Climate Capitalists*

Niels Joachim Gormsen Kilian Huber Sangmin S. Oh

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Abstract

Climate capitalists invest in green firms in order to lower these firms' cost of capital and thereby stimulate green investments. This "green investing" channel only works if green firms actually reduce their perceived cost of capital and discount rates in response to green investing. Using data from Gormsen and Huber (2022), we find that the average difference in the perceived cost of capital between the greenest and the brownest firms was close to zero before 2016 but has fallen to -2.6 percentage points in the years since 2016, concurrent with the rise of green investing. Similarly, the difference in discount rates was small before 2016 and has fallen to -5.8 percentage points since 2016. In a simple stylized model, the observed differences in discount rates are large enough to reduce firm-level emissions by 20 percent. We survey corporate managers to study how firms incorporate greenness into their discount rates. Overall, the results are consistent with an important role for climate capitalists in stimulating climate-friendly production.

Keywords: Cost of capital, discount rates, green investing, ESG investing
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1 Introduction

Capital markets play a key role in the allocation of resources. By setting the cost of capital for different firms and projects, capital markets determine which projects receive capital. If capitalists are concerned about climate change, they may attempt to channel more capital toward climate-friendly firms by lowering these firms' cost of capital. In recent years, the number of such climate capitalists, or "green investors", has enormously increased, with more than ten trillion USD managed under climate mandates as of 2022 (PWC 2020). One salient example of a climate capitalist is the European Central Bank, which in 2022 initiated a "green bond" purchase program aimed at decreasing the cost of capital of green firms.[1]

Despite the recent surge in green investing, it is unclear to what extent climate capitalists have affected the cost of capital and real investment of green firms. Existing work has focused on capital markets data. While one line of work argues that the expected returns of green firms in capital markets are lower, implying a lower cost of capital (Bolton and Kacperczyk 2021, Pástor et al. 2021), it is also possible that investor preferences and beliefs lead to a higher cost of capital for green firms (Pedersen et al. 2021, Goldstein et al. 2022) or that the effects of green investment on the cost of capital are too small to materially impact investment (Berk and van Binsbergen 2022). Given capital markets data alone, a wide range of values for the cost of capital of green firms thus appears plausible.

However, what matters for the impact of green investing on real outcomes is how green firms themselves perceive their cost of capital and how green firms adjust their discount rates used to evaluate investment projects. Firms typically follow a two-step procedure in their capital budgeting decisions. They first estimate their perceived cost of capital (based on capital markets data and other sources). They then use this perceived cost of capital as basis for their required return (their so-called discount rate), which determines whether a given project receives funding or not. Green investing will result in more capital allocated to green projects if green investing makes green firms perceive that their cost of capital is lower and if, as a result, green firms use lower discount rates.

In this paper, we study directly how firms' perceived cost of capital and discount

[1] See Papoutsi et al. (2022). Other notable climate capitalists include institutional investors like BlackRock (BlackRock 2020), sovereign wealth funds (Invesco 2022), and the Catholic Church (Vatican 2022).

rates vary between green and brown firms. We use a new dataset constructed by Gormsen and Huber (2022). The data contain the perceived costs of capital, debt, and equity as well as discount rates for some of the world's largest firms, obtained from manual reading of corporate conference calls. We merge these data to firm-level measures of "greenness" provided by the rating agency MSCI.

We first study the cross-sectional relation between firms' perceived cost of capital and firms' greenness. We find that the average perceived cost of capital was significantly lower for greener firms in the last 20 years. The effect is economically large as the perceived cost of capital of the greenest firms was on average 1.5 percentage points lower than that of the brownest firms. The result is stronger in the US but also holds in our global sample. Given the rising popularity of green investing in recent years, one would expect that the relation between greenness and cost of capital has strengthened over time. Consistent with this conjecture, we find no difference in the perceived cost of capital of green and brown firms before 2016 and a 2.6 percentage points difference after 2016.

Observing that green firms have lower perceived cost of capital is only the first step toward understanding potential real impacts. According to the textbook recommendation, firms should use their cost of capital as discount rate when they evaluate new investment projects. However, to the extent that firms have market power, they are free to keep their discount rates high even if their cost of capital has fallen. If green firms do not adjust their discount rates, decreases in the perceived cost of capital of green firms would have no real impact on green investment, disappointing the hopes of climate capitalists. Gormsen and Huber (2022) find that discount rates, on average, comove with firms' perceived cost of capital, but also that there are large and time-varying "discount rate wedges" between the perceived cost of capital and discount rates, making the above concern all the more acute.

We find a strong relation between firm greenness and discount rates. The average discount rate of the greenest firms was on average 4 percentage points lower in the last 20 years, both in the US and abroad. Moreover, the difference in discount rates between green and brown firms was statistically insignificant up to 2016 and rose to almost -6 percentage points from 2016 onward. Taken together, these findings suggest that green firms have incorporated recent decreases in their perceived cost of capital into their discount rates fully. If anything, green firms seem to have adjusted discount rates downward by more than the perceived cost of capital. This last finding suggests that discount rates wedges of green firms have also fallen, possibly because managers themselves perceive green investments as less risky or because managers favor green investments for other reasons.

In principle, the estimated difference in green firms' discount rates is large enough to affect real activity. Recent work suggests that a percentage point drop in discount rates raises net investment rates by roughly 0.8 percentage points (Philippon 2009, Gormsen and Huber 2022). Taking these estimates at face value, the 6 percentage point difference in discount rates implies that the greenest firms' investment rate has been 4.8 percentage points higher since 2016, relative to the brownest firms. Given that the average firm has a net investment rate close to 2 percentage points, this is a large effect.

We quantify the long-run impact of discount rates on total emissions using a simple stylized production model. This model suggests that the differences in the perceived cost of capital and discount rates, as observed in our data, can decrease the ratio of emissions to total capital by roughly 20 percent. The results of the model need to be interpreted with caution because they depend on assumptions about the relative productivity of green and brown capital. Overall, however, the results are consistent with a substantial impact of climate capitalists on emissions through a cost of capital channel.

Having established large differences in perceived cost of capital and discount rates for green and brown firms, we discuss why these may arise. We consider three potential mechanisms: direct incorporation of greenness, mediating variables, and a perfect information benchmark.

The first potential mechanism is that firms directly account for their greenness when estimating their perceived cost of capital or discount rates, for instance, by incorporating an explicit green factor when estimating their perceived cost of capital. To gauge this possibility, we conducted a survey among corporate managers of large US corporations in 2022. The survey asks managers whether firms explicitly incorporate firm greenness into their cost of capital. Virtually all respondents say "no." However, 7 percent of firms state that they adjust discount rates for the greenness of projects. Moreover, 50 percent of managers think they should incorporate green practices into their financial practices to a larger extent. This suggests that, in future, the trend of lower discount rates for green projects may accelerate further.

