Counterproductive Impact Investing:

The Impact Elasticity of Brown and Green Firms*

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Abstract

We develop a new measure of impact elasticity, defined as a firm's change in environmental and social impact due to a change in its cost of financing. We show empirically that a reduction in financing costs for firms that are already green leads to small improvements in impact at best. In contrast, increasing financing costs for brown firms lead to large negative changes in firm impact. Thus, impact investment that directs capital away from brown firms and toward green firms may have the counterproductive effect of worsening aggregate firm impact on society. Similarly, investor engagement that targets the incentives of green firms would be more effective if targeted at brown firms.

PRELIMINARY AND INCOMPLETE. RESULTS SUBJECT TO CHANGE.

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A wise man gets more use from his enemies than a fool from his friends. -Baltasar Gracian

I. Introduction

There has been dramatic growth in financial investments made with sustainable impact objectives. While a variety of tactics have been employed, the dominant strategy involves making investments in firms that are perceived to be "green" (positive social and environmental impact) and divesting away from firms that are perceived to be "brown" (negative social and environmental impact). To the extent that impact investing can meaningfully change firm incentives, it rewards green firms by lowering their cost of financing and punishes brown firms by raising their cost of financing. A consistent message from impact-driven investors and fund managers is the hope that impact investing will motivate all firms to become more green, thereby improving the aggregate impact of firms on society.

The success of the impact investing movement depends critically on how firms alter their behavior in response to changing financing conditions. If green firms provide the most *additional* green in response to a reduction in their cost of financing, impact investors should reward green firms by investing in them. Likewise, if brown firms provide the largest reduction of brown in response to an increase in their cost of financing, impact investors should punish brown firms by divesting away from them. In this paper, we develop a new measure of "impact elasticity," defined as a firm's change in environmental and social impact due to a change in its cost of financing. Without knowledge of the relative impact elasticities of green and brown firms, it is unclear which and how firms should be targeted by impact investors.[1]

This paper shows that, if the dominant impact investing strategy of directing capital away from brown firms toward green firms succeeds in changing firms' financing costs, such a strategy would likely have the counterproductive effect of worsening aggregate firm impact on society. We show empirically that firms that are considered green (based on carbon emissions, ESG ratings, or holdings of green mutual funds) have little scope for further improvement in their impact. Green firms exhibit low variability in impact and have close-to-zero impact elasticity with respect to changes in their cost of financing. In contrast, brown firms have substantially greater scope for change (about 150 times as much as similarly-sized green firms) and exhibit large negative impact elasticities with respect to their cost of financing. Brown firms become meaningfully less brown in response easier access to capital

[1] In theory, firms should value potential investment projects using a project-specific cost of capital rather than a firm-wide cost of capital. Our impact elasticity measure can accommodate a project-specific valuation method. We assume that firm-level shocks to the cost of financing shifts the firm's project-specific discount rates equally across all projects. The dominant impact investing strategy of investing in green firms and divesting away from brown firms is an example of a firm-level shock to the cost of financing, and its effect would depend on the firm-level impact elasticity.

and substantially more brown if pushed toward financial distress.

Whether the massive inflows of money into impact investing over the past several decades have had a major impact on firm cost of financing is open to debate. For example, Chava (2014) presents empirical evidence of green firms having lower cost of financing, whereas Berk and van Binsbergen (2021) argue the impact-driven investment flows are not large enough to impact market conditions given that non-green funds can offset these flows. Our paper suggests that the best case scenario for aggregate firm impact is the one where the dominant impact investing strategy has not yet shifted firms' cost of financing. To the extent that such a strategy succeeds in changing firms' cost of financing, it would have the counterproductive effect of lowering the overall green impact of firms on society.

A simple case study may help illustrate the intuition of our paper's results. Travelers is an insurance firm in the S&P 500 that looks spectacular on environmental, social, and governance (ESG) metrics. Travelers also does an admirable job in limiting its carbon emissions. In 2021, it emitted 33,477 metric tons of carbon, which is about 1 ton per million dollars of revenue.[2] The average US household emits about 48 tons of carbon per year, but Travelers emits only about 1 ton of carbon per employee.[3] At the opposite extreme lies Martin Marietta Materials, another S&P 500 firm that supplies heavy building materials. Amongst ESG ratings providers, Martin Marietta is uniformly considered poor. In 2021, it emitted about 5.1 million tons of carbon, corresponding to about 1,000 tons per million dollars of revenue and about 500 tons per employee. Relative to Travelers, Martin Marietta has 1000 times as much emissions intensity, measured as emissions per million dollars of revenue.

