Climate Capitalists*

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Abstract

In theory, a cost of capital channel can incentivize green investments like a carbon tax. This channel requires that firms perceive the cost of green capital as lower than that of brown capital. Using hand-collected data, we show that green firms have indeed perceived their cost of capital to be 1 percentage point lower since 2016, when climate concerns by financial investors and governments surged. Moreover, some energy firms have used a lower cost of capital for their green divisions. The findings suggest that the cost of capital can incentivize capital reallocation toward greener investments across firms and within firms.
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1 Introduction

Climate change has sparked a public debate about how to incentivize firms to invest into green production methods. A commonly discussed tool is a carbon tax, which reduces the returns that firms earn from brown production. But current carbon taxes do not match the social cost of carbon, so financial investors, government funds, and central banks have discussed an approach operating through firms' cost of capital.[1] In the long run, the cost of capital determines firms' willingness to undertake an investment, given the investment return. If financial markets set a lower cost of green capital, it becomes profitable for firms to undertake more green investments, even if these investments do not offer high returns.[2] The cost of capital channel can thereby incentivize green investments similarly to a carbon tax (Pedersen 2023, Chitarro et al. 2025).

Despite the prominence of this idea in the public debate, it has not been established whether the cost of green capital differs from that of brown capital and whether this difference has increased with recent climate concerns of investors and governments. A large literature has estimated the cost of green capital in financial markets using realized asset returns. However, the relevant sample is too short to estimate firms' cost of capital without strong assumptions, leading to conflicting results (e.g., Bolton and Kacperczyk 2021, Pástor et al. 2022) and disagreement among experts.[3] Researchers have also surveyed households on their preferences, but it is not trivial to infer the cost of capital from such surveys, as explained by Aron-Dine et al. (2024).

A further challenge for existing approaches is that the cost of capital set in financial markets does not directly enter firm investment decisions (Graham 2022). Instead, firms form their own perceptions of the cost of green capital, which then determine their demand for green investments. Even if the cost of green capital in financial markets falls, firms may not adjust their perceived cost of green capital in tandem,

[1] Proponents include institutional investors like BlackRock (BlackRock 2020), government funds (Invesco 2022), and the Catholic Church (Vatican 2022). Similarly, the European Central Bank operates a bond purchase program providing more capital to green firms (Papoutsi et al. 2022). Sustainable funds make up around 25% of global assets under management today (Bloomberg 2024).

[2] The cost of capital is key because firms adjust the minimum required returns they are willing to accept on new investments (also known as discount rates or hurdle rates) with the cost of capital in the long run (see Sections 3.5 and 4.4 and Gormsen and Huber 2024). Required returns can be stickier than the cost of capital in the short run, so we will also analyze them separately below.

[3] 21% of academics agree that firms pursuing social and environmental initiatives benefit from a lower cost of capital, 55% are uncertain, and 23% disagree (Chicago Booth Clark Center 2024).

eliminating any potential real effects.

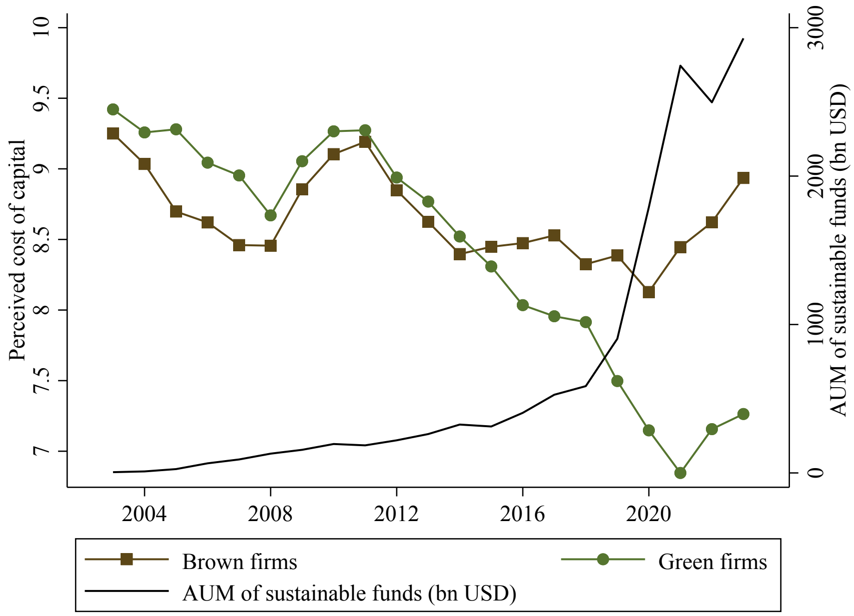
We overcome these issues by directly studying how firms' perceived cost of capital relates to greenness. We analyze data from corporate conference calls where firms report their perceptions of their weighted average cost of capital. The perceptions are based on firms' estimates of expected returns to their outstanding debt and equity in financial markets. Unlike estimates of the cost of capital obtained from financial market data, the perceived cost of capital captures a direct input into firms' investment decisions. Indeed, we confirm that firms' investment rates and realized returns to capital are strongly predicted by the perceived cost of capital observed on conference calls, in line with theory. The conference call data also offer more statistical power than estimates based on asset returns because we do not need to infer the cost of capital from realized returns, but can directly observe firms' ex ante perceptions.

Our main finding, shown in Figure 1, is that the perceived cost of capital has dropped substantially for green firms relative to brown firms as climate concerns have increased. Up until 2016, the perceived cost of capital of green firms was close to that of brown firms. After 2016, climate concerns surged, as exemplified by the enormous inflow into sustainable funds in financial markets, and the perceived cost of capital of green firms fell substantially relative to that of brown firms. On average, the perceived cost of capital of green firms was 1 percentage point lower than that of brown firms after 2016. This difference is large relative to variation in the cost of capital in general, as firm greenness is the third most powerful explanatory variable for the perceived cost of capital post-2016, ranked behind only market beta and leverage. We also find within-firm variation: some of the largest energy and utility firms have started applying a lower perceived cost of capital and discount rate to their greener divisions, such as renewable energy, since 2016. Finally, firms facing a higher spread between the cost of green and brown capital in their sector have pledged to reduce emissions by more, consistent with the cost of capital affecting real outcomes.

Together, the results imply that the cost of green capital relevant for firm investment decisions is lower than that of brown capital and has substantially decreased since 2016. The decline coincided with rising climate concerns and sustainable investing in financial markets by financial investors, governments, and central banks. The results do not point to one specific driver of the cost of green capital and our ambition is not to identify one.[4] Instead, the results offer three implications. First, firm greenness

[4]For example, as discussed in Chitarro et al. (2025), the results are consistent with greater

Figure 1
The perceived cost of capital of green and brown firms



This figure plots the average perceived cost of capital of green and brown firms in different years. We use firm-level data collected from conference calls to measure the perceived cost of capital. For each year, we split firms observed in that year into two evenly-sized groups at the sample median of the MSCI environment score (e-score) in that year. We calculate the average firm-level perceived cost of capital for both groups in every year and plot three-year moving averages. The assets under management (AUM) of sustainable funds from 2010 to 2023 are in billion USD and reported in UNCTAD (2021, 2024). For years prior to 2010, we project the data points using the annual growth rate of passive sustainable AUM as reported in Morningstar (2020). A detailed analysis of this figure is in Section 4.

has been strongly associated with the cost of capital, so the cost of capital channel can incentivize the reallocation of capital to green firms. Second, firms are willing to adjust the relative cost of green capital over time, implying that large-scale changes in financial markets can impact the cost of green capital. And third, a few key firms use within-firm variation, suggesting that firms are in principle sophisticated enough to become greener through a within-firm cost of capital channel.

To approximate an optimal carbon tax of 50USD/tCO2 to 100USD/tCO2, the cost of green capital would need to be 6 to 10 percentage points lower than the cost of brown capital, according to Pedersen (2023) and Chitarro et al. (2025). The 2 percentage point difference we estimate in 2023 is therefore not sufficient to address

non-pecuniary preferences for green assets by financial investors or a decrease in the riskiness of green assets (e.g., due to the risk of future regulation).

climate change on its own and even large-scale changes in financial markets may not suffice. At the same time, a 2 percentage point difference is not negligible, perhaps around 20% to 33% of the optimal tax, so there is potential for a cost of capital channel to partly facilitate the transition to a green economy even absent carbon taxes and improved green technologies.

We motivate the empirical analysis with a theoretical model that includes two types of firms: green and brown. The aim of the model is to illustrate how changes in the cost of green capital in financial markets can affect firm behavior and real outcomes. Green firms are relatively more efficient at using green capital (e.g., machinery that produces low emissions) and brown firms are more efficient at using brown capital. Within this theoretical model, we analyze the implications of a decrease in the cost of green capital. The decrease could be driven by an increase in financial investors' non-pecuniary preferences for green assets or a decrease in the riskiness of green assets (e.g., due to the risk of future regulation), but the exact driver does not affect our analysis. We highlight two channels through which the lower cost of green capital can incentivize green investments. The first channel operates across firms. A decrease in the cost of green capital reduces the firm-level cost of capital of green firms by more, which leads green firms to grow larger and brown firms to grow smaller, reducing total emissions. This "cross-firm channel" of capital reallocation from brown to green firms operates as long as consumers can substitute between the products of brown and green firms (i.e., it depends on the elasticity of substitution across products of green and brown firms).

In addition to the cross-firm channel, there is also a "within-firm channel." The within-firm channel arises because both types of firms recognize that the cost of green capital has decreased and therefore use more green capital relative to brown capital. In practical terms, firms favor projects that are relatively more climate-friendly because they can obtain funding for these projects at a lower cost. This within-firm channel is in operation as long as firms apply a different cost of capital or discount rate to their greener divisions. Since some firms apply only a single cost of capital to all divisions, we show that the implied decrease in emissions that is generated by only the cross-firm channel is lower, but can still be a meaningful contributor to lowering emissions under standard assumptions.

We empirically analyze whether the cross-firm and within-firm channels may have been in operation. We use data on firm perceptions of their cost of capital obtained from manual reading of corporate conference calls. On these calls, firms occasionally share their internal estimate of their cost of capital. We merge a firm-level measure of "greenness" called e-score, which is provided by the rating agency MSCI and associated with the emissions-to-capital ratio of firms. Firms with at least one reported perceived cost of capital and an observed e-score account for around 27% of the total scope 1 and 2 emissions of firms in developed markets, as measured by the S&P Trucost database, and for around 35% of total assets in Compustat. Firms in the sample are thus large enough to matter for aggregate emissions. All our results are similar when we use the "robust" green score from Eskildsen et al. (2024) to measure greenness instead of the e-score.

We follow Gormsen and Huber (2024) and verify that firms' perceived cost of capital reported on conference calls is associated with real outcomes. Firms with a higher perceived cost of capital have lower investment rates and earn higher realized returns on investment. These results suggest that the perceived cost of capital affects long-run capital decisions of firms, consistent with the important role played by the cost of capital in standard investment models.[5]

We find that green firms (i.e., those with a higher e-score) perceived the same cost of capital as brown firms until 2016, but green firms have perceived an increasingly lower cost of capital than brown firms since 2016. The divergence in the cost of capital aligns with the rise in sustainable investing—as illustrated by the increase in assets under management of sustainable funds shown in Figure 1—and the general increase in climate concerns following the Paris Accords in 2016. The correlation between the assets under management of sustainable funds and the spread in the cost of capital between green and brown firms is 0.95.

The difference in the perceived cost of capital between green and brown firms is large not only in absolute terms but also relative to general cross-sectional variation. Greenness post-2016 is the third most powerful predictor of the perceived cost of capital, behind only beta and leverage, according to a Lasso algorithm. It is ahead of, and not explained by, 150 other risk factors that are known to explain asset returns in financial markets (and thus potentially the perceived cost of capital). Similarly to the perceived cost of capital, the discount rates used by firms to evaluate new investments have also fallen for green firms relative to brown firms. Taken together, our findings

[5] In the short run, shocks to the perceived cost of capital affect investment decisions less strongly, as shown by Gormsen and Huber (2025) and discussed in Sections 3.5 and 4.4.

on the firm-level perceived cost of capital are consistent with a cross-firm channel of capital allocation.

There exists no other estimate of whether the perceived cost of capital of green firms has evolved differently to that of brown firms. The literature has instead focused on estimating differences in the expected returns on the assets of green and brown firms. Expected returns may be informative about firms' cost of capital under the assumption that firms perceive expected returns similarly to researchers and incorporate them into their cost of capital in line with standard theory (although this is often not true, Krüger et al. 2015, Gormsen and Huber 2024). We scale the estimates of 19 recent papers to make their magnitude comparable to our estimate of firm perceptions. The range of estimates is large, consistent with the fact that it is generally difficult to estimate expected returns precisely (Fama and French 1997). The estimates from the literature include positive and negative values and their absolute magnitude ranges from 0 to almost 10 times as large as our point estimate. The wide range of estimates implies that green firms could base their perceived cost of capital on a wide range of values, depending on which expected return estimate they adopt. In the absence of data on firms' perceptions, it is therefore difficult to infer how green firms have changed their perceived cost of capital since 2016. As a result, it has been difficult to gauge whether differences in the cost of green capital can affect firm behavior. Our estimate of firm perceptions after 2016 lies roughly in the middle of the range of estimates from the literature, with tighter standard errors than most estimates obtained from realized asset returns.

We next study whether there is within-firm variation in the perceived cost of capital across green and brown investments. Such variation is necessary for the cost of capital channel to generate within-firm reallocation from brown to green investments. We focus on some of the highest-emitting firms in the world in the energy and utilities sectors because they are responsible for a large share of total emissions. We conduct a separate data collection exercise by manually reading through all the investor information slides that the 200 largest energy and utility firms share on their websites. We identify 53 firms that at least once share multiple division-level perceived cost of capital or discount rate values. The sample includes, for instance, BP, EDF, Shell, and TotalEnergies, the four of which jointly account for 3.5% of total emissions in the S&P Trucost data.

The data reveal that the observed energy and utility firms have operated with significantly lower perceived cost of capital and discount rates for their green divisions (e.g., renewable energy) since 2016, relative to their brown divisions (e.g., energy from fossil fuels). The cost of capital for green divisions is, on average, 1 percentage point lower. This within-firm estimate is consistent with the cross-firm estimate described earlier, suggesting that the underlying greenness of firms and divisions drives the difference in the cost of green capital. The within-firm results also suggest that, at least in principle, the within-firm channel could raise green investments because some high-emitting firms are sophisticated enough to adjust their perceived cost of capital and discount rates differently across individual divisions.

The results on the perceived cost of capital discussed so far suggest that both cross-firm and within-firm channels can be in operation (in particular, since we verify that the firm-level perceived cost of capital is associated with firm-level real investment). In the final part of the paper, we present suggestive evidence that perceptions of the cost of green capital can influence firms' emissions plans. We study emissions plans instead of realized emissions of existing investments because we want to analyze only decisions of firms made since the cost of green capital has been lower (i.e., since roughly 2016). Realized emissions data capture the total emissions produced by all existing capital of a firm, which is largely driven by pre-2016 investments. We use data from MSCI on firm-level pledges to reduce emissions. While the evidence can only be suggestive and pledges may not always materialize, pledges are associated with lower future emissions (Bolton and Kacperczyk 2023). In theory, everything else equal, firms should pledge larger reductions in emissions if they perceive the cost of capital applying to potential green investments as lower. To test this hypothesis, we study whether firms pledge to reduce emissions by more if they operate in a sector where the average cost of capital for green investments is relatively lower. Differences across sectors may be partly driven by technological differences in how risky it is for firms to transition to greener capital and production methods. We find that firms pledge to reduce emissions by 10% more for every 1 percentage point difference between green and brown capital in a sector. This finding is consistent with the view that variation in the perceived cost of green capital can impact planned emissions.

Related Literature

The literature on the cost of green capital has focused on the expected returns to green assets in financial markets (reviewed by Giglio et al. 2021). According to theory, changes in expected returns affect firms' cost of capital and can thus lead to greener investments in the real economy (Broccardo et al. 2022, Edmans et al. 2022, Oehmke and Opp 2022, Pedersen 2023). The expected returns to green assets may be higher because investors have non-pecuniary tastes for green assets (Heinkel et al. 2001, Hong and Kacperczyk 2009, Pástor et al. 2021, Baker et al. 2022, Zerbib 2022, Coqueret 2022, Koijen et al. 2024) or lower because investors believe that green assets are riskier (Goldstein et al. 2022). The ultimate sign and magnitude are theoretically ambiguous (Pedersen et al. 2021, Berk and van Binsbergen 2022, De Angelis et al. 2022, Agarwal and Suarez 2024).