The second potential mechanism is that the role of firm greenness is driven by mediating variables. For instance, Gormsen and Huber (2023) find that larger and safer firms have both a lower perceived cost of capital and lower discount rates. To the extent that green firms are larger or safer, this may explain the correlations observed in the data. Controlling for a series of standard variables indeed reduces the unconditional relations between greenness and the perceived cost of capital and discount rates. However, the relations remain large and significant in the post-2016 sample. These results suggest that standard variables account for some but not all of the coefficients on greenness.

The third potential mechanism is that firms have perfect information about their cost of capital in capital markets (i.e., the expected return on their outstanding stocks and bonds) and that expected returns in capital markets have fallen by more for green firms since 2016. In particular, if demand from green investors has lowered expected returns on green firms' assets and firms perfectly know their expected return, they may have lowered their perceived cost of capital. This perfect information benchmark can additionally explain the behavior of discount rates if, as in standard macro-finance models, we also assume that firms fully adjust their discount rates with the perceived cost of capital. Taken together, it is plausible that a combination of direct incorporation of greenness, mediating variables, and firms' superior information on their cost of capital can explain the relations between greenness and the perceived cost of capital and discount rates.

Related Literature

Our paper contributes to three strands of the literature: (i) the asset pricing effects of green investing, (ii) the real effects of green investing, and (iii) surveys about green investing.

First, we relate to a literature on the returns of green firms' assets (reviewed by Giglio et al. 2021 and Coqueret 2022). Theoretically, models by Heinkel et al. (2001), Pástor et al. (2021), Baker et al. (2022), and Zerbib (2022) highlight that green stocks earn lower expected returns if investors have non-pecuniary or risk-based preferences toward them. In contrast, Goldstein et al. (2022) argue that expected returns of green firms may be higher if some investors demand higher returns in exchange for greater risk. Pedersen et al. (2021) show that a higher ESG ratings can raise or reduce expected returns, depending on to what extent ratings provide information and affect investor preferences. Berk and van Binsbergen (2022) and De Angelis et al.

(2022) argue that any effects of green investing on long-run expected returns and real investment are quantitatively small.

Empirically, there exists mixed evidence on how realized stock returns differ between green and brown firms (Bolton and Kacperczyk 2021, Görgen et al. 2020, Pástor et al. 2022, Engelberg et al. 2020, Hsu et al. 2023).[2] It is difficult to relate these estimates to expected stock returns, which affect firms' cost of capital, because expected returns are hard to estimate (Fama and French 1997, Pástor and Stambaugh 1999). Work focusing on bond returns finds that yields on green bonds have been lower in recent years (Baker et al. 2018, Flammer 2021). Similarly, measures of firms' implied cost of capital, based on analyst forecasts of expected returns, have been lower for green firms (Chava 2014, Pástor et al. 2022). Ultimately, the impact of green investing on firm behavior depends not on realized returns or analyst forecasts, but on how green firms perceive expected returns and their cost of capital. Our contribution is to analyze the cost of capital as perceived by green firms themselves.

Our findings quantify capitalists' willingness to pay for green capital, as perceived by firms. Complementary approaches to measuring the willingness to pay for green developments include structural models (Nordhaus 1994, Hassler and Krusell 2018, Barnett et al. 2020, Bilal and Rossi-Hansberg 2023), surveys (Mitchell and Carson 1989, List and Gallet 2001), and experiments (Levitt and List 2007, Rodemeier 2023).

A second related literature concerns the real effects of green investing. Theoretically, green investing is one way to raise green investments (Broccardo et al. 2022, Edmans et al. 2022), but its success may require that green investors accept lower financial returns (Oehmke and Opp 2022). Empirically, existing work has found mixed evidence on the relation between the activities of climate capitalists and subsequent emissions of firms (Akey and Appel 2019, Bellon 2020, Heath et al. 2021, Noh et al. 2022, Gantchev et al. 2023). The real impact of climate capitalists depends on whether green investing changes the discount rates of green firms relative to brown firms (and not on changes in the cost of capital). It is not clear how green firms set their discount rates, given the range of available methods (Hommel et al. 2023). Our contribution is to present direct evidence on how the discount rates of green firms differ.

Finally, our paper relates to surveys on green investing. Krueger et al. (2020) study how institutional investors respond to climate risks, Stroebel and Wurgler (2021)

[2]There also exists work on other types of sustainable practices (Hong and Kacperczyk 2009, El Ghoul et al. 2011, Edmans 2021).

question financial experts about climate risks, Sangiorgi and Schopohl (2021a) survey green bond issuers about drivers of bond issuances, and Sangiorgi and Schopohl (2021b) ask asset managers about their demand for green bonds. We survey how corporate managers determine discount rates for green projects and how they perceive their cost of capital.

2 Framework

We sketch a simple model to illustrate how climate capitalists can influence the allocation of productive capital and, ultimately, emissions by affecting firms' cost of capital and discount rates. Capitalists provide firms with brown capital, which substantially harms the climate (e.g., an oil-powered generator), and green capital, which operates cleanly (e.g., a windmill). Capitalists charge rate r for brown capital and $r - \zeta$ for green capital, where ζ captures the magnitude of capitalists' climate concerns. If capitalists are more concerned about the climate, ζ is larger and capitalists provide green capital at a larger discount relative to brown capital. Estimating ζ is one of the empirical goals of the paper.

Firm i produces output Y_i using brown and green capital

$$Y_i(K_i, L_i, G_i) = A_i K_i^{\alpha_i} G_i^{\beta_i} L_i^{1-\alpha_i-\beta_i},$$

where A_i is the total factor productivity, K_i is brown capital, G_i is green capital, L_i is labor, and $(\alpha_i, \beta_i) \in \{x \in \mathbb{R}^+ | x_1 + x_2 < 1\}$ are the output elasticities of brown and green capital. The output elasticities are firm-specific, reflecting that some firms can more easily use green capital in their production than others.

Firms make investment decisions based on discount rates, which represent the returns that firms require on a specific type of capital. Firms use discount rates δ^B for brown capital and δ^G for green capital. Firms set these discount rates based on the costs of green and brown capital, but they also add two discount rate wedges, κ and χ. The wedge κ may capture risk, constraints, and other factors that firms incorporate into the discount rates for both brown and green capital (see Gormsen and Huber 2022). The wedge χ captures climate concerns that firms incorporate into the discount rate for green capital. We model $\delta^{\text{Brown}} = r + \kappa$ and $\delta^{\text{Green}} = r - \zeta + \kappa - \chi$. If firms believe that green capital is less exposed to climate risk or are biased toward green capital for other reasons, they may use a lower discount rate wedge for green capital ($\chi > 0$). In principle, however, it is also possible that firms use a higher wedge for green capital ($\chi < 0$) if they, for instance, believe that green capital is relatively risky. A further goal of the empirical analysis will be to estimate χ. Note that κ, χ, δ^B, and δ^G are identical across firms.

We model the firm's maximization problem as choosing K_i, G_i, and L_i such that

$$\max_{K_i,G_i,L_i} \quad Y_i(K_i, L_i, G_i) - \delta^{\text{Brown}} K_i - \delta^{\text{Green}} G_i - wL_i,$$

where w is the wage paid to labor.