The most common impact investing strategy dictates that investors with sustainable objectives should invest in Travelers and avoid Martin Marietta. With that said, if money flows toward Travelers allowing further investments in green projects at subsidized rates, where would it go? Across almost every metric, it is already outstanding. If Travelers were able to cut emissions to zero (which seems unlikely), it would be equivalent to Martin Marietta cutting its emissions by 0.1%. As an insurance firm, Travelers would also struggle to become more brown. If it ceased to care at all about carbon emissions, perhaps its emissions might double, but this still would mean that Travelers' overall emissions intensity would be less than 1% of those of Martin Marietta.

On the other hand, Martin Marietta has the capability of becoming much more green or brown. While the company emits a large amount of carbon, it does so after having made significant green

[2] https://sustainability.travelers.com/iw-documents/sustainability/Travelers_ESGAnalystData2021.pdf

[3] https://css.umich.edu/publications/factsheets/sustainability-indicators/carbon-footprint-factsheet

investments to improve its environment impact. From 2016 to 2021, it decreased its scope 1 emissions intensity by more than 20%, from 158 to 124. Martin Marietta has also considered a number of green technologies for future adoption, although the firm currently deems these green investments to be unprofitable absent additional financial incentives.[4] Thus, if investors were willing to make such green investments profitable, Martin Marietta's carbon emissions could decrease further (recall that a 1% decrease would be greater than the entirety of Travelers's emissions). Similarly, if the market forced the firm to worry about its short-term financial survival, the company could invest more into its existing brown projects which deliver more front-loaded cash flows compared to green investment projects. Simply reversing its efficiencies per dollar on carbon emissions since 2016 would result in an increase in emissions of approximately one million tons, equal to 30 times Travelers' annual level of emissions.[5] Overall, Martin Marietta has the potential to significantly decrease emissions, and if pushed to cut corners, could meaningfully increase emissions as well.

In our empirical analysis, we show the intuition of this example is reflective of the overall market. We begin by showing that brown firms have greater year-to-year variability in their impact than green firms. Measures of variability provide a useful upper bound on a firm's absolute impact elasticity; variability that is close to zero implies that the impact elasticity must also be close to zero.

We divide firms into quintiles by their carbon emissions intensity (defined as scope 1 and scope 2 emissions scaled by revenue) in the previous year, with the top quintile representing green firms and the bottom quintile representing brown firms. We show that green firms have very low emissions intensity and have very little year-to-year variation in that level. In contrast, the average brown firm has 260 times as much emissions intensity as the average green firm, and experiences approximately 150 times larger absolute changes in emissions from year to year. The average absolute annual *change* in emissions intensity for a brown firm is equal to the average *level* of emissions intensity from 35 green firms combined. Firms in the middle three quintiles, which we classify as neutral (neither green nor brown), exhibit impact variability that is closer to the variability of green firms than brown firms. This general pattern holds using a variety of measures of carbon emissions and scaling choices.

Some impact investment funds may adjust their investment allocations so that their industry or sector weights are similar to those of the overall market, and they invest in green firms and divest away from brown firms within each industry or sector. We show that brown firms within an industry

[4]For example, the firm cites the friendly regulatory environment in Europe for green investment and argues that it would be unprofitable to implement similar changes in the US without such regulation.

[5]This assumes revenue stays constant at the 2021 level.

exhibit much greater variability in impact than green firms within the same industry. Thus, impact investment that is "industry-adjusted" would nevertheless be tilted toward green firms within each industry with little scope to change their impact.

We focus on carbon emissions as our primary measure of firm impact because it is a standardized measure that clearly matters to impact investors, and because carbon emissions directly contribute to the risk of global climate change. The importance of carbon emissions to impact investors is reflected in recent SEC communications, which focuses on mandatory disclosure of carbon emissions in the portfolio holdings of "funds that consider environmental factors."[6] In addition to carbon emissions, one can also look at firm Environmental, Social, and Governance (ESG) ratings themselves. While ESG ratings have been shown to be very noisy proxies for the true impact of firms (Berg et al., 2019), they have the benefit of capturing a broader number of avenues through which firms can impact the society. Compared to carbon emissions which only measures firms' degree of negative impact, ESG ratings have the additional benefit of being two-sided. They can capture positive firm impact, such as through the development of new green energy products or waste-saving technology.

