	YES	YES	NO	NO
Firm FE	NO	NO	NO	YES
Industry*Fiscal year FE	NO	NO	YES	NO
U.S. state FE	NO	YES	YES	NO
Observations	9,912	9,874	9,708	9,892
Adjusted R-squared	0.081	0.098	0.107	0.145

Table 6: Project lifetime outcomes – Lifetime CO2 savings, monetary savings, and NPV

Panel A: Total lifetime CO2 savings

This table presents results from project-level OLS regressions of *Ln(Lifetime CO2 savings)* on *Short-term payback* (columns 1 to 4) or *Low-carbon energy consumption/generation* (columns 5 and 6) along with control variables and varying combinations of fixed effects (FE). *Ln(Lifetime CO2 savings)* is the natural logarithm of a project's total lifetime CO2 savings in tons. *Short-term payback* is an indicator that equals one if the project's payback period is ≤ 3 years. *Low-carbon energy consumption/generation* is an indicator that equals one if a project targets low-carbon energy efficiency consumption and generation to save CO2 emissions. The regressions include fewer observations because data on project lifetimes is not available for all projects. The regression in column (1) includes fiscal year and industry FE, that in column (2) additionally includes scope (CO2 saving scopes 1, 2 and 3 as well as combinations thereof) and U.S. state FE, the regression in column (3) includes industry*fiscal year, scope and U.S. state FE, and that in column (4) includes fiscal year, firm and scope FE. Standard errors are clustered at the firm level. t-statistics are reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively. All variables are defined in Appendix B.

	Ln(Lifetime CO2 savings)					
	(1)	(2)	(3)	(4)	(5)	(6)
Short-term payback	**-0.274*** **	**-0.325*** **	**-0.337*** **	**-0.248*** **		
	(-3.348)	**(-4.115)**	**(-4.235)**	**(-3.311)**		
Low-carbon energy consumption/generation					**1.034*** **	**0.876*** **
					(6.099)	**(5.236)**
S&P 500	0.780***	0.436**	0.467*	0.329	0.573**	0.336
	(3.444)	(1.989)	(1.877)	(0.988)	(2.419)	(0.998)
ESG rating $_{t-1}$	-0.004	0.016	0.007	0.010	0.006	0.008
	(-0.106)	(0.430)	(0.158)	(0.182)	(0.147)	(0.142)
Short selling $_{t-1}$	0.204	0.095	-1.911	-0.346	-1.498	-0.514
	(0.124)	(0.061)	(-0.984)	(-0.192)	(-0.765)	(-0.286)
# years to emissions target	0.002	0.000	-0.007	0.011	-0.005	0.011
	(0.183)	(0.011)	(-0.526)	(0.909)	(-0.360)	(0.939)
Ln(operations emissions market) $_{t-1}$	0.446***	0.422***	0.317***	0.185*	0.289**	0.171
	(5.339)	(4.477)	(2.699)	(1.725)	(2.579)	(1.604)
Net debt/at $_{t-1}$	0.730	0.554	0.584	0.792	0.526	0.827
	(1.126)	(0.909)	(0.879)	(1.078)	(0.826)	(1.149)
Ln(total assets) $_{t-1}$	-0.054	0.017	0.094	0.081	0.119	0.066
	(-0.504)	(0.146)	(0.744)	(0.264)	(0.996)	(0.217)
ROA $_{t-1}$	-0.406	-1.304	0.082	-2.430	0.496	-2.196
	(-0.237)	(-0.745)	(0.055)	(-1.139)	(0.354)	(-1.027)
Capex/at $_{t-1}$	5.764	4.121	14.978***	-15.406***	14.939***	-14.793**
	(1.477)	(0.954)	(3.592)	(-2.609)	(3.622)	(-2.549)
R&D/at $_{t-1}$	1.194	-2.140	-3.206	6.987	-3.759	6.286
	(0.334)	(-0.631)	(-0.832)	(0.884)	(-1.054)	(0.798)
MTB $_{t-1}$	-0.001	-0.002	-0.006*	-0.001	-0.007*	-0.000
	(-0.315)	(-0.451)	(-1.706)	(-0.202)	(-1.844)	(-0.141)
Fiscal year FE	YES	YES	NO	YES	NO	YES
Scope FE	NO	YES	YES	YES	YES	YES
Industry FE	YES	YES	NO	NO	NO	NO
Firm FE	NO	NO	NO	YES	NO	YES
Industry*Fiscal year FE	NO	NO	YES	NO	YES	NO
U.S. state FE	NO	YES	YES	NO	YES	NO
Observations	7,008	6,984	6,813	6,981	6,790	6,959
Adjusted R-squared	0.444	0.468	0.526	0.530	0.534	0.535