While the cost of green and brown capital is the same across firms, the weighted average cost of capital (WACC) can differ across firms if they use different amounts of green and brown capital:

$$\text{WACC}_i = \frac{K_i r + G_i(r - \zeta)}{K_i + G_i} = r - \zeta \frac{G_i}{K_i + G_i}. \tag{1}$$

Firm-level discount rates similarly vary across firms depending on the amounts of green and brown capital:

$$\delta_i = \frac{K_i \delta^B + G_i \delta^G}{K_i + G_i} = r + \kappa - (\zeta + \chi) \frac{G_i}{K_i + G_i}. \tag{2}$$

We introduce the concepts of firm-level WACC and firm-level discount rates because they play key roles in the empirical analysis. While some firms use different discount rates for different types of capital (as they should according to standard theory), many firms apply just one firm-level discount rate to all their investments (Graham and Harvey 2001, Krüger et al. 2015). In our framework, such behavior could be justified if all of the firm's investments use the same relative amounts of green and brown capital.

Equations (1) and (2) show that firm-level WACC and firm-level discount rates decrease in the ratio of green to total capital. Moreover, the parameters ζ and χ can be recovered through linear regressions of firm-level discount rates and cost of capital on the ratio of green to total capital. We will adopt this approach in the empirical analysis below.

In choosing the amount of green and brown capital, the firm trades off the relative productivity of these two types of capital with their relative discount rates. The heterogeneity in output elasticities is the only driver of differences across firms in the ratio of green versus brown capital, since cost of capital and discount rates for each type of capital are common for all firms. When at the first order condition,

$$\frac{G_i}{K_i} = \frac{\beta_i}{\alpha_i} \times \frac{\delta^{\text{Brown}}}{\delta^{\text{Green}}}.$$

Given the output elasticities of firm i, a change in the ratio of brown to green discount rates induces a change in the ratio of green to brown capital. For instance, imagine that $\delta^{\text{Brown}} = 0.12$ and that δ^{Green} changes from 0.12 to 0.08 (i.e., $\zeta + \chi$ increases by 0.04). Such a change in δ^{Green} will increase the ratio of green to brown capital by 0.12/0.08 - 1 = 50 percent.

Changing the ratio of brown to green discount rates will similarly influence firms' emissions-to-capital ratio. In particular, assume that each unit of brown capital produce emissions of e^{Brown}, whereas green capital produces emissions e^{Green}, where $e^{\text{Brown}} > e^{\text{Green}}$. The ratio of total emissions to capital is then given by

$$\frac{\text{Emissions}_i}{\text{Total capital}_i} = e^{\text{Brown}} - (e^{\text{Brown}} - e^{\text{Green}})\frac{G_i}{K_i + G_i}. \tag{3}$$

This ratio decreases when $\zeta + \chi$ rises, as a relatively lower discount rate for green capital incentives firms to shift from brown to green capital. This shift toward green capital, in turn, lowers emissions. The magnitude of the decline in the emissions-to-capital ratio depends on the relative output elasticities (β_i/α_i) and the emissions produced per unit of capital (e^{Brown} and e^{Green}).

Figure 1 illustrates how the emissions-to-capital ratio changes as a function of $\delta^{\text{Brown}} - \delta^{\text{Green}}$, using the above equation. We set $e^{\text{Brown}} = 363.9$ and $e^{\text{Green}} = 33.7$, as measured using data by S&P Trucost (see Section 3.3 for details). We assume $\delta^{\text{Brown}} = 12$ percent, for illustrative purposes, and plot three curves using different values for the ratio of output elasticities β_i/α_i. The emissions-to-capital ratio on the figure is scaled so that it equals 1 when $\delta^{\text{Brown}} = \delta^{\text{Green}}$.

Increases in climate concerns of capitalists (ζ) or firms (χ) reduce the discount rate for green capital relative to the discount rate for brown capital ($\delta^{\text{Brown}} - \delta^{\text{Green}}$). A plausible magnitude for the change in the relative discount rate in recent years is a roughly 6 percentage point increase (as we show in Section 4.) In the case of a firm where brown and green capital are equally productive ($\beta_i/\alpha_i = 1$), the emissions-to-capital ratio falls by about 20 percent when the relative discount rate rises to 6 percentage points. The change in the emissions-to-capital ratio is of the same order of magnitude but slightly smaller for firms where brown capital is more productive ($\beta_i/\alpha_i = 0.5$) and slightly larger where green capital is more productive ($\beta_i/\alpha_i = 2$). Taken together, this simple model illustrates how changes in climate concerns can feed through the cost of capital and discount rates to ultimately affect emissions.

3 Data

We combine firm-level data on the perceived cost of capital and discount rates, firm-level ratings of environmental sustainability, and firm-level emissions statistics. We also conduct a firm survey to study mechanisms.

3.1 Data on the Perceived Cost of Capital and Discount Rates

Firms do not typically report a perceived cost of capital and discount rates in official reports, while data from surveys are often anonymized and cannot be merged to firm environmental scores. However, on quarterly conference calls, listed firms occasionally disclose their own, internal perception of their cost of capital as well as discount rates used to assess the net present value of new investment projects. Gormsen and Huber (2022) manually read through all conference calls on the Thomson One database where firms disclose this information for the period January 2002 to September 2021. In total, the data contain around 2,500 firm-quarter observations on the perceived cost of capital and 2,400 observations on discount rates.

To identify the perceived cost of capital, the data rely on statements by managers about the "cost of capital" or the "weighted average cost of capital" for the firm as a whole. The data do not consider speculative statements (e.g., "if we had a cost of capital of x percent"), values posited by outsiders (e.g., "your cost of capital is x percent, right?"), or descriptions of specific debt issuances (e.g., "our latest bond yield was x percent.") To identify discount rates, the data rely on statements about the firm's minimum required internal rate of return (IRR). In cases where managers discuss multiple discount rates, the data include the discount rate relating to the core of the firm's business. The included values for the cost of capital and discount rates are unlevered and in post-tax terms. Other financial indicators (e.g., realized and expected IRR, ROA, ROIC, and ROE) were separately recorded from the conference calls, so that the perceived cost of capital and discount rates were not confused with these other indicators.

Managers have incentives to report accurate numbers on conference calls. Since managers often want to score strongly on analysts' ratings and raise capital, conference calls are a relatively high-stakes setting. Analysts and investors often question managers with reference to past statements on conference calls and the past performance of their firm. Both past statements and performance can be checked against each other and current statements, requiring manager statements to be consistent with respect to actual financing situation and investment decisions.

Gormsen and Huber (2022) provide further details on the data and evidence supporting the view that the observed discount rates are used in actual investment decisions. For instance, within-firm changes in discount rates predict within-firm changes in future investment rates. Moreover, values for the perceived cost of capital are generally consistent with other measures of the cost of capital based on capital markets data.

Table 1 provides summary statistics of the main variables used in our analyses. Figure A2 shows the distribution of the perceived cost of capital and discount rates.

3.2 Data on the MSCI Environment Score

We obtain firm-level ratings of environmental sustainability from MSCI, the world's largest provider of ESG ratings (Eccles and Stroehle 2018, Berg et al. 2022). We use the "environment pillar score," which is a number between 0 (worst) and 10 (best) that represents the weighted average score across various dimensions related to environmental performance of the firm.[3] We normalize the environment score to range from 0 to 1. The score is available from 1999 to 2021.