Empirically, expected returns are not directly observed, so they need to be estimated using realized returns on stocks and bonds, which is difficult (Fama and French 1997, Pástor and Stambaugh 1999). The evidence on how realized stock returns differ between green and brown firms is mixed (e.g., Bolton and Kacperczyk 2021, Pástor et al. 2022, and Section 4.3).[6] Bond returns (e.g., Baker et al. 2018) and the implied cost of capital, which is based on analyst return forecasts (e.g., Pástor et al. 2022, Eskildsen et al. 2024), have been lower for green firms.

Given this existing evidence, it is not clear how firms set the cost of green capital that determines their investment decisions. There are many potential methods (Graham and Harvey 2001, Hommel et al. 2023) and the range of existing estimates is wide, as we show in Figure 8 and discuss in Section 4.3. Ultimately, the cost of capital used in investment decisions does not directly depend on estimated stock returns, bond returns, or analyst forecasts, but on how firms themselves perceive their cost of capital. Our contribution is to directly estimate the cost of green capital as perceived by firms, which can inform the cross-firm and within-firm channels of capital reallocation.[7]

2 Theory

We introduce a simple model in which firms produce output using green and brown capital. The aim of the model is to clarify how the cost of green capital can affect firm

[6] There is also work on other sustainable practices (e.g., El Ghoul et al. 2011, Edmans 2021).

[7] Our estimates can also be interpreted as measuring investors' willingness to pay for green investments in the marketplace (List 2006), as perceived by firms. Complementary approaches to measuring the willingness to pay 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, Krüger et al. 2020, Stroebel and Wurgler 2021, Sangiorgi and Schopohl 2021a,b, Giglio et al. 2025, Edmans et al. 2024), and experiments (Levitt and List 2007, Rodemeier 2023).

behavior and emissions, thereby motivating the empirical analysis. We thus use the model to analyze a shock to the cost of green capital. This shock could, in principle, be driven by an increase in climate concerns of investors, a decrease in the riskiness of green assets, or similar forces, but the source of the shock is not key for our analysis. Instead, we focus on how the cost of capital affects firm decisions.

We highlight two channels through which a decrease in the cost of green capital can cause firms to use more green capital and thereby reduce aggregate emissions.

The first channel operates through cross-firm reallocation of capital toward firms whose production process uses green capital more efficiently. These green firms use relatively more green capital. If green firms can obtain green capital at lower prices than brown firms obtain brown capital, green firms can offer their output in the product market at lower prices. The relative decline in the product prices of green firms leads consumers to substitute toward the products of green firms and away from the products of brown firms. As a result, green firms become larger and brown firms become smaller, leading to a reduction in total emissions. This "cross-firm channel" is in operation whenever consumers are willing to substitute across products of brown and green firms (i.e., when the substitution elasticity is not zero).

The second channel operates through within-firm reallocation from brown to green capital. If investors provide green capital at lower costs than brown capital, all firms will optimally raise the ratio of green to brown capital in their production, leading to a reduction in total emissions. This "within-firm channel" is in operation as long as firms distinguish between the costs of brown and green capital in their investment decisions.

The model considers two different scenarios for how firms make investment decisions. In the baseline scenario, firms operate with a different cost of capital for green and brown capital. In this setting, both the cross-firm channel and the within-firm channel above are in operation. In the second scenario, firms use the same cost of capital for green and brown capital, which turns out to eliminate the within-firm channel but not the cross-firm channel. We study the second scenario because some firms traditionally only use one firm-level cost of capital, rather than specific discount rates for individual divisions (Graham and Harvey 2001, Krüger et al. 2015).

2.1 Model Setup

A continuum of firms produces output using brown and green capital. Brown capital harms the climate (e.g., an oil-powered generator) and green capital operates relatively cleanly (e.g., a wind turbine). Since the model focuses on the production decisions of firms, we assume that both types of capital are supplied inelastically at a given rate (e.g., by a foreign investor or the central bank). Investors charge rate r for brown capital and $r - \zeta$ for green capital, where the parameter ζ captures the effect of greenness on the cost of capital. If investors are more concerned about the climate or if they perceive green assets to be less risky, ζ is larger. A unit of brown capital produces emissions of e^{Brown} and a unit of green capital produces e^{Green}.

Firms are indexed by $i \in [0, I]$. Firms sell their differentiated products to a representative household, which forms utility over the products based on a constant elasticity of substitution:

$$U = \left(\int_{i=0}^{I} Q_i^{(\sigma-1)/\sigma} di \right)^{\frac{\sigma}{\sigma-1}}, \tag{1}$$

where Q_i is the quantity consumed of firm i's product and σ governs the elasticity of substitution across products. The budget constraint of the household is $W = \int_{i=0}^{I} P_i Q_i di$, where W denotes wealth and P_i denotes the price of product i. We define the price index $\boldsymbol{P}^{1-\sigma} = \left(\int_{i=0}^{I} P_i^{1-\sigma} di \right)^{1/(1-\sigma)}$. Maximizing utility subject to the budget constraints leads to the demand curve,

$$Q_i = P_i^{-\sigma} \frac{W}{\boldsymbol{P}^{1-\sigma}}. \tag{2}$$

Firm i produces output Y_i using brown and green capital

$$Y_i(K_i, L_i, G_i) = K_i^{\alpha_i} G_i^{1-\alpha_i}, \tag{3}$$

where K_i is brown capital, G_i is green capital, and α_i and $1 - \alpha_i$ are the output elasticities of brown and green capital. There are two types of firms. Brown firms have $\alpha_i = 0.7$, reflecting that brown capital is relatively more productive for brown firms. In contrast, green firms have $\alpha_i = 0.3$, reflecting that green capital is relatively more productive for green firms.

Baseline optimization problem In the baseline scenario, firms internalize that investors provide brown and green capital at different prices. Firms therefore maximize profits using the cost of capital $r^{\text{Brown}} = r$ for brown capital and $r^{\text{Green}} = r - \zeta$ for green capital:

$$\Pi_i^{\text{Baseline}} = \max_{K_i, G_i} \quad P_i Y_i(K_i, L_i, G_i) - r^{\text{Brown}} K_i - r^{\text{Green}} G_i. \tag{4}$$

At their first order condition, firms combine brown and green capital based on the relative output elasticities and cost of capital,

$$\frac{K_i^*}{G_i^*} = \frac{\alpha_i}{1-\alpha_i} \times \frac{r^{\text{Green}}}{r^{\text{Brown}}}, \tag{5}$$

with K_i^* and G_i^* denoting the optimal choice of brown and green capital according to the optimization problem (4). Given the demand for products in (2), the optimal price is a constant markup over the marginal cost of output,

$$P_i^* = \frac{\sigma}{\sigma - 1} \left(\frac{r^{\text{Brown}}}{\alpha_i}\right)^{\alpha_i} \left(\frac{r^{\text{Green}}}{1-\alpha_i}\right)^{1-\alpha_i}. \tag{6}$$

The cost of brown and green capital is the same across firms. However, the firm-level cost of capital, which is the weighted average cost of capital (WACC) across the two types of capital, differs across firm if they use different amounts of brown and green capital:

$$\text{WACC}_i = \frac{K_i r^{\text{Brown}} + G_i r^{\text{Green}}}{K_i + G_i} = r - \zeta \frac{G_i}{K_i + G_i}. \tag{7}$$

Optimization with a single discount rate We also consider a scenario where firms understand that the firm-level cost of capital (WACC) depends on the amount of brown versus green capital (because of the green cost of capital effect, ζ), but firms do not distinguish between the cost of brown and green capital when choosing the relative amounts of brown and green capital. Instead, firms maximize:

$$\Pi_i^{\text{WACC}} = \max_{K_i, G_i} \quad P_i Y_i(K_i, L_i, G_i) - \text{WACC}_i (K_i + G_i), \tag{8}$$

where WACC_i is the firm-level cost of capital defined in (7). The optimal ratio of brown to green capital for firms with just one discount rate depends solely on the relative output elasticities:

$$\frac{K_i'}{G_i'} = \frac{\alpha_i}{1-\alpha_i}, \tag{9}$$

with K_i' and G_i' denoting the optimal choice of brown and green capital according to the optimization problem in (8). The optimal price is again a markup over marginal cost:

$$P_i' = \frac{\sigma}{\sigma-1}\frac{\text{WACC}_i}{\alpha_i^{\alpha_i}(1-\alpha_i)^{1-\alpha_i}}. \tag{10}$$

The firm-level weighted average cost of capital simplifies to

$$\frac{K_i' r^{\text{Brown}} + G_i' r^{\text{Green}}}{K_i' + G_i'} = r - \zeta(1-\alpha_i). \tag{11}$$

2.2 Model Results

We study the effects of a lower cost of green capital (i.e., greater ζ). In these analyses, we vary the green cost of capital effect, ζ, while keeping the unweighted mean cost of capital $(r^{\text{Brown}} + r^{\text{Green}})/2$ constant, which means we simultaneously vary r and ζ in opposite directions. We focus on the outcomes of a brown firm ($\alpha_i = 0.7$), a green firm ($\alpha_i = 0.3$), and the aggregate across the continuum of firms. The brown and green firms each have a mass of $0.01 \times I$. We scale total wealth W to 100. In the initial analysis, we set the elasticity of substitution σ equal to 3. We standardize emissions per unit of brown and green capital to $e^{\text{Brown}} = 1$ and $e^{\text{Green}} = 0$, respectively.

Baseline results We begin with the baseline model where firms distinguish between the cost of brown and green capital. Figure 2 shows the effect of a lower cost of green capital by varying the green cost of capital effect, ζ, between 0 and 6 percentage points. Panel A shows that the firm-level cost of capital (WACC) rises with ζ for brown firms (brown line) and falls with ζ for green firms (green line). The increase in the cost of capital of brown firms is smaller than the decrease for the green firms because both firms reallocate toward the cheaper green capital. Panel B shows that the lower firm-level cost of capital of green firms leads them to reduce their product prices (see equation (6)), while brown firms raise their prices. The product prices of brown firms increase more than their cost of capital because brown firms shift toward green capital and are less productive at using green capital, which increases their marginal output cost.

The decrease in the prices of green products increases consumer demand and leads to a larger quantity sold (Panel C). Green firms are thus larger and deploy more capital. The opposite happens for brown firms, which experience decreased product demand and therefore deploys less capital.[8] The capital reallocation from brown to green firms and the relative increase in the size of green firms represents the cross-firm channel, through which a decrease in the cost of green capital can lower emissions.

In addition to the cross-firm channel, greater ζ also leads to within-firm reallocation toward green capital. The lower cost of green capital incentivizes both brown and green firms to reduce the ratio of brown to green capital (see equation (5)), as shown in Panel D of Figure 2. The aggregate ratio (aggregate brown capital to aggregate green capital, $(\int K_i di)/\int(G_i di))$ also falls, as illustrated by the yellow line in Panel D. The aggregate ratio decreases in ζ more strongly than the ratio within each type of firm because the aggregate ratio reflects both within-firm reallocation and cross-firm reallocation (shown in Panel C).

Finally, Panel E plots the ratio of emissions to output. Both brown and green firms reduce emissions per output as ζ increases because of the within-firm reallocation channel. The aggregate emissions-to-output ratio decreases more strongly than the firm-level ratios because it reflects both cross-firm reallocation toward green capital (shown in Panel C) and within-firm reallocation (shown in Panel D).

Results with a single discount rate Figure 3 shows results when firms use only a single firm-level cost of capital (as in equation (8)). The dynamics for the firm-level cost of capital (WACC), product prices, and output are similar to the baseline case. A lower cost of green capital reduces the firm-level cost of capital of green firms, which decreases green firms' product prices and raises their output. The patterns for brown firms go in the opposite direction. The magnitudes are roughly similar to the baseline case. The cross-firm reallocation channel is thus largely unaffected when firms use only a single discount rate.

[8] Product demand and capital of brown firms fall even if the cost of capital and product prices of brown firms do not change, as long as ζ is larger, because the prices of green products are lower, leading consumer to substitute away from brown products.

However, the within-firm reallocation channel is eliminated when firms use a single discount rate, as shown in Panel D of Figure 3. Greater ζ no longer incentivizes a within-firm shift toward green capital, with the ratio of green to brown capital pinned down only by the respective output elasticities (see equation (9)). Panel D also plots the aggregate ratio of brown to green capital. The ratio decreases in ζ because of the cross-firm reallocation channel, but the effect is weaker than in the baseline where both channels are active (as in Figure 2). Similarly, the emissions-to-output ratio of green and brown firms does not change with ζ, but the aggregate emissions-to-output ratio decreases because of the cross-firm channel, as shown in Panel E.

Comparison of the two channels We study the importance of the two channels (cross-firm and within-firm reallocation) under different scenarios in more detail in Figure 4. We plot the aggregate emissions-to-output ratio against the elasticity of substitution σ. The figure contains three lines for different scenarios: (1) the blue line for $\zeta = 0$; (2) the orange line for $\zeta = 3\%$ and firms use a single discount rate for brown and green capital; and (3) the yellow line for $\zeta = 3\%$ and firms use capital-specific discount rates, as in the baseline model.

If $\zeta = 0$, investors do not have a preference for green capital and the cost of green capital does not change. As a result, the emissions-to-output ratio is also unchanged for any value of σ.

If $\zeta = 3\%$ and firms use a single discount rate, only the cross-firm channel is in operation. The emissions-to-output ratio falls by more for greater values of σ. Intuitively, a greater σ implies that consumers are more willing to substitute toward the products of green firms and therefore more capital is reallocated from brown to green firms when the cost of green capital is lower. If σ is close to 1, the cross-firm channel is weak, which is the case that represents the argument in Hartzmark and Shue (2023). But once σ exceeds 1, as is the standard assumption in the literature (Redding and Weinstein 2020), the cross-firm channel generates capital reallocation to green firms and lowers emissions.

If $\zeta = 3\%$ and firms use capital-specific discount rates, both the cross-firm and within-firm channels are in operation. The within-firm channel does not directly depend on σ. As a result, the additional reduction in the emissions-to-output ratio induced by the within-firm channel, relative to only the cross-firm channel, is relatively constant across different values of σ. Hence, even if σ were very low, reductions in the cost of green capital still reduce emissions when firms use capital-specific discount rates.

2.3 Implications for the Empirical Analysis

The theoretical analysis highlights several open questions that we need to address in order to determine how the cost of green capital could reduce emissions. For the cross-firm channel to operate, we need to understand whether green firms perceive that their firm-level cost of capital (WACC) differs in any way from that of brown firms and how that difference has evolved over time.

For the within-firm channel to operate, we need to discern whether firms, in principle, distinguish between the cost of green and brown capital, for example, by applying different cost of capital and discount rates to their greener divisions. Moreover, we need to gauge to what extent the within-firm difference in the perceived cost of green versus brown divisions has changed.

In the remainder of the paper, we will use data on the firm-level perceptions of the cost of capital (from conference call transcripts) to analyze the potential role of the cross-firm channel. In addition, we will use data on the cost of capital and discount rates for specific divisions (from slides shown during investor events) to analyze the potential role of the within-firm channel.

3 Firm-Level Data

We combine firm-level data on the perceived cost of capital and discount rates with environmental sustainability ratings and emissions statistics.

3.1 Data on the Firm-Level Perceived Cost of Capital

We first describe the data on the firm-level cost of capital (WACC), which is based on conference calls. We collect and analyze division-level data separately in Section 5, since firms do not frequently discuss division-level data on conference calls.

Firms do not typically report their firm-level perceived cost of capital in official reports, while data from surveys are mostly anonymized and cannot be merged to firm environment scores. However, on quarterly conference calls, listed firms occasionally disclose their own, internal perception of their cost of capital. In addition, firms occasionally report discount rates used to assess the net present value of new investment projects (i.e., required returns to capital). Gormsen and Huber (2025) manually read through all conference calls where firms disclose this information. We use an updated version of their dataset, based on all conference calls available on the databases Refinitiv and FactSet for the period January 2002 to June 2023, which contains roughly 3,100 firm-quarter observations on the perceived cost of capital and 3,300 observations on discount rates. We describe the measurement in detail in Appendix B.

To identify the perceived cost of capital, the data collection relies on explicit statements by managers reporting their cost of capital. We only record values for the cost of capital of the firm as a whole from the conference call transcripts. We take care to record only instances where the cost of capital mentioned by managers captures a firm's perception of its funding cost, which is typically the estimated weighted average cost of capital and often based on the firm's estimate of the expected returns to its outstanding debt and equity in financial markets.

To identify discount rates, the data collection relies on explicit statements about the firm's minimum required internal rate of return on new investments (IRR). In cases where managers discuss multiple discount rates, the data include the discount rate relating to the core of the firm's business (see Section 5 for division-level data).

Speculative statements (e.g., "if we had a cost of capital of x%"), values posited by outsiders (e.g., "your cost of capital is x%, right?"), or descriptions of specific debt issuances (e.g., "our latest bond yield was x%.") are not included. Managers typically discuss post-tax values and we correct instances where managers state that they use a pre-tax value. Manager statements of their perceived cost of debt and perceived cost of equity are recorded separately, so that the perceived cost of capital and discount rates are not confused with these other measures. Moreover, other financial indicators (e.g., realized and expected IRR, ROA, ROIC, and ROE) are also recorded separately to avoid data entry mistakes.