To evaluate the variability of ESG impact across firms, we categorize firms as brown or green using their previous year's overall, environmental, social, or governance scores as rated by Refinitiv, a leading ESG ratings firm. We find that green firms are associated with significantly greater annual absolute changes in their environmental, social, and overall ESG ratings compared to brown firms, with the largest differences in the environmental rating. The one exception is the governance rating: green and brown firms as classified by their governance ratings exhibit approximately equal variability in their governance ratings across years. For this reason, and because it is not obvious whether governance quality (e.g., whether a firm has a staggered board takeover defense) has large impact externalities on society, we limit our arguments to firm impact excluding governance.

In the next part of our paper, we examine the impact elasticity of green and brown firms to changes in their cost of financing. To obtain sufficient statistical power, we examine a general class of shocks to firms' cost of financing without restricting our attention to changes in financing costs that are specifically due to impact investment. The underlying assumption is that, if impact investing succeeds in altering firm's financing costs, firms would react in a similar fashion as they react to other changes in

[6]"ESG-focused funds that consider environmental factors... would be required to disclose the carbon footprint and the weighted average carbon intensity of their portfolio. The requirements are designed to meet demand from investors seeking environmentally focused fund investments for consistent and comparable quantitative information regarding the GHG emissions associated with their portfolios and to allow investors to make decisions in line with their own ESG goals and expectations." https://www.sec.gov/files/ia-6034-fact-sheet.pdf

their financing costs.

Across a broad set of empirical tests, we find that brown firms have greater negative impact elasticity than green firms. First, we show that brown firms react to financial distress, as proxied by low interest coverage or a low Altman Z-score, by increasing their emissions. In contrast, green firms exhibit a much smaller and less significant response, sometimes in the opposite direction.

Second, we show that brown firms exhibit a greater negative impact elasticity in response to changes in their real or financial performance. Stronger firm performance likely eases the firm's financial constraints and lowers the firms' cost of financing. To estimate a causal relationship between firm performance and impact, we examine the relation between firm emissions and the firm's industry average performance, calculated excluding the focal firm. The intuition is that industry performance shocks strongly affect firm-level performance, but individual firm choices should not have a strong effect on the industry average performance calculated excluding the focal firm. Our analysis shows that brown firms are much more elastic to industry shocks to firm performance than green firms.

Third, we examine impact elasticity with respect to the firm's implied cost of capital (ICC). The ICC is the internal rate of return that equates the firm's market value to the present value of its expected future cash flows. A lower ICC corresponds to lower cost of financing. Because ICCs have been shown to be noisy with conflicting estimates across methodologies (Lee et al., 2021), we present these tests as a complement to our earlier analysis which proxies for financing costs using bankruptcy risk and industry performance. Across a variety of ICC measures, we find that brown firms exhibit a large negative impact elasticity with respect to their ICC while green firms exhibit elasticities close to zero. To estimate the causal impact of firm cost of capital on firm emissions, we examine the relation between firm emissions and the firm's industry value-weighted average ICC, calculated excluding the focal firm. We estimate a large negative elasticity of brown firm emissions with respect to industry ICC, and a smaller and insignificant relation for green firms.

We note that these empirical patterns are consistent with basic corporate finance theory. Brown firms likely face a choice between dark-brown investment projects (e.g., continuing or expanding existing high-pollution operations, or cutting corners on pollution abatement) and light-brown investments (e.g., shifting toward cleaner production or green energy). Because the light-brown investment project entails a departure from existing production methods, it likely requires investment in new capital which costs more up front and delivers more back-loaded cash flows compared to the dark brown investment project. Financial distress or an increase in the cost of financing will make short-term cash

flows more attractive relative to long-run cash flows. Thus, an increase in the cost of financing causes the dark-brown project to look more attractive relative to the light-brown project, leading brown firms to have a negative impact elasticity.[7] In contrast, a green firm likely operates in a line of business (e.g., insurance in the case of Travelers) where the firm cannot generate substantial environmental or social externalities regardless which investment projects it chooses to pursue, leading green firms to have impact elasticities close to zero.