To merge the score with the conference call data, we map the ISIN provided by MSCI to GVKEY using tables from CRSP and Compustat. For the remaining unmatched observations, we merge GVKEY to the MSCI score using (i) a combination of CUSIP and date, (ii) a combination of ticker and date, and (iii) fuzzy name matching. We manually review all merges based on ticker-date and fuzzy name matching.

[3]MSCI scores each firm on 13 issues spanning four broad themes: (i) climate change, (ii) natural capital, (iii) pollution and waste, and (iv) environmental opportunities. See MSCI's website for the full list of issues.

3.3 Data on Emissions and Relation to Firm Greenness

We obtain data on firm-level greenhouse gas emissions from S&P Trucost. We focus on scope 1 emissions, which are directly emitted by sources controlled or owned by the firm. The reported emissions capture the environmental impact of all emitted greenhouse gases, measured in the environmental impact of carbon dioxide equivalent units.

We scale emissions by net property, plant and equipment (PPE in Compustat) of the firm in the same year to measure the ratio of emissions to total capital. As emissions are reported in tons of CO_2 equivalent (tCO_2e) and PPE is in million USD, the emissions-to-capital ratio is in tons of CO_2 per million USD ($tCO_2e/\$M$).

Figure A1 shows a binned scatter plot of the emissions-to-capital ratio and firm environment score, conditional on year fixed effects. We document a negative relation, suggesting that the environment score captures emissions well. The slope point estimate indicates that the greenest firms emit approximately 330 $tCO_2e/\$M$ less than the brownest firms. This is a large difference relative to the average emissions-to-capital ratio in our sample (205.9 $tCO_2e/\$M$). According to this linear regression model, the predicted emissions-to-capital ratio is 363.9 for a firm with MSCI environment score equal to 0 (e^{Brown}) and 33.7 for a firm with score equal to 1 (e^{Green}).

3.4 Survey Among Corporate Managers

Our survey investigates how firms adjust their cost of capital and discount rates in response to green investing. The survey was conducted electronically and distributed to corporate managers of large corporations in collaboration with the Association of Financial Professionals (AFP). The responses are anonymous. The respondents were notified beforehand that their answers are confidential. The survey was conducted in the fall of 2022 and completed on October 28, 2022. The survey generated 54 responses from corporate practitioners. As this is a small sample, the results should be interpreted with caution.

Table A2 provides an overview of the respondent characteristics. The firms are predominantly multinational companies or active in the US and Canada. Half of the firms have annual revenues greater than one billion USD. The sample features a balanced mix of publicly owned and privately owned firms and spans multiple industries.

4 Firm Greenness, Perceived Cost of Capital, and Discount Rates

In this section, we study the relation between firms' greenness and their perceived cost of capital and discount rates. If climate capitalists do not affect firms' perceived cost of capital or discount rates, then green investing cannot affect real outcomes or emissions through a cost of capital channel.

4.1 Cross-Sectional Relations Between Greenness and the Perceived Cost of Capital and Discount Rates

We begin by focusing on cross-sectional differences in the perceived cost of capital by estimating the specification:

$$\text{perceived cost of capital}_{it} = \mu + \eta \text{e-score}_{it} + \phi_t + \varepsilon_{it}, \tag{4}$$

where perceived cost of capital$_{it}$ is the perceived cost of capital of firm i in year t and e-score is the environment score, which ranges from 0 to 1. We include year fixed effects ϕ_t to control for general macroeconomic trends.

The above regression can be mapped to Equation (1) in our model, which describes the firm-level weighted average cost of capital. To establish the mapping, we interpret green capital in the model as capital with an e-score of 1 and brown capital as capital with an e-score of 0. In that case, the slope coefficient η in Equation (4) equals ζ. The parameter ζ captures the difference in capitalists' required return on green versus brown capital. In the model, it is a key parameter for quantifying the effect of climate capitalists on emissions.

The results of estimating Equation (4) are reported in Table 2. In column (1), which includes only US firms, we find that the perceived cost of capital of the greenest firms is 1.6 percentage point lower compared to the brownest firms (which implies that $\zeta = 1.6$ percentage points). The estimate is significant at the 1 percent level. In columns (2) and (3), we repeat the analysis for a sample that also includes non-US firms. In column (2), we continue to include year fixed effects and in column (3) we add country and year fixed effects. In both specifications, we find a negative, statistically significant relation between the perceived cost of capital and firm greenness, with point estimates slightly below the estimate for the US.

We next study the behavior of discount rates. If green investing is to succeed in lowering emissions through a cost of capital channel, green investing must impact discount rates and not just the cost of capital. While firms use their perceived cost of capital as basis for their discount rates, firms often choose discount rates above the cost of capital (Graham 2022). Moreover, wedges between the perceived cost of capital and discount rates fluctuate significantly over time, as firms incorporate changes in the perceived cost of capital into discount rates to different extents (Gormsen and Huber 2022). As a result, it is not at all clear whether the difference in the perceived cost of capital between green and brown firms has also translated into different discount rates.

We re-estimate Equation (4) using discount rates as dependent variable. This regression maps to Equation (2) in our model, which described firm-level discount rates. If we use e-score as a measure of green to brown capital, the slope coefficient η in Equation (4) equals $\zeta + \chi$. The parameter χ captures climate concerns of firms and represents another key parameter for quantifying emissions.

Table 3 shows a negative relation between discount rates and firm greenness. The discount rate of the greenest firms is 4.2 percentage point lower than the brownest firm. The relation is statistically significant at the 5 percent level and of similar magnitude in the US and abroad. The estimate implies that $\zeta + \chi = 4.2$ and, since $\zeta = 1.6$, that $\chi = 2.6$ percentage points. This finding is consistent with the view that green firms have not only incorporated the difference in the perceived cost of capital (captured by ζ) into their discount rates, but that green firms have additionally reduced their discount rate wedges by more. A potential reason is that green firms perceive their investments as less risky or have their own climate concerns (captured by χ), inducing green firms to require a lower return on their investments.

4.2 Time Variation in the Relations Between Greenness and the Perceived Cost of Capital and Discount Rates

The activities of climate capitalists and green investing have surged since 2016 (Bloomberg 2021). We examine whether green firms' perceived cost of capital and discount rates have also fallen by more since 2016.

We amend the specification with an interaction term $\mathbb{1}_{t \geq 2016}$, an indicator for the years since 2016:

$$\text{perceived cost of capital}_{it} = \mu + \eta_1 \text{e-score}_{it} + \eta_2 \text{e-score}_{it} \times \mathbb{1}_{t \geq 2016} + \phi_t + \varepsilon_{it}. \quad (5)$$

The coefficient of interest is η_2, which we expect to be negative if the relation between the perceived cost of capital and firm greenness has strengthened since 2016.