Panel B: Total lifetime monetary savings and net present value (NPV)

This table presents results from project-level OLS regressions of *Ln(Lifetime monetary savings)* (columns 1 and 2) or *NPV* (columns 3 and 4) or *Negative NPV* (columns 5 and 6) on *Short-term payback* along with control variables and varying combinations of fixed effects (FE). *Ln(Lifetime monetary savings)* is the natural logarithm of a project's total lifetime monetary savings in tons, while *NPV* is the project's net present value in 1,000 USD. *Negative NPV* is an indicator that equals one if a project's NPV is negative. *Short-term payback* is an indicator that equals one if the project's payback period is ≤ 3 years. The regressions include fewer observations because data on project lifetimes is not available for all projects. The regression in columns (1), (3) and (5) include industry*fiscal year FE as well as scope (CO2 saving scopes 1, 2 and 3 as well as combinations thereof) and U.S. state FE, while the regressions in column (2), (4) and (6) include fiscal year, firm and scope FE. Standard errors are clustered at the firm level. t-statistics are reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively. All variables are defined in Appendix B.

	Ln(Lifetime monetary savings)		**NPV**		**Negative NPV**	
	(1)	(2)	(3)	(4)	(5)	(6)
Short-term payback	**-0.029**	**0.029**	**3,554.947*** **	**3,375.086*** **	**-0.417*** **	**-0.406*** **
	(-0.366)	**(0.395)**	**(3.715)**	**(3.831)**	**(-20.995)**	**(-22.153)**
S&P 500	0.661**	0.508	559.006	3,048.553	0.063*	0.006
	(2.144)	(1.448)	(0.447)	(1.646)	(1.843)	(0.093)
ESG rating $_{t-1}$	-0.065	-0.027	-90.309	-85.212	-0.001	0.010*
	(-1.578)	(-0.553)	(-0.364)	(-0.316)	(-0.255)	(1.652)
Short selling $_{t-1}$	0.420	1.372	9,746.684	15,164.201	-0.372	-0.100
	(0.234)	(0.826)	(1.045)	(1.389)	(-1.181)	(-0.362)
# years to emissions target	-0.019*	0.004	-99.147	-34.340	0.002	0.001
	(-1.689)	(0.340)	(-1.269)	(-0.532)	(1.007)	(0.455)
Ln(operations emissions	0.075	0.016	-162.906	608.703	-0.005	-0.009
market) $_{t-1}$	(0.833)	(0.128)	(-0.316)	(0.904)	(-0.407)	(-0.602)
Net debt/at $_{t-1}$	-0.175	0.369	-825.489	5,212.469	-0.042	-0.155*
	(-0.290)	(0.554)	(-0.291)	(1.437)	(-0.594)	(-1.841)
Ln(total assets) $_{t-1}$	0.212*	0.187	617.956	-566.555	-0.027*	0.040
	(1.908)	(0.675)	(0.751)	(-0.351)	(-1.700)	(0.982)
ROA $_{t-1}$	2.798*	-0.100	11,618.171	8,128.104	0.022	0.174
	(1.937)	(-0.078)	(1.521)	(1.182)	(0.109)	(0.915)
Capex/at $_{t-1}$	14.910***	-7.968	58,877.240**	-38,927.855	-0.285	0.292
	(3.546)	(-1.322)	(2.212)	(-1.245)	(-0.506)	(0.504)
R&D/at $_{t-1}$	-5.818*	-0.990	-14,978.421	17,636.362	-0.113	1.420**
	(-1.878)	(-0.123)	(-1.418)	(0.886)	(-0.345)	(2.105)
MTB $_{t-1}$	-0.008**	-0.001	-0.539	1.606	0.002**	0.001*
	(-2.512)	(-0.451)	(-0.031)	(0.090)	(2.474)	(1.867)
Fiscal year FE	NO	YES	NO	YES	NO	YES
Scope FE	YES	YES	YES	YES	YES	YES
Firm FE	NO	YES	NO	YES	NO	YES
Industry*Fiscal year FE	YES	NO	YES	NO	YES	NO
U.S. state FE	YES	NO	YES	NO	YES	NO
Observations	6,172	6,341	6,456	6,615	6,456	6,615
Adjusted R-squared	0.468	0.455	0.190	0.208	0.347	0.343

Table 7: Firm-level outcomes

Panel A: ESG ratings

This table presents results from firm-level OLS regressions of *Environmental rating* $_{t+1}$ on *% short-term projects* along with control variables and varying combinations of fixed effects (FE). *Environmental rating* $_{t+1}$ is the firm's numeric environment-related ESG rating (by MSCI) at the end of the next fiscal year. *% short-term projects* is a firm's annual share of short-term projects that have a payback period of ≤ 3 years out of all of its GHG emissions reduction projects in the fiscal year. The regressions in columns (1) and (3) include firm and fiscal year FE, the regressions in columns (2) and (4) include (4-digit SIC) industry and fiscal year FE. Standard errors are clustered at the firm level. t-statistics are reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively. All variables are defined in Appendix B.