We argue that managers have incentives to report accurate values for the cost of capital and discount rate on conference calls, so that the reported values reflect those they use in their internal decisions. In support of this view, the perceived cost of capital indeed lines up with firms' real activities, as we detail in Section 3.5. Since managers typically want to score strongly on analyst ratings and convince investors to provide capital, conference calls are relatively high-stakes settings. Analysts and investors often question managers with reference to past statements on conference calls and the past performance of their firm. Managers' statements can be checked against past and present balance sheet measures, requiring manager statements to be consistent with respect to their actual financing situation and investment decisions.

3.2 Data on the 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 the environmental performance of the firm.[9] We normalize the environment score (e-score) to range from 0 to 1. In robustness checks, we will also use the "robust green score" from Eskildsen et al. (2024), which combines different measures of greenness into one score.

To merge the environment 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 to ensure accuracy.

3.3 Data on Emissions and Relation to Firm Greenness

Data on firm-level greenhouse gas emissions are 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 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 ($tCO_2e/\$M$).

[9] 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.

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. According to this linear 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}). This is a large difference relative to the average emissions-to-capital ratio in our sample (205.9 $tCO_2e/\$M$).

3.4 Summary Statistics and Representativeness

We summarize the sample used in our analysis in Table 1. The mean firm-level perceived cost of capital (WACC) is 8.4%. There is substantial variation across firms, as shown in Figure A2, with a standard deviation of 2.7. The mean discount rate is 17% and the standard deviation is 6.7. The level of the reported discount rates is not directly informative about firms' overall return on investments and cannot be directly compared to the cost of capital because many firms do not fully account for overhead costs in their report discount rates, as discussed in detail in Gormsen and Huber (2025). We control for differences in the extent of overhead accounting when we analyze discount rates.

Our final sample contains 729 firms for which we observe the perceived cost of capital and e-score. All these firms are in the US and Europe. Firms in the sample account for a large fraction of total emissions and assets in the economy. Firms with at least one reported perceived cost of capital and an observed e-score account for around 27% of total scope 1 and 2 emissions of firms in developed markets measured by S&P Trucost. For US firms, the ratio is higher, with the included firms accounting for approximately 40% of total emissions. The firms with at least one reported perceived cost of capital and an observed e-score account for 35% of total assets in Compustat in developed markets. These facts show that the firms in the sample are large enough to be important for aggregate outcomes, such as total emissions.

Gormsen and Huber (2025) compare the characteristics of firms in the cost of capital sample to other listed firms. We reproduce this analysis in Table A1. Panel A displays the average percentile of firms in the samples, relative to the distribution of all listed firms in Compustat in the same year and country. Firms in the samples are larger (e.g., percentile 83 in the cost of capital sample), likely because large firms hold more conference calls. Firms in the samples are also less financially constrained since large firms are less constrained. The average percentiles for the return to equity, book to market ratio, investment rate, capital to asset ratio, bankruptcy risk (Z-score), and leverage are relatively close to 50, suggesting that the average firm in the samples is close to the average firm in Compustat along these characteristics.

Panel B of Table A1 shows that the within-firm timing of when discount rates and the perceived cost of capital are reported does not coincide with unusual times for the firm, such as high distress or returns. By including firm fixed effects in these regressions, we analyze only changes in reporting likelihood over time within the same firm. For instance, column (3) shows that a firm is only 0.07 percentage points more likely to report a perceived cost of capital in the hypothetical scenario where its bankruptcy risk changes from the highest to the lowest value in the country-year bin.

3.5 The Perceived Cost of Capital, Discount Rates, and Real Investment

Given the important role played by the cost of capital in investment decisions, the perceived cost of capital reported on conference calls should be associated with firms' real activities. Following Gormsen and Huber (2024), we indeed find that firms with a higher perceived cost of capital earn higher returns on their invested capital and invest less, as shown in Table A5. The magnitudes of the relations are close to those predicted by standard theory. For instance, the investment rate of a firm with a 1 percentage point higher perceived cost of capital is on average 0.7 percentage points lower. This magnitude is consistent with the prediction of a standard Q-model given typical adjustment costs used in the literature (Philippon 2009).

Shocks to firms' cost of capital may not immediately affect real investment. Firms instead use discount rates (also known as hurdle rates or required returns to capital) as inputs in their investment decisions. The discount rates are typically based on the perceived cost of capital, but are distinct objects. There are often wedges between the perceived cost of capital and discount rates. One reason for the wedges is timing. Firms incorporate changes in the perceived cost of capital into their discount rates slowly, as shown by Gormsen and Huber (2025). In the short to medium run, shocks to the perceived cost of capital are hardly incorporated into discount rates, but in the long run, shocks are incorporated almost one-to-one. A second reason is that managers may incorporate other factors into their discount rates, apart from the perceived cost of capital. For instance, managers' non-pecuniary preferences for certain projects, the idiosyncratic risk perceptions of managers, corrections for the real option value of certain projects (McDonald 2000), or capacity constraints can affect discount rates. However, independent of the drivers of discount rates, Gormsen and Huber (2025) show that persistent shocks to the cost of capital influence discount rates and investment decisions in the long run, consistent with the estimated long-run relation between the cost of capital and real investment in Table A5.

In this paper, we are interested in understanding the potential of the cost of green capital to shape the long-run transition to green investments. We will therefore focus on changes in firms' perceived cost of capital. In an additional analysis, we will also address the separate question of whether there are differences in discount rates between green and brown firms. But, as long as the perceived cost of green capital changes persistently, the existing evidence suggest that long-run capital allocation will also be affected.

4 The Firm-Level Perceived Cost of Capital and Greenness

In this section, we study whether the firm-level perceived cost of capital of green firms, which are firms whose average investments are more environmentally friendly, differs from that of brown firms. The main finding is that greener firms have reduced their firm-level perceived cost of capital to a greater extent since 2016, concurrent with surging climate concerns by financial investors, governments, and central banks. The findings are consistent with the view that the cost of green capital has fallen in the eyes of firms, which would lead to cross-firm reallocation of capital toward green firms.

4.1 Firm-Level Greenness and the Perceived Cost of Capital

We start the analysis by plotting the firm-level perceived cost of capital for brown and green firms over time. For each year, we split firms observed in that year into two evenly-sized groups at the median MSCI environment score (e-score) in that year. We calculate the average perceived cost of capital for each group in every year and then plot three-year moving averages for each group in Figure 1. The perceived cost of capital of brown and green firms moved in parallel until roughly 2016 and started to diverge afterward. The gap between the perceived cost of capital of brown and green firms widened further in the subsequent years.[10]

The figure also shows that the total assets under management by sustainable investors started growing faster after 2016 and surged sharply in the subsequent years. This surge in sustainable investing was driven in part by rising public interest after the enactment of the 2015 Paris Agreement and by advances in corporate sustainability disclosures.[11] The "equity greenium" studied by Pástor et al. (2022)—the difference in expected stock returns between green and brown firms—and issuances of green bonds (Flammer 2021) also increased after 2016.

We formally test the relation between the firm-level perceived cost of capital and firm greenness by estimating

$$\text{Perc. cost of capital}_{i,t} = \beta_0 + \beta_1 \text{E-score}_{i,t} + \phi \text{X}_{i,t} + \varepsilon_{i,t}, \tag{12}$$

where Perc. cost of $\text{capital}_{i,t}$ is the perceived cost of capital of firm i in quarter t, $\text{E-score}_{i,t}$ is the MSCI environment pillar score normalized to be between 0 and 1, and $\text{X}_{i,t}$ are controls. All specifications include quarter-by-year fixed effects to absorb aggregate trends in the perceived cost of capital over time.

The above regression can be cleanly mapped to Equation (7) in our model, which describes the relation between the firm-level cost of capital and the firm-level share of green capital. We use the e-score to measure the share of green capital in the data (i.e., we interpret green capital 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 β_1 in Equation (12) equals ζ. In the model, ζ measures the difference in the cost of green versus brown capital and ultimately affects emissions.

Table 2 shows the results of estimating Equation (12). We study only US firms in columns (1) to (3). On average over all years, US firms with higher e-scores have lower perceived cost of capital, although the relation is statistically insignificant, as

[10]The pattern is very similar when we control for time-invariant differences across countries, which may arise due to cross-country differences in long-run inflation or other factors. Specifically, the figure is almost unchanged if we first condition on country fixed effects and then plot the residualized values of the perceived cost of capital.

[11]For instance, the Financial Stability Board established the Task Force on Climate-Related Financial Disclosures (TCFD) and the Global Reporting Initiative (GRI) updated its ESG standards.

shown in column (1). We interact the e-score with a post-2016 indicator in column (2). The coefficient on the post-2016 e-score is -1.9 percentage points. It represents the extreme difference in the post-2016 perceived cost of capital between the brownest firm and the greenest firm. The coefficient is statistically significant at the 5% level. The coefficient on the e-score pre-2016, on the other hand, is small and insignificant. The findings suggest that green firms disproportionately lowered their perceived cost of capital only after 2016. We find similar results when we use other years around 2016 to define the cutoff.

The results using the global sample in columns (4) and (5) of Table 2 are similar. We find a negative relation between the perceived cost of capital and the e-score after 2016 and a small and insignificant association before 2016.

We explore whether the post-2016 relation between e-score and the perceived cost of capital could be explained by other firm characteristics that are associated with both firms' e-score and changes in the perceived cost of capital. In columns (3) and (6), we control for four classic variables often used in asset pricing: market beta, leverage, book-to-market, and market capitalization. The coefficient on the post-2016 e-score remains stable and significant, suggesting that these classic variables do not mediate the effect.

We conduct a more comprehensive exercise to identify whether the e-score on its own is a strong predictor of the perceived cost of capital after 2016. To this end, we follow Gormsen and Huber (2024) and use a Lasso procedure to identify the best combination of firm-level characteristics that are associated with the perceived cost of capital. We allow the Lasso procedure to pick among any of the 153 firm characteristics that make up the "equity risk factor zoo" assembled by Jensen et al. (2024). This set includes a wide range of firm characteristics that have been shown to affect firms' cost of capital in financial markets. Unlike Gormsen and Huber (2024), which does not include any measures of greenness in the set of candidate risk factors, we also include the MSCI e-score. Specifically, we include the e-score interacted with a post-2016 indicator and the e-score interacted with a pre-2016 indicator. We also include a post-2016 indicator and an indicator for region (US, Europe).

The Lasso procedure identifies 14 characteristics as strong predictors of the perceived cost of capital, as shown in Figure 5. One of them is the post-2016 e-score, implying that the e-score does not simply stand in for other determinants of the perceived cost of capital that have already been discussed in the literature. Apart from the post-2016 e-score, the Lasso procedure selects almost the same variables as Gormsen and Huber (2024), including market beta (input into the CAPM), leverage, size, and age. The sign identified by the Lasso on the other predictors is consistent with standard findings in the asset pricing literature.

4.2 Robustness of the Firm-Level Results

The results are similar when we drop firms in the financial sector, as shown in column (1) of Table A2. We find stable coefficients when we include additional firm-level financial controls (e.g., for profitability and financial constraints) and sector-by-year fixed effects, as reported in column (2) of Table A2. The point estimate is slightly larger but not statistically different in the European Union, as shown in column (3). Dropping the Covid years 2020 and 2021 has little impact on the coefficient, as reported in column (4).

We verify that our results are robust to using other measures of firm greenness than the MSCI e-score. Many measures of greenness have been proposed in the literature and these measures are not always highly correlated with one another (Berg et al. 2022). Given the large set of possible measures, we focus on the "robust green score" from Eskildsen et al. (2024), a weighted average of different measures suggested in the literature. The measure puts a weight of 17% on the e-score from MSCI, which means it is mostly based on information from other measures. Figure 6 plots the time series based on the robust green score along with the original time series based on the e-score. In the subfigure to the left, the perceived cost of capital of green firms evolves almost identically for both series, with a negligible level difference. The subfigure to the right shows similar results for brown firms.

Figure 7 illustrates the robustness across the two measures of greenness in an alternative way. The figure plots the difference between the perceived cost of capital of brown firms and green firms for each of the two measures of greenness. The difference in the cost of capital of brown and green firms is close to zero in the early part of the sample for both series and the two series increase in lockstep post 2016.

Finally, we repeat the main panel regressions from Table 2 using the robust green score on the right-hand side (instead of the e-score). To make the estimated slope coefficients comparable, we multiply the robust green score with the ratio of the standard deviation of the e-score and the standard deviation of the robust green score (the latter of which is 1 by construction). The results are reported in Table 3. The coefficient on the post-2016 dummy in column 2 is -1.8, close to the -1.9 reported in Table 2. The estimates in the global sample are also similar to those in Table 2.

4.3 Comparison to Estimates of the Cost of Green Capital in the Literature

There exist no estimates in the literature about how green and brown firms themselves perceive their cost of capital. However, the literature has used surveys, asset pricing models, and quantitative theories to gauge expected returns and thereby infer the cost of green capital. The idea is that, according to the textbook definition, a firm's true cost of capital is the weighted average of the expected returns on the firm's outstanding assets in financial markets. Estimates of expected returns may be informative about the cost of capital used in firm investment decisions, as long as firms' perceptions of expected returns are similar to those documented by researchers and as long as firms incorporate expected returns in line with standard theories. Firm practice may differ from theory, however (Graham 2022), and firms' perceived cost of capital often deviates substantially from true expected returns (Gormsen and Huber 2024). The estimated expected returns of green firms may thus deviate from the perceived cost of capital of green firms.

We assess how firms' perceptions of their cost of capital relate to estimates of expected returns from the literature. We identify academic papers estimating the difference in expected returns for brown firms versus green firms. We focus on papers studying the difference in recent years, using mostly post-2016 data. We scale the estimate in each paper, so that it captures how a 2 standard deviation increase in firm greenness impacts the firm-level cost of capital. For example, in the case of our paper, 2 standard deviations of the e-score equal 0.44, whereas the point estimate of 1.7 percentage points in column 6 of Table 2 compares the brownest to the greenest firm. We therefore get a scaled estimate of 0.75 percentage points for our paper. We summarize how we scale the estimate of each paper in Table A3 and provide details in Appendix C.[12] Most estimates in the literature are for expected returns on stocks, which account for roughly 70% of the cost of capital of the average listed firm.

[12] The estimates of a few relevant papers could not be easily scaled, so we summarize the magnitudes of these papers in Table A4.

Since we are interested in the rough magnitude of the estimates, we abstract from potential differences between expected stock returns and the overall cost of capital in our comparisons.

Figure 8 presents the estimates implied by the different academic papers. The range is large and includes positive and negative values. It spans from 3.8, which implies that brown firms' cost of capital is 3.8 percentage points higher, to -7.1. The absolute magnitude of point estimates ranges from 0 to almost 10 times as large as our point estimate.

The wide range of estimates likely reflects the inherent difficulty in estimating long-run expected stock returns precisely (Fama and French 1997, Pástor and Stambaugh 1999). This difficulty is also reflected in a 2024 survey: 21% of finance academics agree that firms pursuing social and environmental initiatives benefit from a lower cost of capital, 55% are uncertain, and 23% disagree (Chicago Booth Clark Center 2024). The wide range of estimates and the uncertainty among experts highlight that, using estimates of expected returns in financial markets alone, it is difficult to infer how the cost of green capital has changed.

From the point of view of firms, the wide range of estimates implies that it is unclear how green firms should perceive their cost of capital relative to brown firms. Firms could base their perceived cost of green capital on a range of possible values. As a result, it has been difficult for the literature to gauge to what extent differences in the cost of green capital can affect firm behavior.

The perceived cost of capital that we analyze reflects how firms themselves have perceived their cost of capital, shedding light on the potential implications for firm behavior. Our estimate of 0.75 lies roughly in the middle of the estimates from the literature. It represents an economically and statistically significant difference in the perceived cost of capital of green and brown firms.

4.4 Firm-Level Greenness and Discount Rates

We also study the behavior of discount rates. While the perceived cost of capital is the firm's internal estimate of its opportunity cost of funds in financial markets, the discount rate is the required return on new investments that the firm uses in its internal net present value calculations. In the long run, variation in the perceived cost of capital is incorporated into firms' discount rates, such that the perceived cost of capital influences the allocation of capital (Gormsen and Huber 2024). In the short run, however, discount rates and the perceived cost of capital do not move one-to-one because some firms incorporate other idiosyncratic factors into their discount rates (Graham 2022, Gormsen and Huber 2025, Edmans 2023). It is therefore not obvious to what extent discount rates of green firms have incorporated the changes in the perceived cost of capital of green firms since 2016. It is also possible that other factors unrelated to the perceived cost of capital influenced discount rates over this period.