Table 4 presents the results. In column (1), we document strong time variation in the relation between firm greenness and the perceived cost of capital in the US. We find that η_1 is -0.2 and insignificant, which implies that there is little difference in the perceived cost of capital between green and brown firms before 2016 (i.e., ζ was close to zero). However, η_2 is around -2.6 and significant at the 5 percent level, indicating that the negative relation between the perceived cost of capital and greenness has strengthened substantially over time. To a large extent, the cross-sectional differences established in the previous analyses are thus driven by the period since 2016. The time variation is also present for our global sample (columns 2 and 3). The results are consistent with the view that the recent rise of climate capitalists and green investing has lowered firms' perceived cost of capital.

We find similar time variation for discount rates by estimating Equation (5) using discount rates as dependent variable. Column (4) of Table 4 shows that there was no difference in US discount rates in the pre-2016 period (i.e., $\zeta + \chi$ was close to zero). However, the greenest firms had a 5.8 percentage point lower cost of capital than the brownest firms in the post-2016 period. This time variation is also present in the global sample (columns 5 and 6).

The results on time variation are not sensitive to the choice of the year 2016 and look similar if we instead include a linear time trend (see Table A1 in the Appendix).

Taken together, the findings suggest that green firms have lowered their perceived cost of capital and discount rates since 2016 relative to their brown counterparts, both in the US and globally. The strong relation between discount rates and firm greenness assuages potential concerns regarding the limited pass-through from the perceived cost of capital to discount rates. If anything, the cross-sectional relation and the decrease since 2016 are stronger for discount rates than for the perceived cost of capital.

5 Exploring Mechanisms

Having established the relations between greenness and the perceived cost of capital and discount rates, we turn to exploring how greenness has come to influence internal decisions of firms.

From the point of view of climate capitalists, a reduced form effect on discount rates is sufficient to establish the success of green investing. Nonetheless, it is instructive to understand how firms adjust their perceived cost of capital and discount rates for green projects. We discuss three potential mechanisms: direct incorporation of greenness, mediating variables, and a perfect information benchmark.

5.1 Direct Incorporation of Greenness

The first potential mechanism is that firms explicitly take into account their greenness when calculating the perceived cost of capital and discount rates. For instance, firms may explicitly incorporate a "green factor" if they use factor models to estimate their perceived cost of capital. Alternatively, greener firms may just adjust downward their cost of capital in a discretionary, ad hoc manner if they believe that their true cost of capital in capital markets is lower. Similarly, the discretionary discount rate wedge (κ in our simple model) may be smaller for green firms if firms believe that green projects are less risky or if managers have an ideological preference for green projects.

We use the responses of corporate managers in our survey to investigate this mechanism. We find little evidence that firms directly incorporate greenness when calculating their perceived cost of capital in Figure 2. Only 2 percent of firms answer yes when asked whether they adjust their perceived cost of capital based on the greenness of their company, while 87 percent say no. A slightly larger share of firms, 7 percent, say yes when asked whether they adjust project discount rates based on the greenness of projects.[4]

Looking into the future, 36 percent of respondents say that they are considering incorporating greenness or that it would be a good idea. In general, over 50 percent of firms believe that their company should incorporate green practices into their financial decision-making. This suggests that firms may further reduce the discount rate wedge

[4]The terms "discount rate" and "hurdle rate" capture the same concept in corporate practice, namely, the minimum required return on a new investment project. We ask managers about their "hurdle rate," since this term is more common among practitioners.

applying to green projects in future, which could further boost the difference between green and brown discount rates.

5.2 The Role of Mediating Variables

A second potential mechanism is that there are mediating variables, which respond to a firm's greenness and also affect the perceived cost of capital and discount rates. For instance, larger companies tend have higher environment scores and also lower perceived cost of capital and discount rates (Gormsen and Huber 2023). Such an association could explain the cross-sectional relations that we have documented. Furthermore, if the perceived cost of capital and discount rates of larger firms have fallen by more since 2016, this association could also explain the post-2016 trend.

We explore whether a standard set of other variables can explain the post-2016 relation between greenness and the perceived cost of capital and discount rates. We include the firm-level market beta, log market capitalization, the book-to-market ratio, and leverage. Table 5 displays the results. We find that the point estimates on greenness are slightly smaller when conditioning on the other variables. However, the coefficients on greenness remain economically and statistically significant. In an additional test, we also find similar results when interacting all variables with a post-2016 indicator. Overall, this indicates that the standard variables explain some of the effect of greenness, but cannot explain the full effect since 2016.

5.3 Perfect Information Benchmark

A third possibility is that firms are perfectly informed about their cost of capital in capital markets, which means that firms know perfectly the expected returns required by their equity holders and bond holders. This mechanism is distinct from the other two mechanisms because it does not require firms to actively introduce a greenness factor into their calculations or to consider mediating variables. If green investing has lowered the cost of capital in capital markets for green firms by more, this perfect information benchmark could explain the decrease in firms' perceived cost of capital since 2016.

The perfect information benchmark does not directly address how firms should move their discount rates with their perceived cost of capital. However, standard macro-finance models often implicitly assume that the perfect information benchmark holds in conjunction with the additional assumption that firms use their cost of capital as discount rate. This additional assumption could explain why discount rates of green firms have fallen by more since 2016. However, this assumption cannot account for the presence of discount rate wedges and the suggestive evidence that discount rate wedges of green firms are lower than those of brown firms.

Taken together, the evidence suggests that a combination of direct incorporation of greenness, mediating variables, and firms' information on their cost of capital can explain the relations between greenness and the perceived cost of capital and discount rates.

6 Conclusion

Climate capitalists have led a recent wave of green investing. The aim is to lower the cost of capital for green firms, thereby stimulating real investments into green capital. While recent work has analyzed how green investing influences stock and bond returns, and thereby the cost of capital in capital markets, we know little about how firms have perceived green investing.

For climate capitalists to succeed, two conditions need to hold. First, green firms need to perceive that their cost of capital is lower. And second, green firms need to reduce the discount rates that they use to make real investment decisions. If either of these conditions fails, green investing cannot influence real outcomes through a cost of capital channel.

We present new evidence on how the perceived cost of capital and discount rates differ between green and brown firms. We find that the perceived cost of capital of green firms is lower than that of brown firms. This difference has widened since 2016. The difference in discount rates between green and brown firms follows a similar pattern.

Using a simple stylized model, we gauge to what extent such differences in discount rates could actually reduce emissions. We calculate that the differences in discount rates between green and brown firms could reduce firm-level emissions per unit of capital by around 20 percent. This suggests that climate capitalists could have meaningful impact on real outcomes by determining the allocation of funding.

Finally, we discuss potential mechanisms that explain the relation between greenness and discount rates. We analyze evidence from a new survey among corporate managers.

The tentative results suggest that direct incorporation of greenness, mediating variables, and a perfect information benchmark could all explain the patterns. The survey responses suggest that firms may emphasize greenness even more in their future decision-making.

Table 1
Summary statistics

This table reports summary statistics of variables used in our analyses. We report the mean, standard deviation, the 5th percentile, and the 95th percentile.