Finally, we confirm that our measures of whether a firm is considered green or brown aligns with the views of impact investment funds active in US markets in the past three decades. We classify mutual funds as green if they state an impact-investing objective, and as non-green otherwise. We find that higher ESG ratings and lower emissions intensity are strong predictors of whether the firm is overweighted in the portfolios held by green investment funds. We also show that firms that are overweighted by green investment funds exhibit lower variability in their environmental and social ESG ratings as well as in their emissions intensity. These results imply that impact investment has so far targeted green firms with little scope to change their environmental and social impact, and divested from brown firms with greatest scope to become more green. To the extent that impact investing increases the cost of capital for brown firms and/or pushes them toward financial distress, brown firms may cut corners by shifting toward investment projects that have greater negative impact but deliver more front-loaded cash flows.

Our paper complements recent theoretical work by Edmans et al. (2022), which argues that an optimal impact investing strategy should tilt away from brown industries but be willing to hold brown firms that take actions to improve their impact. Their model describes a managerial agency problem in which a self-interested manager of a brown firms benefits from a short-term increase in the stock price. Our paper is similar in spirit because we show that divestment away from brown firms can be suboptimal. However, our conclusions does not require a managerial agency conflict. Rather, brown and green can firms fundamentally differ in their impact elasticities due to differences in their investment opportunity set.

Another related literature has highlighted problems in the current system of evaluating firm ESG and sustainability (Berg et al., 2019). A common theme is that removal of green washing and more con-

[7] The simple intuition here is similar in spirit to a more sophisticated and specialized model presented in Eisfeldt and Rampini (2007), which shows that financial distress or an increase in the cost of capital induces firms to favor investment in "used capital" (e.g., older technologies or existing projects) that is cheaper up front and may require greater maintenance costs in the future. The ability of brown firms to choose between projects with more or less front-loaded cash flows is underscored by recent evidence from Gilje et al. (2020) showing that financial distress causes firms in the oil and gas industry to pull forward drilling in existing oil wells at the expense of long-run project returns.

sistency in ratings standards are important steps toward a more effective green investment industry. Heath et al. (2021) show that socially responsible investment funds buy firms with green characteristics, but these characteristics do not meaningfully improve after they are purchased. Our paper offers a complementary explanation for why green firms do not improve—green firms have little scope to improve, even when incentivized to do so.

A potential concern with our analysis is that we measure impact elasticity at the one year horizon. Some impact investment strategies may have the goal of improving long-term firm impact, such as the development of green technologies that will implemented many years into the future. By lowering the cost of capital for green firms, the dominant impact investing strategy may also incentivize brown firms to transition to becoming green firms in the long run. While theoretically plausible, such long term motives do not appear to drive impact investment flows in practice. Most impact investments are made based on the current level of ESG ratings or emissions rather than changes in impact or potential for future changes in ratings. Under the current dominant impact investment strategy, a brown firm that becomes less brown would still be classified as brown and excluded from impact investing portfolios.[8] Further, Cohen et al. (2020) empirically demonstrates that energy sector firms, which are typically considered to be brown and excluded from impact investing portfolios, produce the most impactful green innovation. These innovations have the potential to dramatically improve firm impact in the long run. While Cohen et al. (2020) does not measure the long-term impact elasticity of brown firms, their results complement ours by suggesting that brown firms have the greatest scope to change their long term impact as well as their short term impact.

Our paper contributes to the broader academic literature exploring the optimal impact investment strategy. Much of the debate of how impact investment should be implemented is split into arguments for divestment (holding green firms and avoiding brown firms) versus engagement (engaging directly firms to change their impact). In practice, the divestment camp represents the bulk of impact investing (see e.g. Pástor et al. (2021)), though the engagement strategy has been widely discussed in the academic literature (e.g. Broccardo et al. (2020)). The engagement literature largely focuses on corporate governance interactions, such as voting your shares or obtaining board seats.[9] Our paper complements the existing literature in three ways. First, the theory literature generally

[8] A focus on current carbon emissions will not capture such a long-term motive. Nevertheless, proposed SEC rules focus on disclosure of current emissions. Many firms rated highly on ESG metrics do not have scope for dramatic positive change. For example, while Travelers can decrease carbon emissions, it is very unlikely that they would depart from their business focus on insurance to branch into green energy.

[9] While engagement is not as common in the real world, there are some notable examples such as Engine No. 1, which has successfully engaged with Exxon Mobil to change its impact.

models green investment with costs and/or benefits that are not a function of the firm's current level of green. Our paper suggests that adding an elasticity term that is a function of the firm's current level of green would both more closely reflect reality and possibly lead to different conclusions. Second, our findings provide empirical support for the idea that engagement efforts directed at brown firms will be more effective than engagement efforts directed at green firms. Because brown firms have the greatest scope to become more brown or green, impact investing aimed at changing project-specific incentives for brown firms may be particularly effective. Third, while other research has argued that a divestment strategy may ineffective (e.g., Berk and van Binsbergen (2021) and Broccardo et al. (2020)), we show conditions where such a strategy can be actively counterproductive.