We test whether discount rates of green firms have changed by estimating Equation (12) using discount rates as the dependent variable.[13] Table 4 suggests that green firms reduced their discount rates by more than brown firms after 2016. The post-2016 coefficient for US firms is significant at the 10% level with and without controls, whereas the coefficient for the global sample is significant at 10% without controls but not with controls. All the point estimates are economically significant (-3.7 in the US sample and -3.2 in global sample with controls).

The point estimates for discount rates are slightly larger than for the perceived cost of capital in Table 2, which may indicate that green firms have not only incorporated a lower perceived cost of capital into their discount rates, but also other idiosyncratic factors. For instance, the risk of green investments may have fallen more in the eyes of green firms than is implied by the perceived cost of capital, which may have led green firms to reduce their discount rates by more than the perceived cost of capital. Similarly, managers of green firms may be more optimistic than managers of brown firms about the riskiness of their investments, which could lead to discount rates of green firms falling by more than the perceived cost of capital. However, the coefficients for discount rates and the perceived cost of capital are not statistically different from each other, so we do not find strong statistical evidence for a different magnitude. Taken together, the main takeaway is that green firms not only reduced their internal perception of their cost of capital after 2016, but also the discount rates used in investment decisions.

[13]Some firms fully account for all overhead costs in the discount rates used for investment decisions, while others do not. We can observe on the conference calls which firms fully account for overhead and include an indicator in all the regressions to control for such differences. The results do not depend on the inclusion of this indicator.

5 The Division-Specific Perceived Cost of Capital and Greenness

In this section, we study to what extent the same firm varies the perceived cost of capital and discount rate across its divisions depending on the greenness of the capital used in a division. In our baseline model in Section 2, firms apply a lower perceived cost of capital and discount rate to green divisions if the cost of green capital falls. This practice gives rise to a within-firm channel that can increase green investments even in a world where capital reallocation across firms is ineffective because consumers are unwilling to substitute across products.

Our analysis relies on new measurement of division-level data for the largest utility and energy companies. We find that the division-level perceived cost of capital and discount rates are indeed lower for greener divisions and that the difference is driven by post-2016 observations.

5.1 Division-Level Data Collection

The main sources for the division-level data are presentation slides that firms share with investors during conference calls, investor conferences, and similar events. On conference calls, firms typically do not discuss in detail the division-level cost of capital and discount rates. Instead, firms tend to report a firm-level cost of capital (WACC) and a discount rate for the typical investment project undertaken by the firm. However, the slides can be more detailed and occasionally report firms' perception of the cost of capital of green and brown divisions as well as different discount rates for specific divisions.

We identify the 100 largest global firms by market value in Compustat in the energy sector and the 100 largest in the utilities sector. We focus on energy and utilities firms because they are responsible for a large share of aggregate emissions and efforts at reducing aggregate emissions will have to involve these firms. We manually download all available slide packs from firms' websites. We then manually go through each slide and identify all division-level values of the perceived cost of capital and discount rates as well as information on the corresponding division. In total, we analyze 6,800 slide packs. An example of a Shell slide containing multiple division-level discount rates varying by greenness is in Figure 9.

The data collection produced 645 division-specific values of the perceived cost of capital (from 28 distinct firms) and 255 division-specific values of discount rates (from 23 distinct firms). The number of included firms is small because most firms do not report division-level values on their slides, possibly because managers have multiple ways of communicating their divisional strategy and division-level values of the cost of capital and discount rates are just one of those ways (see also Gormsen and Huber 2025). Despite the small number of firms, the sample includes a few of the largest and highest-emitting firms in the world, for example, BP, EDF, Shell, and TotalEnergies. These four firms alone account for around 3.5% of the total emissions in the S&P Trucost data.

We classify each perceived cost of capital or discount rate depending on whether it applies to a division that is green, brown, or neutral. Green divisions typically generate renewable energy, including wind, hydrogen, and solar power. Brown divisions involve high-emissions energy sources, such as coal and oil. Neutral divisions involve activities with mixed emissions intensity, for example, the building or repair of a general electricity grid or telecommunication infrastructure. Only around a dozen values are for nuclear energy. We do not include them in this analysis, since there is disagreement on their environmental impact, but the results hardly change whether we classify nuclear divisions as green, as brown, or exclude them. Green divisions account for 23% of all division-specific values, brown divisions for 20%, and neutral divisions for the rest.

5.2 Division-Specific Cost of Capital and Discount Rates

We aim to estimate whether firms perceive a lower cost of capital for their greener divisions. We therefore analyze only within-firm variation in the perceived cost of capital by estimating

$$\text{perc. cost of capital}_{i,t,k} = \beta_0 + \beta_1 \mathbb{1}[\text{green}]_{i,t,k} + \beta_2 \mathbb{1}[\text{brown}]_{i,t,k} + \eta_i + \phi_t + \varepsilon_{i,t,k},$$

where $y_{i,t,k}$ is the perceived cost of capital for division k of firm i in year t; $\mathbb{1}[\text{green}]$ is an indicator equal to one if the division-specific rate is for a green division; and $\mathbb{1}[\text{brown}]$ is an indicator equal to one if the division-specific rate is for a brown division. The omitted category is neutral divisions. The regressions include year and firm fixed effects, which implies that we are only comparing values within the same firm while also controlling for aggregate differences across years.

Energy regulators occasionally determine a division's cost of capital and force the division to adopt this cost of capital. Regulators typically use the CAPM and other traditional risk models. In column (1) of Panel A of Table 5, we analyze only divisional values of the cost of capital determined by regulators and reported by firms. We find no significant association between greenness and the cost of capital. In column (1) of Panel B, we also find no significant difference for pre- and post-2016 values. Regulators typically calculate the cost of capital using relatively simple and traditional models, like the CAPM, which do not account for the greenness of the division. This finding implies that standard methods for estimating the cost of capital do not give rise to an effect of greenness in itself, suggesting that the relation between greenness and the perceived cost of capital documented in the previous section arises through non-standard channels.

We analyze values of the perceived cost of capital that are determined by the firm itself and not by regulators in column (2) of Panel A. We find that the perceived cost of capital is significantly lower for green divisions. The difference is driven by post-2016 observations, as shown in column (2) of Panel B. The within-firm point estimate indicates a 0.8 percentage point spread. This magnitude is smaller than the 1.7 percentage point cross-firm spread between the greenest firm (e-score of 1) and brownest (e-score of 0) firm in the economy (see Table 2), which may partly reflect that divisions do not have extreme e-scores. The magnitudes of the cross-firm and within-firm estimates are roughly comparable, however, and the cross-firm and within-firm estimates are not statistically different from each other.

We additionally find that the discount rates of green divisions are significantly lower, as shown in column (3) of Panel A of Table 5. This difference is driven by post-2016 observations, as reported in column (3) of Panel B. The post-2016 point estimate is around 4.1 percentage points, slightly larger than the point estimate for the perceived cost of capital. Firms' discount rates for green divisions may have fallen by more than the perceived cost of capital of green divisions because managers believe that green divisions have become even less risky than is implied by the cost of green capital. Similarly, it is possible that managers have non-pecuniary or ideological preferences for green investments. Such non-pecuniary preferences could decrease discount rates of green divisions, as also discussed in Sections 3.5 and 4.4.

By controlling for firm fixed effects, we remove all unobserved variation across firms and isolate a within-firm estimate of how firms perceive the difference between the cost of brown and green capital. Despite the different sources of underlying variation, both cross-firm and within-firm estimates are similar. This suggests that the underlying explanation for the lower perceived cost of green capital is tied to the greenness of firms and divisions.

The results in this section reveal that some of the largest firms are sophisticated enough to adopt division-specific values for the cost of capital and discount rates. So far, there was little evidence in the literature that such within-firm variation could exist and influence green investments. Much of the discussion has instead focused on cross-firm reallocation, leading some scholars to argue that sustainable investing may be ineffective (e.g., Hartzmark and Shue 2023). But if firms are able to adopt division-specific values, then a lower cost of green capital can also reduce emissions through a within-firm channel, in line with the baseline model in Section 2.

Not all firms use multiple discount rates across divisions (Graham and Harvey 2001, Krüger et al. 2015), which means the within-firm channel may not play a role in all parts of the economy. However, the results show that some of the largest firms in the utilities and energy sectors have started to favor their green divisions by lowering the relevant perceived cost of capital and discount rates. The within-firm channel could thus play a role in those parts of the economy that are among the most important for the green transition.

6 Impact on Pledged Reductions in Emissions

We have so far documented that the perceived cost of capital of green firms and divisions has decreased since 2016, relative to brown firms and divisions. We now explore whether the lower perceived cost of capital can affect firms' emissions plans.

We present suggestive evidence showing that firms facing a lower average perceived cost of green capital in their sector have pledged greater reductions in harmful CO2 emissions.[14] The evidence is suggestive because it measures what firms say they will do and not realized outcomes. Nonetheless, recent research suggests that firms making pledges subsequently reduce emissions (Bolton and Kacperczyk 2023) and that firms'

[14]Existing work has found mixed evidence on the relation between sustainable investing and subsequent emissions of firms, but has not directly observed firms' perceived cost of capital (e.g., Akey and Appel 2019, Bellon 2020, Heath et al. 2021, Noh et al. 2022, Gantchev et al. 2023, Hartzmark and Shue 2023).

self-reported emissions data are consistent with third-party estimates from Thomson Reuters (Ramadorai and Zeni 2024).

We study emissions pledges instead of realized emissions of existing investments because we want to analyze only decisions of firms made since the cost of green capital has been lower (i.e., since roughly 2016). Firm-level emissions data typically capture the total emissions produced by all existing capital, rather than the emissions of capital installed only since 2016. New investments undertaken after 2016 make up a small part of total capital for most firms and it takes "time to build" until investments actually produce and emit, so firm-level total emissions may not be informative about post-2016 investments. Pledges made since 2016 may instead capture potential long-run changes in firms' green investments and emissions since the cost of green capital has been lower.

6.1 Empirical Approach and Data on Emissions Pledges

We analyze sector-level variation in the cost of green capital and that of brown capital. For each sector, we calculate the average perceived cost of capital of green firms (with e-score above the median in the sector) and of brown firms (with e-score below the median in the sector). We use only post-2016 data for this calculation. We interpret the average cost of capital of green firms in a sector as the cost of green capital that a firm in that sector has to pay for greener investments. Similarly, the average cost of capital of brown firms in that sector captures the cost of capital for brown investments. A greater cost of brown capital in their sector should incentivize firms to use more green capital and to reduce emissions, whereas a greater cost of green capital should incentivize firms to use less green capital and raise emissions. Differences across sectors in the cost of green and brown capital may be driven by technological variation in how risky (relative to the market) it is for firms to transition to using greener capital and production methods. For instance, the cost of green capital is relatively high in the materials sector (e.g., chemicals and mining), where few riskless green technologies are available, but relatively lower in the consumer staples sector (e.g., food and household products).[15]

[15] An alternative approach could have used within-firm differences in brown versus green capital estimated in the previous section to measure the cost of brown and green capital faced by the firm. An advantage of the sector-level variation is that idiosyncratic firm-level shocks to both a firm's cost of capital and its opportunities to invest in green capital do not directly impact the estimates.

To measure a firm's green investments, we obtain each firm's pledged emissions reductions from the MSCI's Climate Targets and Commitments dataset. MSCI collects these data from publicly available sources, including annual reports, sustainability reports, CDP disclosures, and the Science Based Targets initiative. We merge the data to our conference call data using the same procedure employed as the MSCI environment score.

A firm's emissions pledge can take multiple forms. It can involve different types of emissions (e.g., Scope 1, 2, or 3) and metrics (e.g., absolute emissions change or relative emissions intensity). The horizons of pledges vary from 1 to 92 years, with a mean and median of around 11 years. We control for fixed effects for all the variables measuring the form of the pledge (emission type, metric, announcement year, horizon) and region (US, Europe). The sample includes all pledges made since 2016.

6.2 The Perceived Cost of Capital and Emissions Pledges

We regress a firm's emissions pledge on the average cost of brown capital in its sector and the average cost of green capital in its sector. In columns (1) and (2) of Table 6, we use the total pledged percentage change in emissions over the lifetime of the pledge as outcome variable. In columns (3) and (4), we use the geometric average of the pledged percentage change per year as outcome variable.

The results indicate that firms facing a higher cost of brown capital in their sector pledge to decrease emissions by more. Similarly, firms facing a higher cost of green capital in their sector pledge to decrease emissions by less. These findings are consistent with the view that a relatively higher cost of brown capital makes it optimal for firms to shift away from brown and toward green capital, thereby reducing their planned emissions. The results are robust to controlling for potential confounding variables, such as ROE, Q, and the financial cost of capital of the firm (estimated using the CAPM).

A 1 percentage point increase in the sector-level cost of brown capital combined with a 1 percentage point decrease in the sector-level cost of green capital jointly generate a 2 percentage point spread between the cost of brown and green capital. The point estimates in column (1) of Table 6 imply that such an increase in the spread is associated with a decrease in pledged emissions of 22.4%. The average perceived cost of brown capital was roughly 2 percentage points above the average cost of green capital in 2023, as shown in Figure 1. (The cost of capital measures in Figure 1 and Table 6 are both based on cuts at the median greenness.) The findings thus suggest that an empirically realistic spread between the cost of green and brown capital is associated with a meaningful decrease in emissions pledges.

7 Conclusion

In theory, the cost of capital channel can facilitate the transition to a greener economy, even if carbon taxes remain low and brown investments offer high financial returns. In practice, does this channel have the potential to affect real investment? Recent trends have potentially shifted the cost of green capital in financial markets, including rising climate concerns among institutions ranging from BlackRock to the Catholic Church, the post-2016 surge in sustainable investing, and disproportionate capital allocation to green firms by government funds and central banks.

However, the ultimate potential of the cost of capital channel depends on how firms perceive the cost of green capital that influences their investment decisions. We use hand-collected data and find that the perceived cost of capital of green firms has fallen by more than that of brown firms since 2016. The average difference in the post-2016 period is 1 percentage point. In contrast, the cost of capital of green and brown firms was on average the same and moved in parallel before 2016. The association between firm greenness and the perceived cost of capital after 2016 is not explained by over 150 firm characteristics associated with expected returns in the literature. In fact, greenness is the third-strongest predictor of the perceived cost of capital post-2016.

We additionally analyze newly collected data on the division-level perceived cost of capital and discount rates employed by large energy and utility firms. We show that these firms have started to apply a lower perceived cost of capital to their greener divisions since 2016. These within-firm findings suggest that a lower cost of green capital can contribute to lowering emissions even if cross-firm reallocation is weak because consumers do not easily substitute the products of brown and green firms.

Overall, the findings suggest that a cost of capital channel can at least partly facilitate the transition to a green economy, both through cross-firm and within-firm channels.

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Tables and Figures

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 regression:

$$\text{Perc. cost of capital}_{i,t} = \beta_0 + \beta_1 \text{E-score}_{i,t} + \phi \text{X}_{i,t} + \varepsilon_{i,t},$$

where Perc. cost of capital$_{i,t}$ is the perceived cost of capital of firm i in quarter t, E-score$_{i,t}$ is the MSCI environment pillar score normalized to be between 0 and 1, and $\text{X}_{i,t}$ are controls. All specifications include quarter-by-year fixed effects. Standard errors are clustered at the firm and quarter-by-year level. The samples include observations from the years 2002 to 2023.

	(1)	(2)	(3)	(4)	(5)	(6)
	Perceived cost of capital					
	US sample			Global sample		
E-score	-0.53	0.22	0.94	-1.38***	-0.74	-0.10
	(0.40)	(0.52)	(0.61)	(0.38)	(0.45)	(0.49)
E-score × Post-2016		-1.90**	-2.12**		-1.46**	-1.71***
		(0.87)	(0.84)		(0.65)	(0.60)
Controls:						
Beta			1.95***			2.18***
			(0.43)			(0.36)
Leverage			-2.53***			-2.98***
			(0.73)			(0.59)
Market value (log)			-0.20			-0.18**
			(0.12)			(0.084)
Book-to-market			0.43			0.55**
			(0.32)			(0.26)
Observations	1,026	1,026	885	1,606	1,606	1,384
Within R^2	0.0029	0.012	0.15	0.021	0.027	0.19

Table 3
Greenness and the perceived cost of capital: alternative measure of greenness

This table reports results of the regression:

$$\text{Perc. cost of capital}_{i,t} = \beta_0 + \beta_1 \text{E-score}_{i,t} + \phi \text{X}_{i,t} + \varepsilon_{i,t},$$

where Perc. cost of capital$_{i,t}$ is the perceived cost of capital of firm i in quarter t. E-score$_{i,t}$ is the "robust green score" from Eskildsen et al. (2024), normalized to have the same standard deviation as the e-score used in Table 2. $\text{X}_{i,t}$ are controls. All specifications include quarter-by-year fixed effects. Standard errors are clustered at the firm and quarter-by-year level. The samples include observations from the years 2002 to 2023.