	(1) Mean	(2) SD	(3) 5th	(4) 95th
Perceived cost of capital	8.41	2.67	3.81	12
Discount rate	17.0	6.93	8	30
Environment score	0.46	0.22	0.12	0.84
Book-to-market	0.57	0.43	0.096	1.28
Leverage	0.24	0.22	0	0.69
Log market cap	8.26	1.68	5.66	11.1
Emissions-to-capital ratio	205.9	598.8	2.34	1001.4

Table 2
Greenness and the perceived cost of capital

This table reports results of the following regression:

$$\text{perceived cost of capital}_{it} = \mu + \eta \text{e-score}_{it} + \phi_t + \varepsilon_{it},$$

where perceived cost of capital$_{it}$ is the perceived cost of capital of firm i in year t and e-score$_{it}$ is the MSCI environment pillar score normalized to be between 0 and 1. We include year fixed effects ϕ_t to control for general macroeconomic trends. Standard errors are clustered at the firm level. The sample includes the years 2002 to 2021.

	(1) CoC (US only)	(2) CoC (Global)	(3) CoC (Global)
Environment score	-1.62***	-1.08**	-1.14**
	(0.58)	(0.47)	(0.46)
Observations	878	1,744	1,603
FE	Year	Year	Country/Year
R^2	0.132	0.068	0.147
Within R^2	0.020	0.0088	0.0096

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3
Greenness and discount rates

This table reports results of the following regression:

$$\text{discount rate}_{it} = \mu + \eta\text{e-score}_{it} + \phi_t + \varepsilon_{it},$$

where discount rate_{it} is the discount rate of firm i in year t and e-score_{it} is the MSCI environment pillar score normalized to be between 0 and 1. Standard errors are clustered at the firm level. We include year fixed effects ϕ_t to control for general macroeconomic trends. The sample includes the years 2002 to 2021.

	(1) DR (US only)	(2) DR (Global)	(3) DR (Global)
Environment score	-4.21**	-4.90***	-3.81***
	(2.07)	(1.30)	(1.43)
Observations	792	1,577	1,448
FE	Year	Year	Country/Year
R^2	0.048	0.046	0.129
Within R^2	0.021	0.033	0.020

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4
Time variation: Greenness and the perceived cost of capital and discount rates

This table reports results of the following regression:

$$y_{it} = \mu + \eta_1 \text{e-score}_{it} + \eta_2 \text{e-score}_{it} \times \mathbb{1}_{t \geq 2016} + \phi_t + \varepsilon_{it},$$

where y_{it} is either the perceived cost of capital or the discount rate of firm i in year t; e-score$_{it}$ is the MSCI environment pillar score normalized to be between 0 and 1; and $\mathbb{1}_{t \geq 2016}$ is an indicator denoting whether the year is greater than or equal to 2016. We include year fixed effects ϕ_t to control for general macroeconomic trends. Standard errors are clustered at the firm level. The sample includes the years 2002 to 2021.

	(1) CoC (US only)	(2) CoC (Global)	(3) CoC (Global)	(4) DR (US only)	(5) DR (Global)	(6) DR (Global)
Environment score	-0.24	-0.19	-0.30	-1.19	-2.76**	-1.63
	(0.83)	(0.72)	(0.66)	(2.13)	(1.39)	(1.53)
Environment score × Post-2016	-2.55**	-1.53*	-1.45*	-5.76**	-3.74*	-3.97*
	(1.19)	(0.78)	(0.76)	(2.93)	(1.91)	(2.09)
Observations	878	1,744	1,603	792	1,577	1,448
FE	Year	Year	Country/Year	Year	Year	Country/Year
R^2	0.143	0.072	0.150	0.057	0.051	0.134
Within R^2	0.032	0.013	0.014	0.031	0.038	0.026

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5
Time variation in multifactor models

This table reports results of the following regression:

$$y_{it} = \mu + \eta_1 \text{e-score}_{it} + \eta_2 \text{e-score}_{it} \times \mathbb{1}_{t \geq 2016} + \eta_3 \text{Controls}_{it} + \phi_t + \varepsilon_{it},$$

where y_{it} is the perceived cost of capital or discount rate of firm i in year t; e-score$_{it}$ is the MSCI environment pillar score normalized to be between 0 and 1; $\mathbb{1}_{t \geq 2016}$ is an indicator denoting whether the year is greater than or equal to 2016; and Controls$_{it}$ is a vector of control variables including market beta, log market capitalization, book-to-market ratio, and leverage. We include year fixed effects ϕ_t to control for general macroeconomic trends. Standard errors are clustered at the firm level. The sample includes the years 2002 to 2021.

	(1) CoC (US only)	(2) CoC (Global)	(3) CoC (Global)	(4) DR (US only)	(5) DR (Global)	(6) DR (Global)
Environment Score	0.54	0.20	0.36	1.04	-0.44	-0.10
	(0.82)	(0.59)	(0.61)	(2.19)	(1.42)	(1.60)
Environment Score × Post-2016	-2.36*	-1.71**	-1.56**	-5.14*	-3.31*	-3.38
	(1.22)	(0.74)	(0.68)	(2.86)	(1.82)	(1.99)
Market beta	2.52***	2.29***	2.30***	4.51***	4.67***	3.36***
	(0.66)	(0.51)	(0.52)	(1.60)	(1.11)	(1.03)
Log market cap	-0.17	-0.30***	-0.26**	-1.21***	-0.99***	-0.97***
	(0.15)	(0.088)	(0.098)	(0.41)	(0.24)	(0.25)
Book-to-market	0.42	0.19	0.20	-0.43	-1.01	-0.71
	(0.36)	(0.29)	(0.31)	(1.13)	(0.66)	(0.55)
Leverage	-3.05***	-2.37***	-2.07**	-2.01	-3.32	-2.38
	(0.90)	(0.79)	(0.86)	(2.96)	(2.03)	(2.08)
Observations	748	1,352	1,350	660	1,143	1,140
FE	Year	Year	Country/Year	Year	Year	Country/Year
R^2	0.222	0.193	0.233	0.154	0.125	0.193
Within R^2	0.12	0.12	0.086	0.11	0.11	0.082

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure 1
Emissions-to-capital ratio and discount rates

This figure shows the emissions-to-capital ratio as a function of the difference between the discount rate for brown capital (δ^{Brown}) and the discount rate for green capital (δ^{Green}), according to the simple model presented in Section 2. We scale the emissions-to-capital ratio so that it equals 1 at $\delta^{\text{Brown}} = \delta^{\text{Green}}$. We plot the equation for three different values of β_i/α_i, which is the ratio of the output elasticities of green capital to that of brown capital.