	Environmental rating $_{t+1}$			
	(1)	(2)	(3)	(4)
% short-term projects	**0.209****	**0.270***	**0.210****	**0.205****
	(2.027)	**(1.884)**	**(2.146)**	**(2.084)**
S&P 500	-0.027	0.128	-0.016	-0.017
	(-0.094)	(0.623)	(-0.066)	(-0.139)
Short selling $_{t-1}$	-0.311	0.267	-0.507	-0.846
	(-0.346)	(0.225)	(-0.610)	(-1.066)
# years to emissions target	0.007	-0.010	0.008	-0.004
	(1.036)	(-1.038)	(1.161)	(-0.601)
Ln(operations emissions market) $_{t-1}$	-0.022	-0.179**	-0.011	-0.092**
	(-0.259)	(-2.451)	(-0.153)	(-2.408)
Net debt/at $_{t-1}$	0.664	0.580	0.660*	0.470*
	(1.561)	(1.396)	(1.667)	(1.701)
Ln(total assets) $_{t-1}$	0.274*	0.496***	0.202	0.215***
	(1.752)	(4.577)	(1.419)	(3.295)
ROA $_{t-1}$	0.433	1.003	0.579	0.967
	(0.563)	(1.009)	(0.824)	(1.401)
Capex/at $_{t-1}$	1.166	3.334	1.110	1.344
	(0.437)	(1.037)	(0.457)	(0.748)
R&D/at $_{t-1}$	2.783	-3.883	2.538	-1.994
	(0.721)	(-1.294)	(0.751)	(-1.060)
MTB $_{t-1}$	0.002	0.002	0.003	0.004*
	(0.944)	(0.787)	(1.293)	(1.721)
Environmental rating $_{t-1}$			0.152***	0.504***
			(5.740)	(16.169)
Firm FE	YES	NO	YES	NO
Industry FE	NO	YES	NO	YES
Fiscal year FE	YES	YES	YES	YES
Observations	2,025	2,088	2,025	2,088
Adjusted R-squared	0.833	0.647	0.839	0.759

Panel B: CO2 savings

This table presents results from firm-level OLS regressions of *Ln(Sum CO2 savings)* on *% short-term projects* (in columns 1 and 2) or *% short-term projects* and *% short-term projects squared* (in columns 3 and 4) or *% short-term projects = 0%* and *% short-term projects = 100%* (in columns 5 and 6) along with control variables and varying combinations of fixed effects (FE). *Ln(Sum CO2 savings)* is the logarithmized sum of CO2 savings of all emissions reduction projects in the fiscal year. *% short-term projects* is a firm's annual share of short-term projects that have a payback period of ≤ 3 years out of all of its GHG emissions reduction projects in the fiscal year. *% short-term projects = 0%* is an indicator that equals one if none of the projects is short-term. *% short-term projects = 100%* is an indicator that equals one if all of the projects are short-term. The regressions in columns (1), (3) and (5) include firm and fiscal year FE, the regressions in columns (2), (4) and (6) includes industry and fiscal year FE. Standard errors are clustered at the firm level. t-statistics are reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively. U-test (p-value) reports the p-value for the Lind and Mehlum (2010) test for U-shaped relationships. All variables are defined in Appendix B.