	(1)	(2)	(3)	(4)	(5)	(6)
	Perceived cost of capital					
	US sample			Global sample		
"Robust green score"	0.56	1.19*	1.17**	-0.69	0.18	0.35
	(0.48)	(0.61)	(0.54)	(0.58)	(0.63)	(0.44)
"Robust green score" × post 2016		-1.82**	-1.31*		-2.08**	-1.62*
		(0.84)	(0.77)		(1.04)	(0.94)
Beta			1.97***			2.45***
			(0.45)			(0.38)
Leverage			-3.28***			-3.63***
			(0.72)			(0.59)
Market value (log)			-0.22*			-0.23***
			(0.12)			(0.085)
Book-to-market			0.58*			0.55*
			(0.34)			(0.32)
Observations	835	835	821	1,348	1,348	1,259
FE	Quarter	Quarter	Quarter	Quarter	Quarter	Quarter
Within R^2	0.0039	0.013	0.18	0.0054	0.017	0.22

Table 4
Greenness and discount rates

This table reports results of the regression:

$$\text{Discount rate}_{i,t} = \beta_0 + \beta_1 \text{E-score}_{i,t} + \phi \text{X}_{i,t} + \varepsilon_{i,t},$$

where Discount $\text{rate}_{i,t}$ is the discount rate of firm i in quarter t, $\text{E-score}_{i,t}$ is the MSCI environment pillar score normalized to be between 0 and 1, and $\text{X}_{i,t}$ are controls. All specifications include quarter-by-year fixed effects and a fixed effect for firms fully accounting for overhead in their discount rates. Standard errors are clustered at the firm and quarter-by-year level. The samples include observations from the years 2002 to 2023.

	(1)	(2)	(3)	(4)	(5)	(6)
	Discount rate					
	US sample			Global sample		
E-score	-3.20**	-1.01	0.46	-5.10***	-3.19**	-1.31
	(1.56)	(1.50)	(1.46)	(1.42)	(1.24)	(1.31)
E-score × Post-2016		-5.21*	-3.68*		-4.35*	-3.20
		(2.77)	(2.20)		(2.54)	(2.19)
Controls:						
Beta			3.84**			4.14***
			(1.68)			(1.41)
Leverage			-1.54			-2.74
			(2.67)			(1.96)
Market value (log)			-0.62**			-0.71***
			(0.27)			(0.21)
Book-to-market			-0.60			-1.12
			(1.01)			(0.91)
Observations	985	985	829	1,426	1,426	1,154
Within R^2	0.015	0.025	0.073	0.038	0.045	0.10

Table 5
Within-firm variation in perceived cost of capital and discount rates

This table reports results of the regression:

$$y_{i,t,k} = \beta_0 + \beta_1 \mathbb{1}_{\text{green}} + \beta_2 \mathbb{1}_{\text{brown}} + \phi \mathrm{X}_{i,t} + \varepsilon_{i,t,k},$$

where $y_{i,t,k}$ is either a perceived cost of capital or discount rate for division k of firm i in quarter t, $\mathbb{1}_{\text{green}}$ is an indicator equal to 1 if $y_{i,t,k}$ is for a green division, $\mathbb{1}_{\text{brown}}$ is an indicator equal to 1 if $y_{i,t,k}$ is for a brown division, and $\mathrm{X}_{i,t}$ are controls. All specifications include firm fixed effects, so we analyze only within-firm variation, and year fixed effects. Standard errors are clustered at the firm level. The samples include observations from the years 2011 to 2023.

	(1)	(2)	(3)
Panel A	Regulated CoC	Perceived CoC	Discount rate
Green division	0.50	-0.67***	-4.01***
	(0.37)	(0.15)	(1.55)
Brown division	0.25	0.11*	-0.054
	(0.29)	(0.053)	(0.57)
Observations	443	193	248
Within R^2	0.0002	0.029	0.22

	(1)	(2)	(3)
Panel B	Regulated CoC	Perceived CoC	Discount rate
Green division	0.49	-0.84***	-4.06**
× Post-2016	(0.36)	(0.20)	(1.57)
Green division	-3.07	0.043	2.65
× Pre-2016	(2.57)	(0.74)	(1.57)
Brown division	0.21	0.16**	-0.0096
	(0.25)	(0.063)	(0.57)
Observations	443	193	248
Within R^2	0.0062	0.041	0.24

Table 6
Emissions pledges and the perceived cost of capital

This table reports results of the regression:

$$y_{i,t} = \beta_0 + \beta_1 \text{CoC green sector}_i + \beta_2 \text{CoC brown sector}_i + \phi \text{W}_{i,t} + \varepsilon_{i,t},$$

where $y_{i,t}$ is the reduction in CO2 pledged by firm i announced in year t, CoC green sector is the average perceived cost of capital in the post-2016 period of the 50% greenest firms in the sector of firm i, and CoC brown sector is the average perceived cost of capital of the 50% brownest firms in the post-2016 period in the sector of firm i. Sectors are based on GICS 2-digit sectors and include all sectors except real estate because it contains too few observations. $\text{W}_{i,t}$ is a vector of fixed effects for all the variables measuring the form of the pledge (emission type, metric, announcement year, horizon) and region (US, Europe). The samples include observations from the years 2017 to 2023. Standard errors are clustered at the sector level.

	(1)	(2)	(3)	(4)
	Firm-level CO2 change (pct)		Firm-level CO2 change per year (pct)	
Cost of brown capital in sector	-15.5**	-17.0**	-2.38***	-2.08***
	(4.89)	(5.37)	(0.67)	(0.57)
Cost of green capital in sector	6.88**	2.91	1.41**	-0.067
	(2.79)	(4.63)	(0.51)	(0.48)
Fin. cost of capital		7.01		1.31*
		(5.13)		(0.63)
Return on Equity		1.25		0.45***
		(1.02)		(0.13)
Tobin's Q		-0.78		-2.19*
		(7.40)		(1.00)
Observations	615	615	520	520
R^2	0.49	0.50	0.12	0.13

Figure 2
Model: Baseline effects of varying the cost of green capital

This figure presents results for the baseline model where firms apply a different cost of capital to brown and green capital. We vary the green cost of capital effect, ζ, which lowers the cost of green capital in financial markets. Panel A shows the firm-level cost of capital (WACC) for brown and green firms. Panel B displays product prices. Panel C illustrates the quantity of output produced. Panel D shows the ratio of brown to green capital for each firm type and in the aggregate. Panel E presents the emissions-to-output ratio for both firm types and in aggregate. Both the within-firm and the cross-firm channel of capital reallocation are in operation.

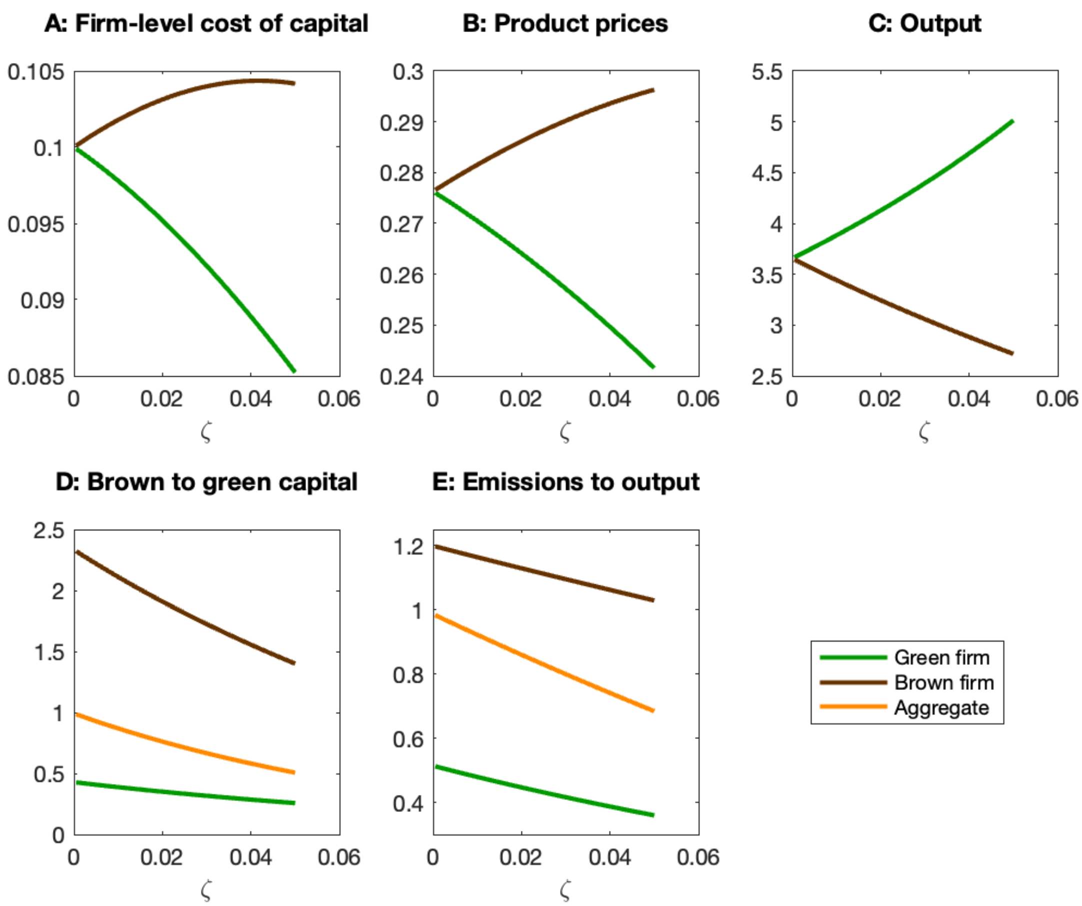


Figure 3
Model: Effects of varying the cost of green capital when firms use a single cost of capital

This figure presents results for the model where firms use a single firm-level discount rate for both brown and green capital. Only the cross-firm channel of capital reallocation is in operation. The panels plot the same outcomes as Figure 2.

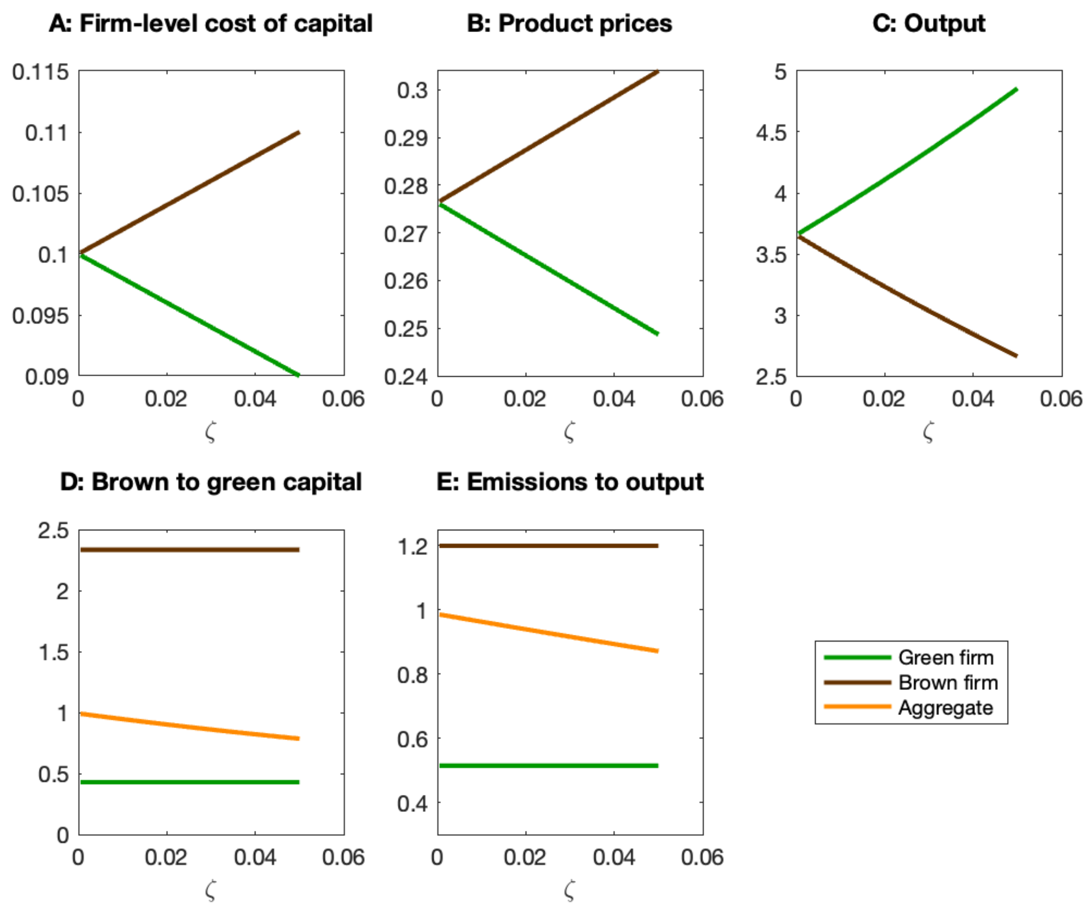


Figure 4
Model: Emissions-to-output and the elasticity of substitution

This figure shows how the aggregate emissions-to-output ratio varies with the elasticity of substitution across products σ. We plot the scenarios: (1) $\zeta = 0$, representing no difference between the cost of green and brown capital; (2) $\zeta = 3\%$ and firms use a single discount rate for brown and green capital; and (3) $\zeta = 3\%$ and firms use capital-specific discount rates.

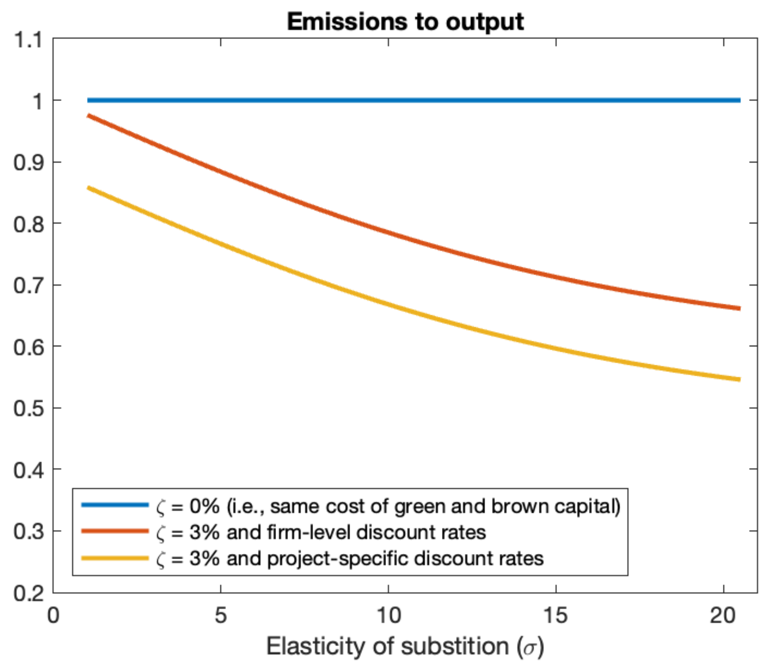


Figure 5
E-score versus of predictors of the perceived cost of capital

This figure shows the relation between the perceived cost of capital and firm-level characteristics that predict the perceived cost of capital well according to a Lasso procedure. The plotted values are slope coefficients from regressing the firm-level discount rate on predictors of the perceived cost of capital that are selected by a Lasso procedure. We allow the Lasso procedure to select any of: the 153 firm characteristics of the "factor zoo" in Jensen et al. (2024); a dummy for region (US, Europe); an indicator for years after 2016; e-score interacted with a pre-2016 indicator; and e-score interacted with a post-2016 indicator. The 153 firm-level characteristics are measured in cross-sectional percentiles of the distribution of Compustat firms in the same country and same year, ranging from 0 (lowest) to 1 (highest). The coefficients capture the impact of going from the lowest to the highest characteristic. The sample includes the years 2002 to 2023.