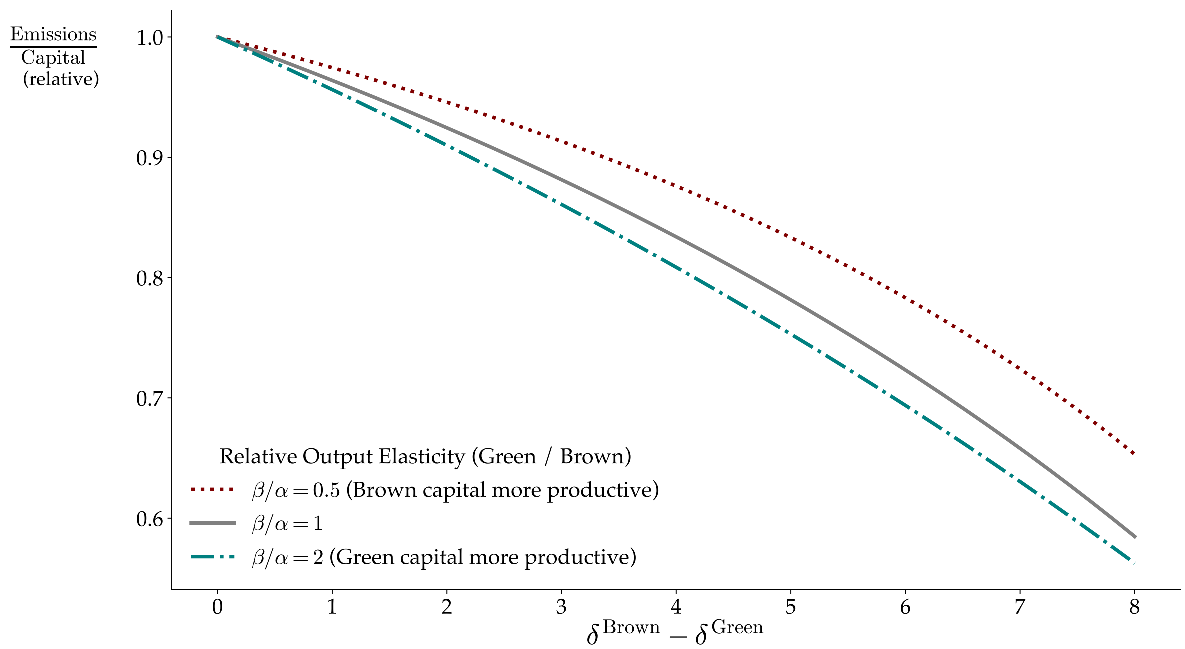
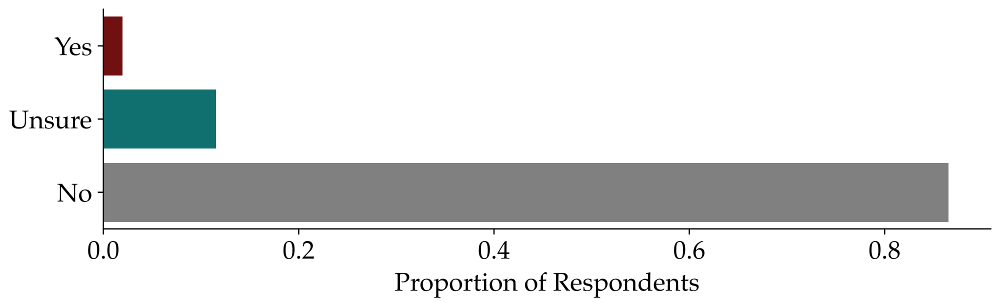


Figure 2
Survey responses about greenness and cost of capital and discount rates

This figure summarizes responses to questions in the survey. The terms "discount rate" and "hurdle rate" capture the same concept in corporate practice, namely, the minimum required return on a new investment project. We ask managers about their "hurdle rate," since this term is more common among practitioners.

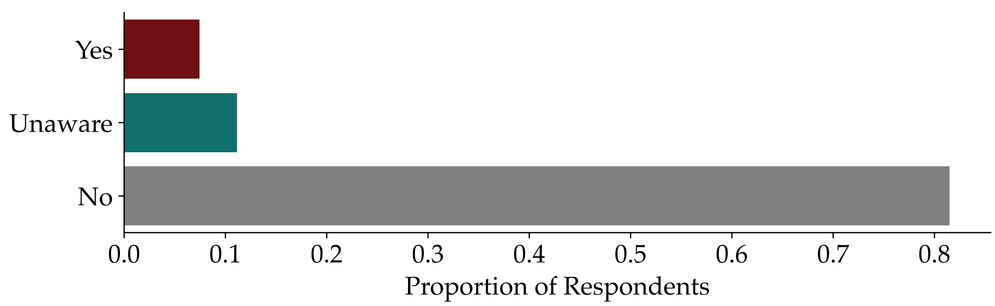
Panel (a): Cost of Capital

Does your company adjust the cost of capital based on the "greenness" of the company?



Panel (b): Hurdle Rates

Does your company adjust hurdle rates based on the "greenness" of individual projects?



Choose the reason for your answer.

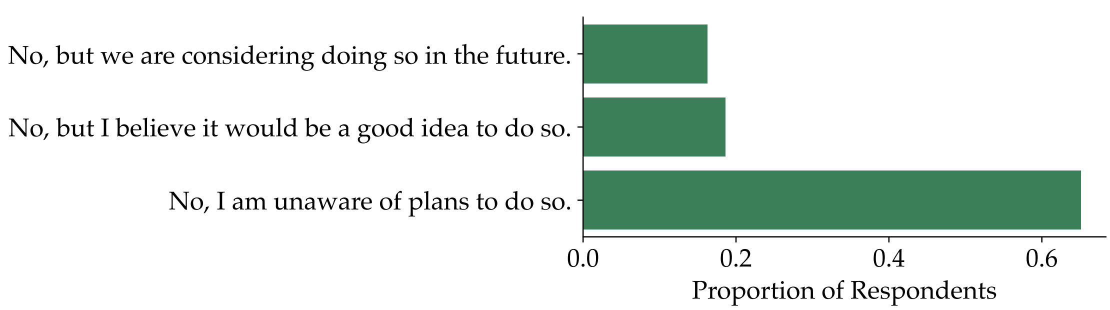


Figure 3
Survey responses about future incorporation of greenness

This figure summarizes responses to a question in the survey.

Do you think your company should incorporate "green" practices into their financial decision-making to a larger extent?

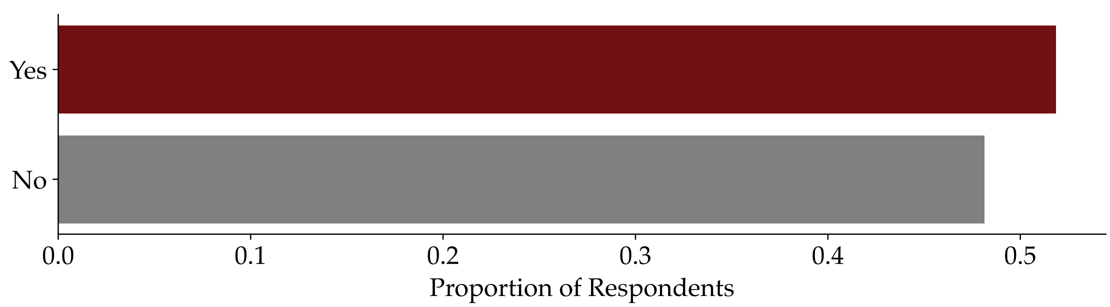


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Table A1
Robustness check for time variation

This table reports results of the following regression:

$$y_{it} = \mu + \eta_1 \text{e-score}_{it} + \eta_2 \text{e-score}_{it} \times t + \phi_t + \varepsilon_{it},$$

where y_{it} is the perceived cost of capital or the discount rate of firm i in year t; e-score$_{it}$ is the MSCI environment pillar score normalized to be between 0 and 1; and t denotes the year of observation. Standard errors are clustered at the firm level. The sample includes the years 2002 to 2021.