	Ln(Sum CO2 savings)					
	(1)	(2)	(3)	(4)	(5)	(6)
% short-term projects	**-0.026**	**0.093**	**1.103****	**2.388*****		
	(-0.140)	**(0.474)**	**(2.012)**	**(3.587)**		
% short-term projects squared			**-1.065****	**-2.201*****		
			(-2.215)	**(-3.810)**		
% short-term projects = 0%					**-0.288***	**-0.636*****
					(-1.700)	**(-3.191)**
% short-term projects = 100%					**-0.321*****	**-0.475*****
					(-2.642)	**(-3.590)**
S&P 500	0.677	0.128	0.656	0.062	0.653	0.058
	(1.634)	(0.522)	(1.536)	(0.253)	(1.527)	(0.236)
ESG rating $_{t-1}$	0.008	0.117***	0.012	0.111**	0.013	0.108**
	(0.184)	(2.630)	(0.285)	(2.527)	(0.300)	(2.472)
Short selling $_{t-1}$	1.062	0.525	1.063	0.655	1.090	0.641
	(0.606)	(0.321)	(0.604)	(0.395)	(0.624)	(0.385)
# years to emissions target	-0.005	-0.018	-0.004	-0.017	-0.005	-0.017
	(-0.381)	(-0.952)	(-0.372)	(-0.897)	(-0.388)	(-0.894)
Ln(operations emissions market) $_{t-1}$	0.113	0.399***	0.113	0.396***	0.112	0.396***
	(1.089)	(4.476)	(1.089)	(4.425)	(1.077)	(4.428)
Net debt/at $_{t-1}$	0.663	0.908	0.725	0.956	0.750	0.970
	(0.874)	(1.421)	(0.949)	(1.503)	(0.975)	(1.529)
Ln(total assets) $_{t-1}$	0.186	0.453***	0.173	0.440***	0.165	0.431***
	(0.722)	(3.561)	(0.669)	(3.519)	(0.635)	(3.461)
ROA $_{t-1}$	1.303	0.648	1.325	0.662	1.293	0.635
	(0.918)	(0.391)	(0.929)	(0.400)	(0.904)	(0.382)
Capex/at $_{t-1}$	-4.092	14.362***	-4.198	13.934***	-4.155	13.840***
	(-0.807)	(3.372)	(-0.834)	(3.352)	(-0.823)	(3.315)

R&D/at $_{t-1}$	0.567	-2.325	1.018	-2.572	1.006	-2.523
	(0.107)	(-0.643)	(0.192)	(-0.709)	(0.191)	(-0.696)
MTB $_{t-1}$	0.003	0.005	0.003	0.004	0.003	0.004
	(0.784)	(1.221)	(0.736)	(1.110)	(0.739)	(1.076)
Firm FE	YES	NO	YES	NO	YES	NO
Industry FE	NO	YES	NO	YES	NO	YES
Fiscal year FE	YES	YES	YES	YES	YES	YES
Observations	1,780	1,841	1,780	1,841	1,780	1,841
Adjusted R-squared	0.709	0.537	0.710	0.543	0.711	0.545
Exact turning point (% short-term projects)			48.3%	46.1%		
U-test (p-value)			0.044	0.001		

Appendix A: Sample Selection

This table presents the sample selection process, detailing the steps from our initial to our final sample. The reduction in sample size from the initial to the final sample does not affect the share of projects with a short-term payback period, which is 63.5% in the initial sample.

Steps from initial to final sample	Sample size	Absolute change
CDP projects with available payback data initiated by U.S. public firms	**15,352**	
Require CDP data on emissions reduction targets	12,520	-2,832
Require CDP data on scope 1 and 2 emissions	12,047	-473
Match with Compustat fundamentals	10,492	-1,555
Match with Compustat supplemental short interest data	10,486	-6
Match with MSCI ESG ratings	9,937	-549
Final project-level sample	**9,937**	

Appendix B: Variable Definitions

This table provides detailed definitions of all variables used. CEO data is from ExecuComp. ESG ratings are from MSCI. Firm fundamentals, market values, and short interest data is from Compustat. Project-level data, as well as emissions and emissions target data, is from the Carbon Disclosure Project.