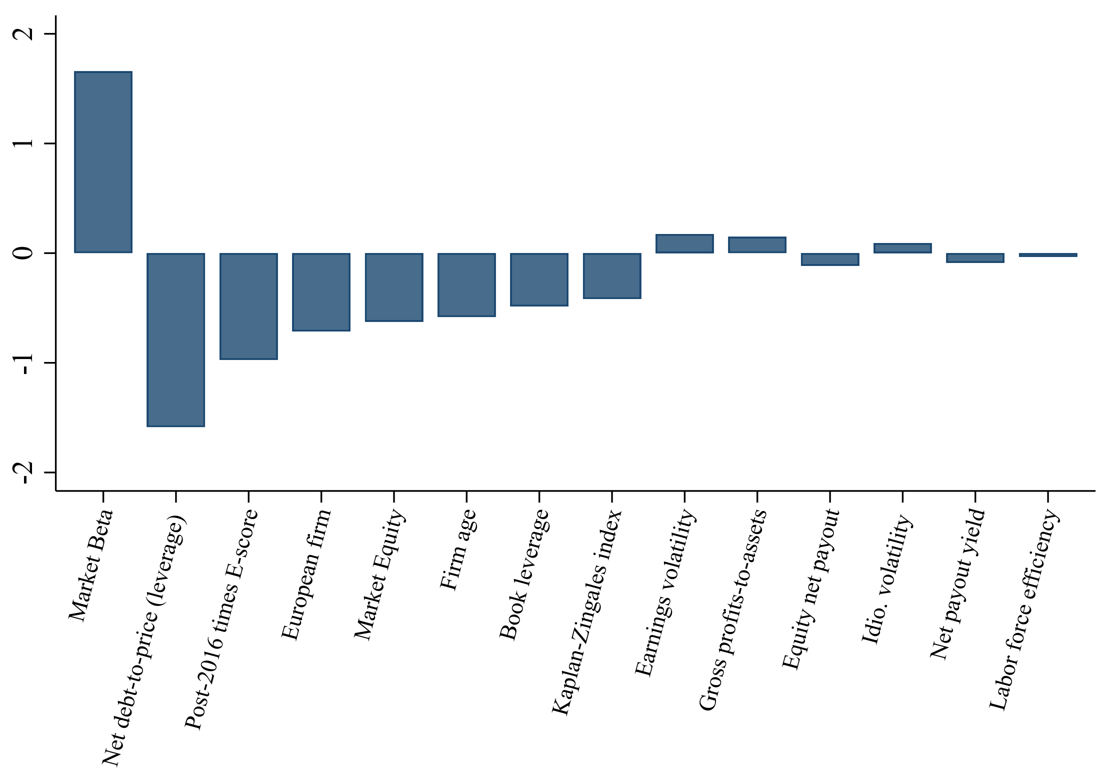
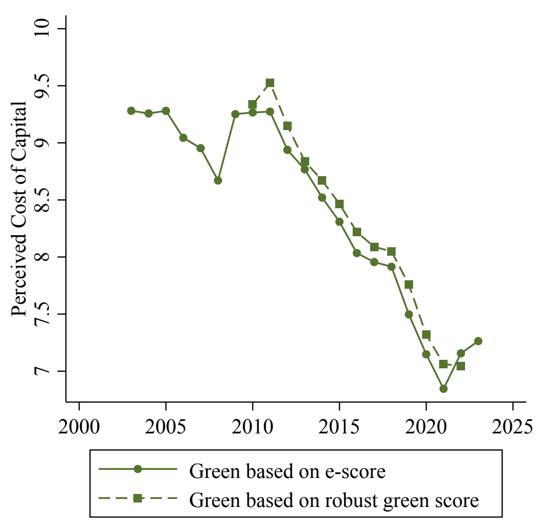


Figure 6
The perceived cost of capital of green and brown firms: alternative measure of grenness

This figure plots the average perceived cost of capital for green and brown firms in different years using two different measures. We use our baseline measure, the MSCI e-score, and an alternative "robust green score," the average of 10 different measures suggested by Eskildsen et al. (2024). In each year, we split all firms into two groups at the median of the given green score (e-score or "robust") and calculate the average firm-level perceived cost of capital in every group. We then plot the three-year moving averages. We use firm-level data collected from conference calls to measure the perceived cost of capital. The subfigure to the left plots the average perceived cost of capital for green firms, as defined by the two measures. The subfigure to the right plots the average perceived cost of capital for brown firms, as defined by the two measures.



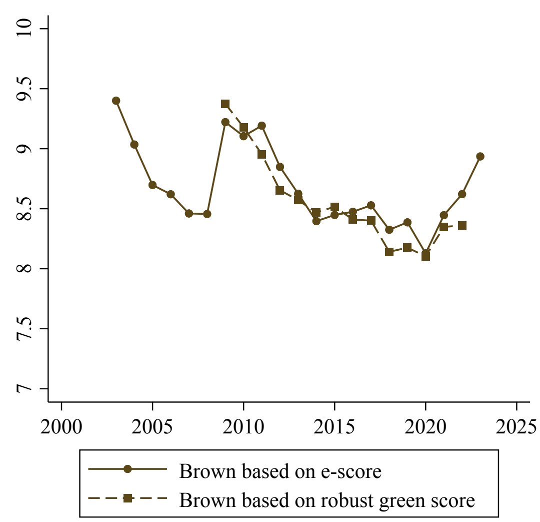


Figure 7
Sustainable investing and the difference in the perceived cost of capital of green and brown firms

This figure plots the difference between the average perceived cost of capital of green and brown firms in different years. The figure considers two different measures of greenness. We use our baseline measure, the MSCI e-score, and an alternative "robust green score," the average of 10 different measures suggested by Eskildsen et al. (2024). In each year, we split all firms into two groups at the median of the given green score (e-score or "robust") and calculate the average firm-level perceived cost of capital in every group. We then plot the three-year moving averages. We use firm-level data collected from conference calls to measure the perceived cost of capital. The assets under management (AUM) of sustainable funds from 2010 to 2023 are in billion USD and reported in UNCTAD (2021, 2024). For years prior to 2010, we project the data points using the annual growth rate of passive sustainable AUM as reported in Morningstar (2020).

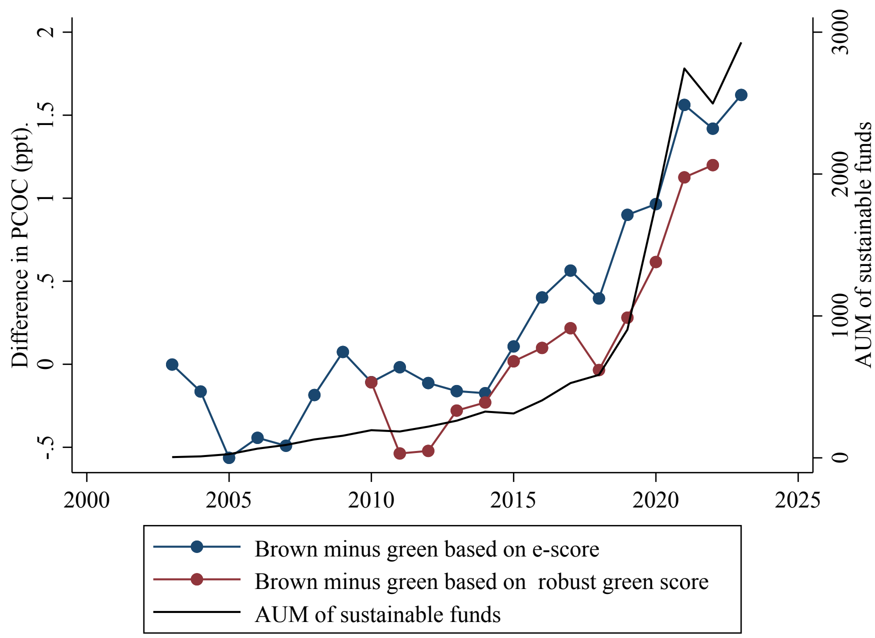


Figure 8
Estimates of the cost of green capital in the literature

This figure presents estimates of the difference in the cost of capital between brown and green firms from different academic paper. The cost of capital difference is computed as the expected return on brown (or low ESG) firms minus the expected return on green (or high ESG) firms. We scale the estimate in each paper, so that it captures how a 2 standard deviation increase in firm greenness impacts the firm-level cost of capital, as detailed in Table A3 and Appendix C. The vertical bars represent 95% confidence intervals. The symbols represent the methodology used in the paper: circles for survey data, squares for estimation based on financial prices or returns, and diamonds for calibrations based on a model. The colors indicate whether the study focuses solely on the environmental profile (green) or considers overall environmental, social, and governance (ESG) factors (blue).

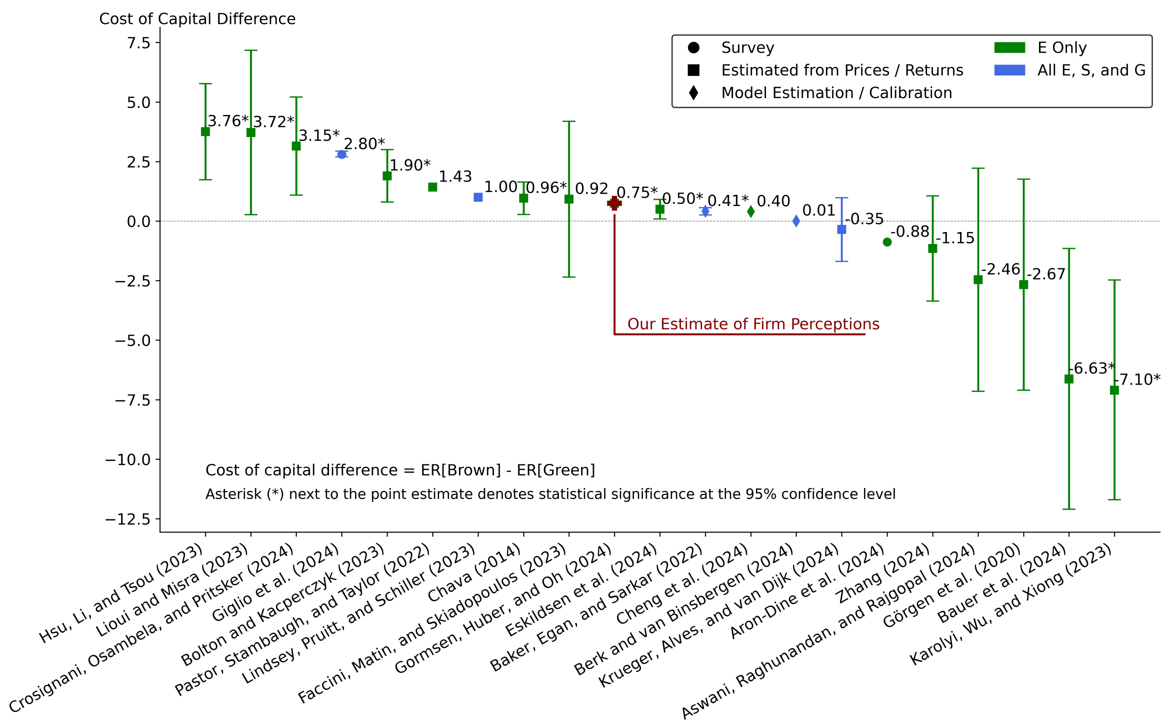


Figure 9
Example of division-specific discount rates (Shell)

This figure presents an example of a slide from Shell in 2023 presenting division-specific discount rates. For clarity, we added the full names of the divisions in yellow font on the left-hand side of the slide. The IRR hurdle rates are the division-specific discount rates studied in Section 5. Glossary for subgroups of hurdle rates: MKT refers to traditional gas stations; LCF refers to the sale of low-carbon fuels to consumers; EV refers to electric vehicle charging; Power generation refers to solar and wind power.

Disciplined, value-focused capital allocation

		Cash Capex				Cash Capex after power dilutions	FCF	IRR hurdle rates
	$ billion	2022	2023	24-25	Power dilutions	24-25	2025[1]	
Integrated Gas	IG	4	~5	~5		~5	~8	11%
Upstream	UP	8	~8	~8		~8	~10	15%
Integrated Gas and Upstream	IGU	12	~13	~13		~13	17-18	
Marketing (gas stations)	MKT	5	~6[2]	~3		~3	~4	MKT ex. LCF/EV 15% LCF 12% EV 12%
Chemicals & Products	C&P	4	3-4	3-4		3-4	~5	12%
Renewables & Energy Solutions	R&ES	3	2-4	4-5	(1-2)	~3	~(2)	R&ES excl. power 10% Power generation 6-8%
Downstream and Renewables & Energy Solutions	DSR	12	11-14	10-12		9-10	7-8	
	Total	**25**	**23-27**	**22-25**		**21-23**	**24-26**	

[1] For price assumptions see appendix [2] Includes acquisition of Nature Energy (nearly $2 billion)

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Online Appendix to "Climate Capitalists"

Appendix A Additional Figures and Tables

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 controlling for 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 (e-score) normalized to be between 0 and 1.

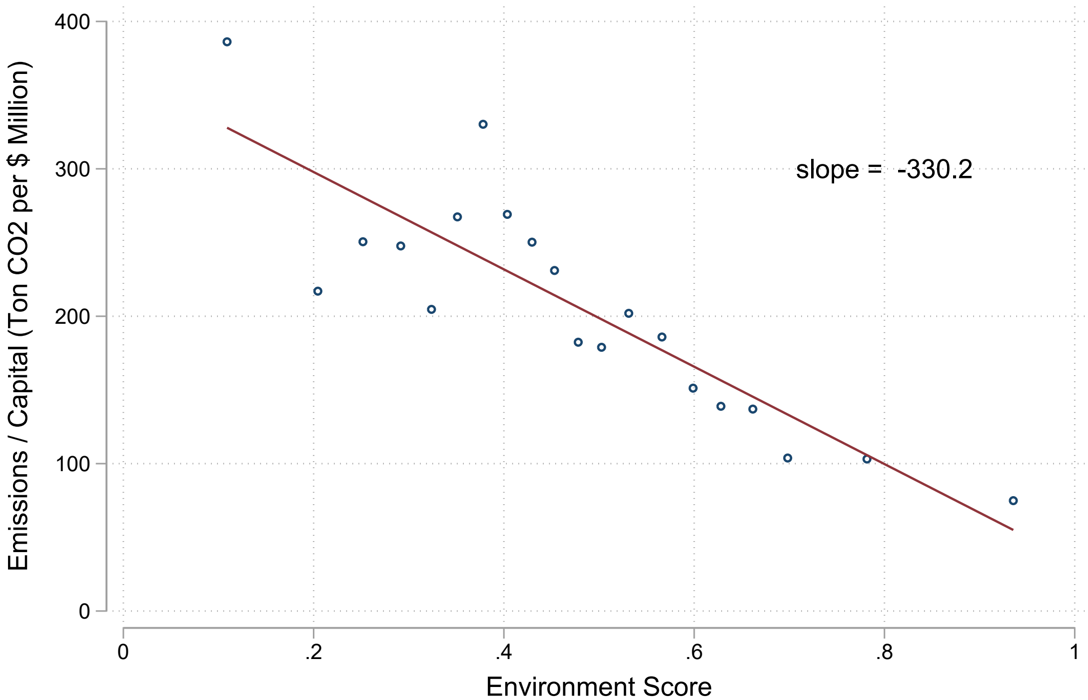
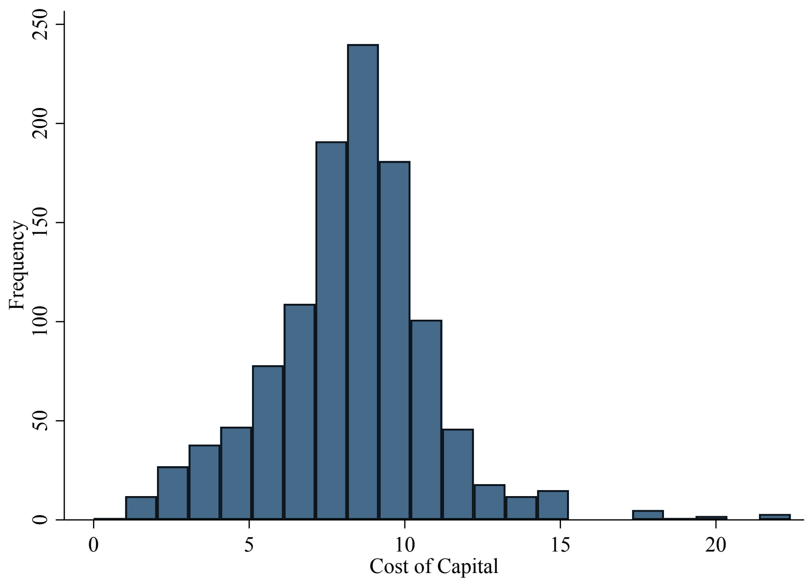


Figure A2
Distribution of perceived cost of capital and discount rates

This figure plots the distribution of the firm-level perceived cost of capital (Panel a) and discount rates (Panel b) in our sample.