	(1) CoC (US only)	(2) CoC (Global)	(3) CoC (Global)	(4) DR (US only)	(5) DR (Global)	(6) DR (Global)
Environment Score	922***	369*	363*	2,130**	1,227**	1,332**
	(328)	(207)	(200)	(954)	(483)	(568)
Environment Score × Year	-0.46***	-0.18*	-0.18*	-1.06**	-0.61**	-0.66**
	(0.16)	(0.10)	(0.099)	(0.47)	(0.24)	(0.28)
Observations	878	1,744	1,603	792	1,577	1,448
FE	Year	Year	Country/Year	Year	Year	Country/Year
R^2	0.147	0.072	0.150	0.060	0.053	0.136
Within R^2	0.037	0.013	0.014	0.034	0.040	0.028

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A2
Summary statistics of survey respondents

This table summarizes the characteristics of firms responding to the survey.

(a) Geography	Respondents	(c) Ownership Type	Respondents
Multinational Companies	43.7%	Publicly owned	32.7%
U.S. and Canada	40.0%	Privately held	52.7%
Asia Pacific	3.6%	Others	14.5%
Middle East and Africa	12.7%		

(b) Annual Revenue	Respondents	(d) Industry Classification	Respondents
Under \$50 Million	12.7%	Manufacturing	30.4%
\$50 – \$500 Million	21.8%	Health Care/Social Assistance	8.9%
\$500 – \$1 Billion	16.4%	Education	7.1%
\$1 – \$5 Billion	30.9%	Software/Technology	7.1%
\$5 – \$10 Billion	9.1%	Banking/Financial Services	7.1%
>\$10 Billion	9.1%	Energy	7.1%
		Others	32.0%

Figure A1
Emissions-to-capital ratio and greenness

This figure shows a binned scatter plot of the emissions-to-capital ratio and firm greenness after residualizing year fixed effects. The emissions-to-capital ratio is measured for each firm in each year by dividing scope 1 greenhouse gas emissions (obtained from S&P Trucost) by the gross amount of property, plant, and equipment (PPE, obtained from Compustat). Firm greenness is measured using the MSCI environment pillar score normalized to be between 0 and 1.

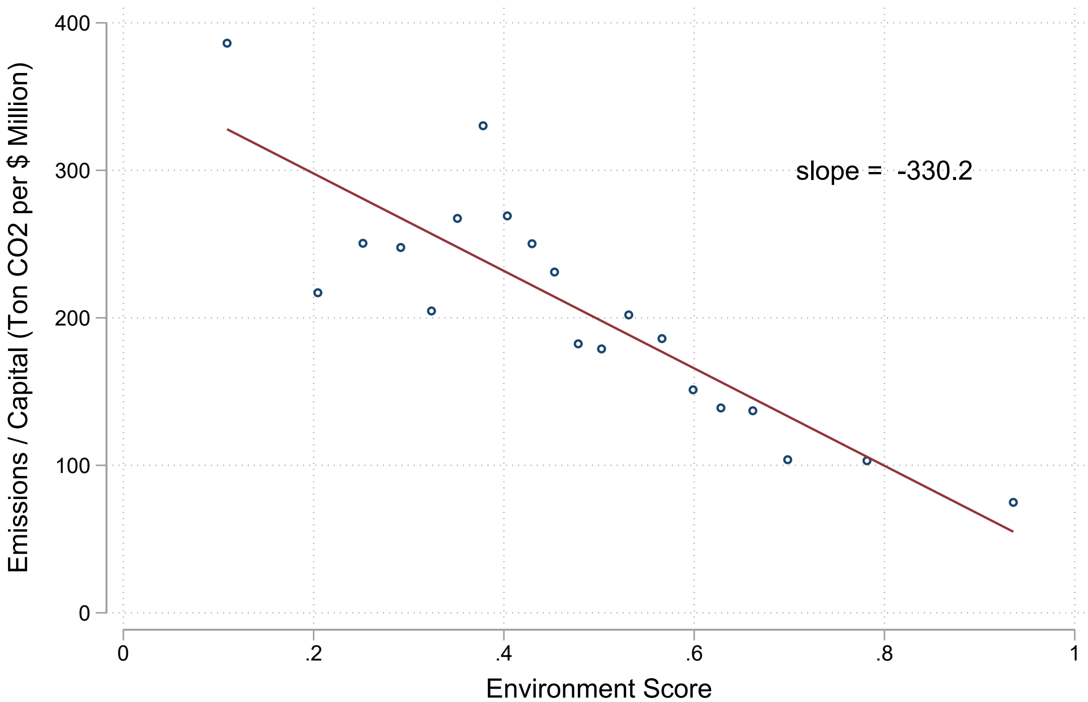
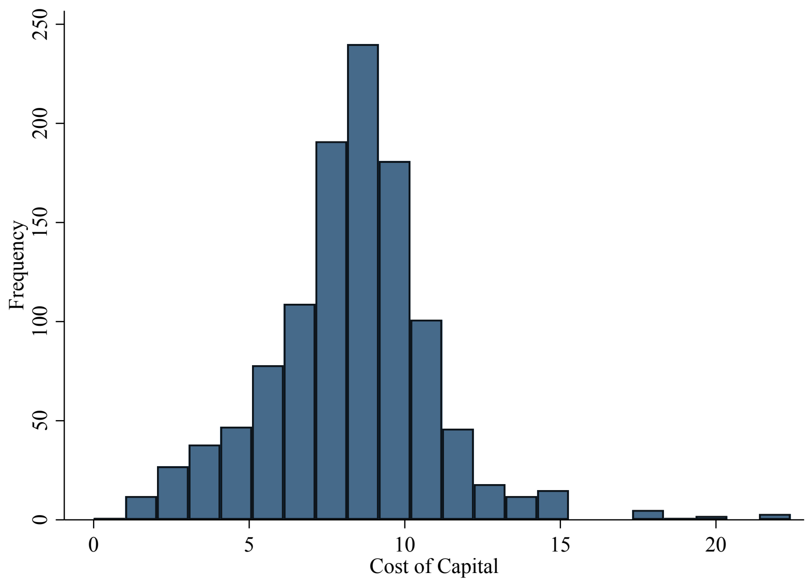


Figure A2
Distribution of perceived cost of capital and discount rates

This figure plots the distribution of perceived cost of capital (panel (a)) and discount rates (panel (b)) in our sample. Data is from Gormsen and Huber (2022) who collect firm-quarter observations on perceived cost of capital and discount rates from conference calls. The sample includes the years 2002 to 2021.

Panel (a): Perceived Cost of Capital



Panel (b): Discount Rates