Variable	**Definition**
Project level	
Annual CO2 savings/investment	Ratio of a project's annual expected CO2 (CO2) savings in tons relative to the USD amount invested in the project.
Annual monetary savings/ annual CO2 savings	Ratio of the amount of a project's annual expected monetary savings in USD relative to its annual CO2 savings in tons.
Annual monetary savings/ investment	Ratio of the amount of a project's annual expected monetary savings in USD relative to the USD amount invested in the project.
Energy efficiency in buildings or production	Indicator variable that equals one for projects targeting energy efficiency in buildings or production processes, and zero otherwise.
Investment	The USD amount invested in the project.
Ln(Annual CO2 savings)	The natural logarithm of a project's annual expected CO2 savings in tons.
Ln(Annual monetary savings)	The natural logarithm of a project's annual expected monetary savings in USD.
Ln(Lifetime CO2 savings)	The natural logarithm of a project's total lifetime expected CO2 savings in tons. Since CDP provides information on project lifetimes only in buckets (e.g., 3-5 or 6-10 years), we use the midpoint of a bucket's interval (e.g., 4 or 8) to calculate lifetime outcome variables.
Ln(Lifetime monetary savings)	The natural logarithm of a project's total lifetime expected monetary savings in USD. Since CDP provides information on project lifetimes only in buckets (e.g., 3-5 or 6-10 years), we use the midpoint of a bucket's interval (e.g., 4 or 8) to calculate lifetime outcome variables.
Low carbon energy consumption/ generation	Indicator variable that equals one for projects targeting the purchase or production of low-carbon energy, and zero otherwise.
NPV	A project's net present value (NPV), calculated as the discounted annual monetary savings minus the project's investment. We use a discount rate of 11%, which equals the S&P 500's historical return over the last 50 years, see https://www.stern.nyu.edu/~adamodar/pc/datasets/histretSP.xls. This return should correspond to the average cost of equity across firms.
Negative NPV	Indicator variable that equals one for projects with a negative net present value.
Short-term payback	Indicator variable that equals one for projects with a payback period of at most three years, and zero otherwise.
Firm level	
% short-term projects	A firm's annual share of short-term projects that have a payback period of at most three years out of all of its GHG emissions reduction projects (with available information on their payback period) in the fiscal year.
# years to emissions target	A firm's timely distance in years from the current year t to its self-proclaimed emissions reduction target year. If a firm has several emissions targets with different target years, the median of the timely distances is used.
Capex/at	A firm's capital expenditures as a share of its total assets.
Environmental rating	A firm's year-end numerical environmental-related ESG rating (E rating) assigned by MSCI.
ESG rating	A firm's year-end numerical ESG rating assigned by MSCI.

Ln(Investment)	The natural logarithm of the total USD amount a firm invests in all of its GHG emissions reduction initiatives in a year.
Ln(Operations emissions market)	The natural logarithm of the sum of a firm's scope 1 and 2 emissions in the fiscal year. Scope 2 emissions determined based on the market method.
Ln(total assets)	The natural logarithm of a firm's total assets.
MTB	A firm's market-to-book ratio, defined as the fiscal year-end market capitalization to the book value of equity.
Net debt/at	A firm's long- and short-term debt minus its cash and cash equivalents as a share of its total assets.
R&D/at	A firm's research and development expenses (R&D) as a share of its total assets. Missing R&D data is filled with zeros.
ROA	A firm's return on assets, defined as net income to total assets.
S&P 500	An indicator variable that equals one if a firm is a member of the S&P 500 stock index in a given fiscal year, and zero otherwise.
Short selling	A firm's short interest, defined as the maximum number of shares held short in the last fiscal year standardized by the number of shares outstanding in the last fiscal year.
CEO level	
CEO age	The CEO's age in years.
CEO tenure	The CEO's tenure (since starting the CEO position) in years.
Ln(TDC 1)	The natural logarithm of a CEO's total compensation.
Option awards/TDC 1	The CEO's option awards, i.e., the grant date fair value of options granted, relative to the CEO's total compensation.
Shares owned	The percentage of a firm's total shares outstanding held by the CEO.

Appendix C: Correlations of main variables

This table shows pair-wise correlations for the independent variables used in the multivariate project-level regressions. * denotes statistical significance at the 1% level.

Variables	**(1)**	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) Short-term payback	**1.000**									
(2) # years to emissions target	**-0.106***	1.000								
(3) Ln(Operations emissions market) $_{t-1}$	**0.024**	0.013	1.000							
(4) S&P 500	**-0.109***	0.027*	0.243*	1.000						
(5) Short selling $_{t-1}$	**0.102***	-0.067*	-0.076*	-0.200*	1.000					
(6) ESG score $_{t-1}$	**-0.026***	0.074*	-0.084*	0.106*	-0.028*	1.000				
(7) Ln(total assets) $_{t-1}$	**-0.115***	0.126*	0.330*	0.506*	-0.326*	-0.050*	1.000			
(8) Net debt/at $_{t-1}$	**-0.012**	0.202*	0.284*	-0.057*	0.071*	-0.083*	-0.050*	1.000		
(9) ROA $_{t-1}$	**-0.013**	-0.051*	-0.058*	0.205*	-0.203*	0.095*	-0.157*	-0.089*	1.000	
(10) Capex/at $_{t-1}$	**0.059***	-0.101*	0.478*	-0.032*	0.044*	-0.041*	-0.167*	0.065*	0.147*	1.000
(11) R&D/at $_{t-1}$	**0.014**	-0.045*	-0.222*	-0.001	0.022	0.148*	-0.119*	-0.359*	0.258*	-0.028*
(12) MTB $_{t-1}$	**-0.038***	-0.189*	-0.026*	0.024	0.013	0.043*	-0.009	-0.103*	0.050*	-0.007

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