Panel (a): Perceived Cost of Capital



Panel (b): Discount Rates

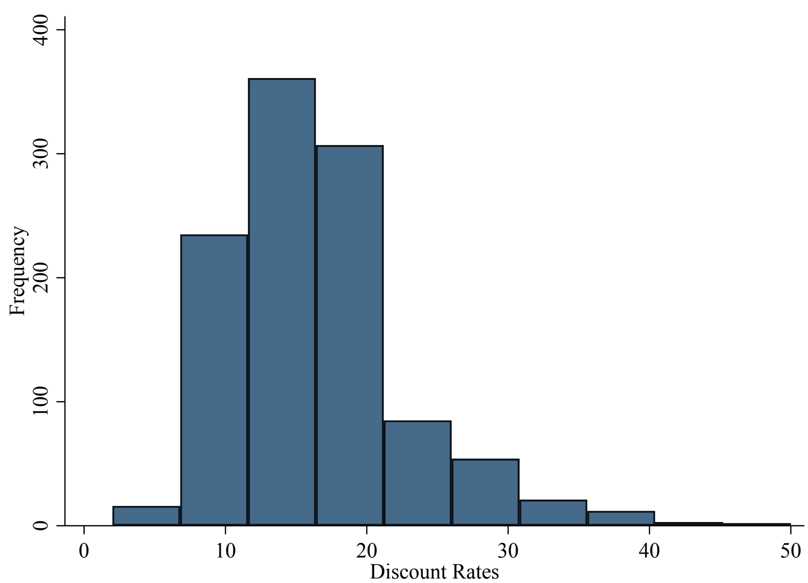


Table A1
Representativeness of the conference call data

Panel A reports characteristics of firms for three samples: firms for which we observe at least one discount rate; at least one perceived cost of capital; and at least one perceived cost of equity or debt. Characteristics are measured in percentile ranks relative to the universe of firms in Compustat in the same year and same country of listing. A mean value close to 50 indicates that the average rank of firms in our dataset is close to the average rank of firms in the Compustat year-country population. Financial constraints are measured using the index by Hadlock and Pierce (2010). Panel B reports firm-level panel regressions using a dataset at the firm-quarter level. The outcome is 100 when we observe the firm's discount rate (columns 1 and 2), the perceived cost of capital (columns 3 and 4), or the perceived cost of debt or equity (columns 5 and 6) in the given quarter, and 0 otherwise. The samples in Panel B include the full panel of firm-quarter observations between 2002 and 2021 for all firms, for which we observe at least once a discount rate, perceived cost of capital, perceived cost of debt, or perceived cost of equity. The regressors are in percentile ranks relative to the universe of firms in Compustat in the same year and country of listing. The table is based on Gormsen and Huber (2024). Standard errors are clustered by firm. Statistical significance is denoted by *** p<0.01, ** p<0.05, * p<0.1.

Panel A: Characteristics of included firms in cross-sectional percentiles

	Firms with observed discount rates			Firms withobserved perc. cost of capital			Firms with observed perc. cost of debt/equity		
	mean	min	max	mean	min	max	mean	min	max
Market value	79.02	8.54	100	82.74	3	100	83.98	7.60	100
Return on equity	58.44	0.64	100	59.87	0.81	100	58.45	0.15	100
Book-to-market	46.64	0.16	100	49.36	0.17	100	45.87	0.26	100
Investment rate	53.77	1.36	100	53.68	0.41	100	53.43	0.13	100
Physical capital to assets	60.58	2.36	100	59.62	2.16	100	65	2	100
Z-score (bankruptcy risk)	49.53	6.56	98.98	48.41	0.77	99.02	37.18	1.40	99.36
Financial constraints	23.28	0.05	90.67	20.17	0.05	100	24.64	0.05	91.52
Leverage	58.88	0.53	100	60.02	1.17	100	61.21	0.84	100

Panel B: Within-firm variation in characteristics and timing of inclusion

	(1)	(2)	(3)	(4)	(5)	(6)
	Discount rate observed in quarter		Perc. cost of capital observed in quarter		Perc. cost of equity or debt observed in quarter	
Z-score (bankruptcy risk)	0.0016		0.00073		-0.00030	
	(0.0022)		(0.0018)		(0.0023)	
Return on equity		0.0018		0.0012		0.0031*
		(0.0014)		(0.0012)		(0.0016)
Book-to-market		0.0015		0.0028		-0.0022
		(0.0017)		(0.0017)		(0.0028)
Investment rate		-0.00057		0.00081		0.00011
		(0.0013)		(0.0014)		(0.0018)
Financial constraints		0.0033		0.0031		0.0017
		(0.0032)		(0.0052)		(0.0047)
Leverage		-0.0028		-0.000033		0.0088***
		(0.0028)		(0.0022)		(0.0031)
Observations	208,596	208,596	208,596	208,596	208,596	208,596
FE	Firm/year	Firm/year	Firm/year	Firm/year	Firm/year	Firm/year
Within R^2	9.0e-06	0.000055	1.7e-06	0.000047	2.5e-07	0.00016

Table A2
Robustness: greenness and the perceived cost of capital

This table reports robustness tests for regressions based on the global sample of Table 2. All specifications include the "main" set of controls listed in column 6 of Table 2, including quarter-by-year fixed effects, beta, leverage, market value (log), and book-to-market. Standard errors are clustered at the firm and quarter-by-year level. Column (1) excludes all firms in the financial sector. Column (2) includes additional controls: sector-by-year fixed effects, the firm's return on equity in the year (measure of profitability), the firm's financial constraints index in that quarter based on by Hadlock and Pierce (2010), a measure of the firm's financial cost of capital in the quarter based on the CAPM as in Gormsen and Huber (2025), and a measure of the firm's interest rate on debt in the year (total interest expenses over total outstanding debt). Column (3) includes only firms listed in the European Union. Column (4) drops the years of the Covid pandemic 2020-21.

	(1)	(2)	(3)	(4)
	Perceived cost of capital			
E-score	-0.12	0.57	0.44	-0.082
	(0.53)	(0.43)	(0.63)	(0.50)
E-score × Post-2016	-1.52**	-2.27***	-2.46**	-1.65**
	(0.65)	(0.63)	(1.01)	(0.65)
Observations	1,255	1,301	494	1,247
Sample	No Fin.	Full	Only EU	No 2020-21
Controls	Main	Main/Sector-Year/Fin.	Main	Main
Within R^2	0.24	0.39	0.18	0.19

Table A3
Comparable studies on cost of capital differences

This table provides additional details on papers included in Figure 8. These papers estimate the expected return differential between brown (or low ESG) firms and green (or high ESG) firms. The table includes the citation, method, sorting variable, object of interest, estimate in paper, unit in paper, and the estimate estimate scaled by us. Appendix C provides additional details on how we convert each paper's estimate into a comparable difference in the cost of capital (i.e., the impact on the cost of capital from a 2 standard deviation decrease in firm greenness).

Citation	Method	Sorting Variable	Object of Interest	Estimate in paper	Unit in paper	Scaled Estimate (95% CI)
Hsu et al. (2023)	Estimated from returns & prices	Emissions	Expected return	4.42% annual	Top-bottom quintile spread	3.76% (1.74%, 5.77%)
Lioui and Misra (2023)	Estimated from prices & returns	Emissions	Expected return	3.72% annual	Long-short spread	3.72% (0.27%, 7.17%)
Crosignani et al. (2024)	Estimated from prices & returns	Emissions	Expected return	0.27% annual	1 unit increase in emissions intensity	3.15% (1.09%, 5.21%)
Giglio et al. (2025)	Survey	ESG	Expected return	1.40% annual	Difference in ESG vs. non-ESG	2.80% (2.70%, 2.94%)
Bolton and Kacperczyk (2023)	Estimated from prices & returns	Emissions	Expected return	0.071% monthly	1SD increase in emissions	1.90% (0.80%, 3.00%)
Pástor et al. (2022)	Estimated from prices & returns	Environmental ratings	Expected return	1.40% annual	Top-bottom tercile spread	1.43%
Lindsey et al. (2021)	Estimated from prices & returns	ESG	Expected return	0.50% annual	Difference in ESG vs. non-ESG	1.00%
Chava (2014)	Estimated from prices & returns	Environmental ratings	Expected return	0.48% annual	Difference in climate change concerns vs. neutral	0.96% (0.28%, 1.64%)
Faccini et al. (2023)	Estimated from prices & returns	Global warming exposure	Expected return	0.09% monthly	Top-bottom quintile spread	0.92% (-2.35%, 4.19%)
Eskildsen et al. (2024)	Estimated from prices & returns	Environmental ratings	Expected return	0.25% annual	1SD increase in greenness	0.50% (0.09%, 0.91%)
Baker et al. (2022)	Quantitative Model	ESG	Willingness to pay	0.20% annual	Difference in ESG vs. non-ESG	0.41% (0.26%, 0.56%)
Cheng et al. (2024)	Quantitative Model	ESG	Expected return	0.20% annual	Difference in ESG vs. non-ESG	0.40%
Berk and van Binsbergen (2022)	Quantitative Model	ESG	Expected return	0.0044% annual	Difference in ESG vs. non-ESG	0.0088%
Krueger et al. (2024)	Estimated from prices & returns	ESG	Expected return	-0.1% monthly	1 unit increase in ESG ratings	-0.35% (-1.69%, 0.98%)
Aron-Dine et al. (2024)	Survey	Sustainability	Expected Return	-0.3% annual	Difference in Green vs. Traditional Equity	-0.60%
Zhang (2023)	Estimated from prices & returns	Emissions	Expected return	-0.048% monthly	1SD increase in emissions	-1.15% (-3.36%, 1.06%)
Aswani et al. (2024)	Estimated from prices & returns	Emissions	Expected return	-0.034% monthly	1 unit increase in log emissions	-2.46% (-7.15%, 2.22%)
Gorgen et al. (2020)	Estimated from prices & returns	Emissions	Expected return	-0.218% monthly	Top-bottom tercile spread	-2.67% (-7.10%, 1.76%)
Bauer et al. (2022)	Estimated from prices & returns	Emissions	Expected return	-0.65% monthly	Top-bottom quintile spread	-6.63% (-12.1%, -1.15%)
Karolyi et al. (2023)	Estimated from prices & returns	Environmental ratings	Expected return	-0.58% monthly	Top-bottom tercile spread	-7.10% (-11.7%, -2.47%)

Table A4
Other studies related to the funding costs of green firms

This table summarizes papers that are relevant to the funding costs of brown (low ESG) and green (high ESG) firms but do not provide estimates that can be directly converted into cost of capital differences. The table includes the citation, title, outlet, method, sorting variable, object of interest, and quantitative estimate (where applicable) for each paper.

Citation	Title	Outlet	Method	Sorting Variable	Object of Interest	Quantitative Estimate
Ardia et al. (2023)	"Climate Change Concerns and the Performance of Green vs. Brown Stocks"	Management Science	Estimated from returns & prices	Climate change concerns	Difference in daily stock returns when climate change concerns increase unexpectedly	1 unit increase in contemporaneous daily unexpected changes in climate change concerns implies a 7.2 basis points daily return in Green-minus-Brown portfolio
Atilgan et al. (2023)	"Does the Carbon Premium Reflect Risk or Mispricing?"	ECGI Working Paper	Estimated from returns & prices	Emissions	Earnings announcement returns	1 SD increase in scope 1 emissions associated with 0.12% higher announcement return
Becht et al. (2023)	"Voice Through Divestment"	ECGI Working Paper	Estimated from returns & prices	Fossil fuel divestment pledges	Cumulative average abnormal returns (CAARs) around viral divestment pledges	CAARs of -0.9% for Carbon Underground 200, -0.4% for other fossil fuel companies, and -0.2% for other high carbon emitters over a 3-day window
Bauer et al. (2021)	"Get real! Individuals prefer more sustainable investments"	Review of Financial Studies	Survey	Sustainable Development Goals (SDGs)	Individual preferences for sustainable investments and beliefs about their financial performance	17.3% expect higher returns with sustainable investments, 25.4% expect equal returns, 14.8% expect lower returns, 42.5% don't know
Bua et al. (2024)	"Transition versus physical climate risk pricing in European financial markets: A text-based approach"	ECB Working Paper	Regression	Text-based climate risk indices	Pricing of physical and transition climate risk in European equities	Climate risk premia of 6.14% (physical) and 7.05% (transition) per year post-2015 (i.e. higher required return for stocks that are a bad hedge against climate risk)
De Angelis et al. (2022)	"Climate impact investing"	Management Science	Quantitative Model	AUM managed by green investors	Emission reduction	An electrical equipment manufacturing company reduces its emissions by an average of 1% per year over a 20-year period when green investments account for 25% of the total AUM in the economy.
Edmans et al. (2024)	"Sustainable Investing: Evidence From the Field"	Working Paper	Survey	Fund type (traditional vs. sustainable)	Portfolio managers' beliefs, objectives, constraints, and actions regarding ES performance	Only 27% of investors would tolerate sacrificing even 1 basis point of return for ES performance.
Engle et al. (2020)	"Hedging Climate Change News"	Review of Financial Studies	Mimicking portfolio approach	ESG scores (MSCI and Sustainalytics)	Construction of climate hedge portfolios using firm characteristics	Hedge portfolios achieve out-of-sample correlations with climate news innovations of up to 0.3 for Sustainalytics-based portfolios and 0.18 for MSCI-based portfolios
Guenster et al. (2011)	"The Economic Value of Corporate Eco-Efficiency"	European Financial Management	Estimated from returns & prices	Eco-efficiency score from a 3rd party provider	Return on assets (ROA) and Tobin's q	For ROA: 0.09% increase in ROA for one-point rise in eco-efficiency ranking. For Tobin's q: 0.07 increase in Q for one-point rise in eco-efficiency ranking, approx. 3.2% of average
Matsumura et al. (2014)	"Firm-Value Effects of Carbon Emissions and Carbon Disclosures"	The Accounting Review	Estimated from returns & prices	Carbon emissions and disclosures	Firm value	Firm value decreases by $212,000 on average for every 1,000 metric tons of carbon emissions. Median firm value $2.3 billion higher for firms that disclose their carbon emissions compared to non-disclosing firms.
Santi and Moretti (2021)	"Carbon Risk Premium and Worries about Climate Change"	SSRN Working Paper	Estimated from returns & prices	Emissions	Carbon risk premium conditional on worries about climate change	Carbon premium of 10.4% annually in worried regions, no significant premium in little worried regions
Sautner et al. (2023)	"Firm-Level Climate Change Exposure"	Journal of Finance	Estimated from returns & prices	Pricing of climate change exposure	Text-based climate change exposure	Average conditional risk premium on the climate change exposure factor is positive at 3.7% per annum.
Zhang and Shi (2025)	"Oil-Driven Greenium"	Working Paper	Estimated from returns & prices	Carbon intensity	Cost of capital difference after removing oil shock effects	Oil shocks explain 20-50% of greenium fluctuations.

Table A5
Long-run capital allocation and the perceived cost of capital

This table reports panel regressions of firm-level real outcomes on the firm's ex ante perceived cost of capital. The table is taken from Gormsen and Huber (2024). In columns (1) and (2), the left-hand side variable is the return on invested capital (ROIC). We calculate the ROIC using Compustat as [earnings before interest] over [long-term book debt plus book equity minus cash minus financial investments]. In columns (3) and (4), the left-hand side variable is the ratio of capital to labor. We measure capital as net property, plant, and equipment (PPEN) and labor as number of employees. In columns (5) and (6), the left-hand side variable is long-run investment. Long-run investment is the average net investment rate over the subsequent five years. We calculate net investment as capital expenditure minus depreciation over the lagged value of property, plant, and equipment (PPEN). Statistical significance is denoted by *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)	(5)	(6)
	ROIC$_{i,t}$		Capital/labor$_{i,t}$		Long-run investment$_{i,t+5}$	
Perc. CoC$_{i,t}$	0.74**	0.63**	-17.3***	-18.6***	-0.78**	-0.84*
	(0.31)	(0.25)	(2.91)	(3.26)	(0.36)	(0.43)
Implied CoC$_{i,t}$		-0.40*		-3.74**		0.24
		(0.23)		(1.65)		(0.21)
Interest expense$_{i,t}$		-0.035		-2.89***		0.23
		(0.16)		(1.09)		(0.31)
Country-year FE	X	X	X	X	X	X
Observations	1,979	1,546	2,338	1,892	1,371	1,133
R^2	0.036	0.049	0.24	0.25	0.088	0.099

Appendix B Details on Measurement

We use an extended dataset based on the data collection procedure established by Gormsen and Huber (2025). The dataset is extended because it contains additional data from conference calls for all years from FactSet and for the years 2021 and 2023 from Refinitiv. For the reader's convenience, we reproduce details on the measurement here based on Gormsen and Huber (2024).

Appendix B.1 Extraction of Paragraphs from Conference Calls

We access all calls held in English during the period January 2002 to June 2023 that are available on the databases Refinitiv and FactSet. We download paragraphs from the calls that fulfill two criteria: first, they contain one of the terms "percent," "percentage," or "%" and second, they contain at least one keyword related to the cost of capital. The keywords are capital asset pricing model, cost of capital, cost of debt, cost of equity, discount rate, expect a return, expected rate of return, expected return, fudge factor, hurdle rate, internal rate of return, opportunity cost of capital, require a return, required rate of return, required return, return on assets, return on invested capital, return on net assets, weighted average cost of capital, weighted cost of capital. We also include abbreviations of the keywords in the search, for example, WACC. We identify roughly 110,000 paragraphs containing a keyword.

We match the firm name listed on the conference call to Compustat Global Company Keys by using a fuzzy merge algorithm, checking each match by hand. Ultimately, we link 93% of the paragraphs to a Compustat firm.

Appendix B.2 Guidelines for Manual Data Entry

With our data collection team, we read through each paragraph and enter relevant figures into tables. We record the following financial variables from the calls:

- discount rate
- hurdle rate
- hurdle premium over the cost of capital
- fudge factor over the cost of capital
- cost of debt
- weighted average cost of capital (WACC)
- opportunity cost of capital (OCC)
- cost of capital
- cost of equity
- required, expected, and realized internal rate of return (IRR)
- required, expected, and realized return on invested capital (ROIC)
- required, expected, and realized return on equity (ROE)
- required, expected, and realized return on assets (ROA)

- required, expected, and realized return on net assets

We do not record hypothetical numbers (e.g., "we may use a discount rate of x%" or "imagine that we use a cost of capital of x") and figures given by someone outside the firm (e.g., an analyst on the call suggesting a specific cost of capital for the firm). The context of statements is often key, so automated text processing cannot easily replace human reading for this task. For instance, the abbreviation OCC may refer to the opportunity cost of capital but more often than not actually refers to Old Corrugated Cardboard, a term for cardboard boxes used in the transport and recycling industries.

We only measure discount rates when managers explicitly discuss them as part of an investment rule. This means, for example, that we do not record discount rates used to value firms' pension liabilities. We focus on discount rates and the cost of capital that represent investment rules of the firm, as opposed to specific figures related to individual projects or divisions. For instance, we do not record the interest rate for a particular bond issuance. The paragraphs in the data entry sheets are sorted by firm and quarter, which helps us to interpret statements from the same firm consistently. When managers list multiple discount rates (usually for different regions and industries), we enter the figures that are representative of most of the company's operations (e.g., US figures for a US company). We discuss all cases with multiple rates among the whole team.

Managers mostly discuss their after-tax discount rate and cost of capital. We convert a few observations where managers state that they use a pre-tax value into an after-tax value in two steps. First, we estimate the average percentage point difference between after-tax and pre-tax observations, controlling for country-by-year fixed effects. Second, we then adjust the pre-tax values reported on the calls using this average difference.

Similarly, managers rarely mention a "levered" discount rate, which is used in return calculations that do not take into account all the capital used to finance an investment. We convert all observations where managers state that they use a levered discount rate into an unlevered rate. Similarly to the after-tax correction, we estimate the average percentage point difference between levered and unlevered discount rate observations, conditional on country-by-year fixed effects, and then adjust the levered values using this difference.

The tax and leverage adjustments apply to few observations and do not affect any of the results.

Managers sometimes specify a range rather than an actual value. We enter the average value in these cases. We do not record values when the range is very large or ambiguous. Managers sometimes give different realized returns depending on the time horizon (e.g., "we have achieved a 5% ROIC over the last five years and a 10% ROIC over the last ten.") We enter the most recent horizon for such cases. Realized returns referring to a previous episode unconnected to current years (e.g., "return in the 1990s") are not recorded.

Appendix B.3 Data Collection Team

A total of 23 research assistants contributed to the data collection. The average team size at any point was 7. The team members were: Alexandra Bruner, Ben Meyer, Cagdas Okay, Charlotte Wang, Chris Saroza, Daniel Marohnic, Esfandiar Rouhani, Henry Shi, Izzy Sethi, Jasmine Han, Jason Jia, Madeleine Zhou, Manhar Dixit, Meena Rakasi, Neville Nazareth, Rachel Kim, Rahul Chauhan, Rohan Mathur, Sanjna Narayan, Scarlett Li, Sean Choi, Sungil Kim, Tony Ma.

Before assistants begin the actual data collection, we teach them basic asset pricing and capital budgeting. Each assistant then reads roughly 2,000 paragraphs to train, which we check and discuss.

All paragraphs containing values for a perceived cost of capital and a discount rate were read at least twice by different assistants and outliers were checked by the authors to avoid errors. The research team met every week to discuss individual cases and to coordinate on consistent data entry rules.

Appendix C The Cost of Capital of Green Firms in the Literature

This section describes how we construct comparable estimates of the difference between the cost of capital of brown firms and green firms from academic papers. For each paper, we aim to construct an estimate of the difference in expected returns from a 2 standard deviation decrease in firm greenness (i.e., the expected return on brown or low ESG firms minus the expected return on green or high ESG firms). The order of the papers follows the order in Figure 8.

Appendix C.1 Hsu, Li, and Tsou (2023)

Hsu et al. (2023) examine the relationship between industrial pollution and stock returns. They construct portfolios sorted on firms' toxic emission intensity within industries. Their key finding is that a long-short portfolio going long high-emission firms and short low-emission firms generates an average annual return of 4.42%. This return spread remains statistically significant even after controlling for common risk factors. The authors refer to this positive return premium for high-pollution firms as the "pollution premium." To align their estimate with ours, we scale their estimate to match the effect corresponding to a two standard deviation spread in emission intensity. Based on the reported t-statistic, we construct a confidence interval around this scaled estimate.

Appendix C.2 Lioui and Misra (2023)

Lioui and Misra (2023) examines how different ways of measuring and transforming carbon emissions data affect estimates of the carbon risk premium. The authors find that using emissions-weighted factors rather than the standard Fama-MacBeth approach leads to larger and more consistent estimates of the premium across different emissions measures. Using emissions-weighted factors, they estimate a positive carbon risk premium (higher returns for high-emitting firms) of around 0.30-0.31% per month for most emissions measures. We compute the confidence interval for the estimate of the cost of capital difference based on the reported t-statistic in the paper. We annualize their estimate and compute the 95% confidence interval based on the reported t-statistic in the paper.

Appendix C.3 Crosignani, Osambela, and Pritsker (2024)

Crosignani et al. (2024) examines whether carbon emissions intensity is priced in U.S. equity markets, addressing measurement error and omitted variable bias in prior studies. They find that firms with higher emissions intensity earn higher expected returns, implying a positive carbon premium (or negative greenium). Their baseline estimate suggests that a one-unit increase in emissions intensity is associated with a 0.27 percentage point increase in expected annual returns. We scale their baseline estimate to match the effect corresponding to a two standard deviation spread in emissions intensity and compute the corresponding confidence interval.

Appendix C.4 Giglio et al. (2025)

Giglio et al. (2025) analyze survey data from Vanguard investors linked to their administrative portfolio data to examine beliefs and behaviors related to ESG investing. They document four key facts, one of which is that investors on average expected ESG investments to underperform the overall stock market by 1.4% annually over a 10-year horizon. We double this figure to estimate the return difference between brown and green investments, assuming the market represents a midpoint between the two. This approach thus assumes that brown investments outperform the market by approximately the same margin that green investments underperform it. We compute the standard errors based on the reported standard deviation and the number of observations, which we then use to construct the 95% confidence interval.

Appendix C.5 Bolton and Kacperczyk (2023)

Bolton and Kacperczyk (2023) analyze a comprehensive global dataset of 14,400 companies across 77 countries to examine the relationship between carbon emissions and stock returns. They find that firms with higher carbon emission levels and growth rates tend to have higher stock returns, a pattern that holds across most sectors and countries. To align their estimate with ours, we scale their baseline estimate (column (1) of Table V) to match the effect corresponding to a two standard deviation spread in emissions. We then annualize their estimate and compute the confidence interval based on the reported t-statistic.

Appendix C.6 Pastor, Stambaugh, and Taylor (2022)

Pástor et al. (2022) examine the performance of green assets and explore the reasons behind their recent outperformance. They find that green stocks delivered high returns in recent years, but argue this reflects unexpectedly strong increases in environmental concerns rather than high expected returns. Using both ex-ante and ex-post methods, they estimate lower expected returns for green stocks compared to brown stocks. One of their approaches uses the implied cost of capital (ICC) and finds that a green-minus-brown portfolio has an average ICC of -1.4% per year. To align their estimate with ours, we scale their baseline estimate to match the effect corresponding to a two standard deviation spread in emission intensity. No confidence interval is provided by the paper.

Appendix C.7 Lindsey, Pruitt, and Schiller (2021)

Lindsey et al. (2021) examines the costs of implementing an ESG investing mandate using a conditional asset pricing model. The authors find that tilting optimal portfolio weights to satisfy a range of ESG mandates negligibly affects portfolio performance. We use the difference in annualized mean returns between the tangency portfolio without ESG constraints (14.58%) and one of the tangency portfolios with ESG constraints (15.08%). We double this figure to estimate the return difference between brown and green investments, assuming the market represents a midpoint between the two.

This approach thus assumes that brown investments outperform the market by approximately the same margin that green investments underperform it.

Appendix C.8 Chava (2014)

Chava (2014) examines the relation between firms' environmental profiles and their cost of equity capital using the implied cost of capital derived from analysts' earnings estimates. He finds that firms with climate change concerns (defined as companies deriving substantial revenues from the sale or combustion of coal/oil and derivative fuel products) have a 0.48% higher implied cost of capital (Table 3, Model 6). Since the climate change dummy compares brown firms to neutral (not green) firms, we double this estimate to capture the full brown-to-green spread and compute the corresponding confidence interval.

Appendix C.9 Faccini, Matin, and Skiadopoulos (2023)

Faccini et al. (2023) examines whether physical risks (e.g., global warming) or transition risks (e.g., government policies to reduce carbon emissions) are priced in U.S. stock returns from 2000-2018. They find that only the transition risk stemming from U.S. climate policy is priced in stock returns, especially after 2012, while the physical risk measures are not priced. To align their estimate with ours, we scale their baseline estimate (last column of Table 2) to match the effect corresponding to a two standard deviation spread in exposure to global warming. We then annualize their estimate and compute the confidence interval based on the reported t-statistic.

Appendix C.10 Eskildsen et al. (2024)

Eskildsen et al. (2024) constructs a "robust green score" which is the average of the key greenness measures from several leading data providers. Authors find an annual equity greenium of -25 basis points per standard deviation increase in greenness. To align their estimate with ours, we scale their baseline estimate to match the effect corresponding to a two standard deviation spread in greenness. We adjust the confidence interval accordingly to reflect this scaling.

Appendix C.11 Baker, Egan, and Sarkar (2022)

Baker et al. (2022) estimate how much investors are willing to pay to invest in index funds with an ESG mandate. Using a discrete choice demand model, they find that investors are willing to pay an additional 20 basis points per year to invest in an ESG index fund compared to an otherwise equivalent non-ESG index fund. We double this figure to estimate the return difference between brown and green investments, assuming the market represents a midpoint between the two. This approach thus assumes that brown investments outperform the market by approximately the same margin that green investments underperform it. We then use the standard error for the ESG coefficient (γ) and the expense ratio coefficient (α) in their paper. Using the delta method, we then construct the 95th confidence interval for $2 * \gamma/\alpha$.

Appendix C.11.1 Cheng et al. (2024)

Cheng et al. (2024) develops a dynamic equilibrium model to study the impact of green investors on stock prices. The model includes three types of investors: green investors who progressively exclude the most polluting firms, passive investors holding a broad market index, and active investors optimizing their portfolios. The authors consider three scenarios with varying proportions of investor types and climate transition risk. In their baseline Scenario 1, they find that over a ten-year period, the cost of capital for excluded firms increases by 18 basis points while it decreases by 2 basis points for non-excluded firms, yielding a difference of 20 basis points. We double this figure to estimate the return difference between brown and green investments, assuming the market represents a midpoint between the two. This approach thus assumes that brown investments outperform the market by approximately the same margin that green investments underperform it.

Appendix C.11.2 Berk and van Binsbergen (2022)

Berk and van Binsbergen (2022) develop a model showing that the impact of divestiture strategies on the cost of capital can be approximated using three key factors: the proportion of socially responsible investors, the percentage of firms targeted for divestment, and how correlated the returns of these targeted firms are with the broader market. When they apply this model to current market conditions, they estimate that the change in cost of capital is only about 0.44 basis points. This estimate represents the difference between targeted firms and the overall market. We double this figure to estimate the return difference between brown and green investments, assuming the market represents a midpoint between the two. This approach thus assumes that brown investments outperform the market by approximately the same margin that green investments underperform it.

Appendix C.12 Krueger, Alves, and van Dijk (2024)

Krueger et al. (2024) conducts a comprehensive analysis of the relation between ESG ratings and stock returns using data on over 16,000 stocks in 48 countries from 2001-2020 and ESG ratings from seven major providers. The authors find little evidence that ESG ratings are related to global stock returns over this period. We compute the confidence interval based on their reported t-statistic. To align their estimate with ours, we scale their estimate to match the effect corresponding to a two standard deviation spread in ESG ratings. We then annualize this estimate and construct a confidence interval around this scaled estimate based on the reported t-statistic.

Appendix C.13 Aron-Dine et al. (2024)

Aron-Dine et al. (2024) explores the impact of green investing on household portfolios and asset prices using German survey data and a heterogeneous agent asset pricing model. The paper uses representative survey data to measure household beliefs, preferences, and portfolio choices regarding green assets. As the baseline estimate of greenium (premium of traditional over green equity returns), we focus on the population-weighted average expected returns from the survey. To estimate the return difference between brown and green investments, this baseline greenium is doubled, assuming brown investments outperform the market by roughly the same margin that green investments underperform it. This approach treats the overall market as a midpoint between brown and green investments.

Appendix C.14 Zhang (2023)

Zhang (2023) examines the carbon return - the return spread between brown (high carbon intensity) and green (low carbon intensity) firms - across global equity markets. Contrary to some previous studies that found a positive carbon premium, this research demonstrates that after accounting for data release lags and controlling for forward-looking sales information, carbon returns are significantly negative in the U.S. and insignificant globally. Specifically, the paper finds that once the sales information is controlled for, emissions and emissions growth are no longer positively associated with returns. To align their estimate with ours, we scale their estimate to match the effect corresponding to a two standard deviation spread in emissions. We then annualize this estimate and construct a confidence interval around this scaled estimate based on the reported t-statistic.

Appendix C.15 Aswani, Raghunandan, and Rajgopal (2024)

Aswani et al. (2024) studies the relationship between carbon emissions and stock returns, challenging previous findings of a positive carbon premium (higher returns for high-emitting firms). The paper argues that previous findings of a positive carbon premium were likely driven by issues with vendor-estimated emissions data and the use of unscaled total emissions rather than emissions intensity. After addressing these issues, they do not find compelling evidence of a carbon premium in most specifications. To align their estimate with ours, we scale their estimate to match the effect corresponding to a two standard deviation spread in emissions. We then annualize their estimate and compute the confidence interval based on the reported t-statistic.

Appendix C.16 Gorgen et al. (2020)

Gorgen et al. (2020) construct a Brown-Minus-Green (BMG) factor to study carbon risk in global equity prices from 2010-2017. They find insignificant but negative realized returns of -0.11% per month for the BMG factor, suggesting green stocks slightly outperformed brown stocks. In Fama-MacBeth cross-sectional regressions, they estimate a carbon risk premium of -0.097% per month (t-stat -1.42) using standard methods, and -0.218% per month (t-stat -1.18) after correcting for errors-in-variables. To align their estimate with ours, we scale their estimate to match the effect corresponding to a two standard deviation spread in ESG ratings. We then annualize this estimate and construct a confidence interval around this scaled estimate based on the reported t-statistic.

Appendix C.17 Bauer et al. (2022)

Bauer et al. (2022) analyze the performance of green versus brown stocks across the G7 countries, with particular attention to the United States. They construct portfolios based on companies' reported CO2 emissions levels and intensities, intentionally avoiding estimated emissions data to reduce potential biases. Their analysis reveals that portfolios based on emission intensity show the strongest evidence of green outperformance. Specifically, for the United States, they find that a value-weighted portfolio going long green stocks and short brown stocks, sorted by emission intensity, yields an average monthly return of -0.65%. To align their estimate with ours, we scale their estimate to match the effect corresponding to a two standard deviation spread in emission intensity. We then annualize this estimate and construct a confidence interval around this scaled estimate based on the reported t-statistic.

Appendix C.18 Karolyi, Wu, and Xiong (2023)

Karolyi et al. (2023) analyze the equity greenium across 21,902 firms in 96 countries. They find evidence that globally, green stocks outperformed brown stocks. Their analysis shows this effect was strongest in North America, where they observed a monthly green-minus-brown (GMB) return of 58 basis points, statistically significant at the 1% level. In contrast, GMB returns in other regions were generally not statistically different from zero. To align their estimate with ours, we scale their estimate to match the effect corresponding to a 2 standard deviation spread in environmental ratings. We then annualize this estimate and construct a confidence interval around this scaled estimate based on the reported t-statistic.

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