II. Data

To measure green and brown we focus on what investors most commonly do, or say they are trying to do.[10] Decreasing carbon emissions is arguably the most important goal of advocates of environmental investing and the most commonly reported concrete measure available for most firms, so we think this offers the best metric for what investors state they are trying to achieve. In practice, perhaps the most widespread implementation of sustainable investing is based on ratings, so we examine both environmental and ESG ratings. Finally, we look at the firms green mutual funds hold as another measure. Demonstrating a similar pattern in the simple and concrete measure of carbon emissions and the multifaceted and complex measures of ratings underscores that empirically the results generally hold regardless of what metric an investor cares about.

Data on carbon emissions comes from S&P Global Trucost. We use data on scope 1 emissions and scope 2 emissions in the paper. Scope 1 emissions are the most directly tied to the firm as they represent emissions from equipment that the firm owns. Scope 2 emissions are the indirect emissions associated with purchase of electricity, steam and heating, so they occur at a location not controlled by the firm, but are directly tied to firm actions.

We think carbon emissions are worth focusing on for a variety of reasons. When asked, investors tend to report environmental concerns as their biggest concern when making sustainable investments (Hartzmark and Sussman (2019)). Further, perhaps the most emphasis in the policy community has been given to carbon. Finally, it is relatively straightforward to measure relative to other ESG benchmarks and widely reported. Thus it seems most closely aligned with investor preferences, most closely linked to real world climate goals and perhaps the least likely to be manipulated of common ESG mea-

[10] While being agnostic as to whether it is sensible.

sures.

For ESG scores we use data provided by Refinitiv. We look at two main measures, the environmental, or E, score separately and also the aggregate measure of ESG. The distribution of scores has a non-normal bimodal distribution. Thus in the analysis we look at what percentile a given score is in a given year.

Standard accounting data we take from Compustat and price and return information is taken from CRSP.

Data on the holdings of green funds are based on the definitions from Cohen et al. (2020). We define a green fund as one that is defined by green based on any of the measures in the Cohen et al. (2020) paper. We merge this with monthly CRSP holdings on mutual funds. We look at the propensity of green funds to overweight a given stock relative to the benchmark of the value weighted market or the benchmark of funds in the dataset that are not considered to be green.

The implied cost of capital we take from Lee et al. (2021). The paper examines multiple potential measures from which we focus on the average of mechanical ICC, the average of analyst based ICC and GLS ICC which the paper argues is the best option to examine. Also, prior papers in the ESG literature (e.g. Chava (2014)) focus on the GLS measure.

Based on both ESG metrics and emissions data we split firms into green brown and neutral. We define green firms to be the top quintile of firms based on the given metric and brown firms to be the worst. Neutral is taken to be the three quintiles in the middle.

Summary statistics of our data can be found in Appendix. Appendix Figure A1 shows the distribution of the raw Refinitiv overall ESG rating as well as the rating for the environmental, social, and governance categories. As can be seen from the figure, the distributions are far from a normal distribution, with the overall, environmental, and social ratings having bimodal distributions. Therefore, we transform the raw ESG rating from Refinitiv into percentile rankings within each year.

Changes in sample composition pose a potential concern with our measurement of the annual change in a firm's ESG rating percentile. Like most other ESG ratings firms, Refinitiv's ESG ratings coverage focused on large firms in the earlier years of our sample and grew in coverage over time. If, for example, coverage of brown firms increased proportionally over time, existing firms in the sample would experience a mechanical increase in their percentile ESG rating purely due to compositional shifts in sample coverage. We develop a measure of the annual change in ratings that is robust to this concern. To measure the change in percentile ratings between years t and t+1, we restrict the sample

to firms that are present in the sample both years t and t+1. We then compute the percentile ranking of each firm in year t and t+1 and measure the change in percentiles within this restricted sample.

In Appendix Figure A2, we plot the distribution of the absolute value of the annual change in ESG ratings for the overall, environmental, social, and governance ratings. In all cases, we see that firms rarely experience an annual change in percentile rating of more than 40 percentile points. Among the three component, governance ratings exhibit the greatest annual variation and environmental ratings exhibit the least annual variation.

III. Results

A. Variability in firm impact

We begin by showing that green firms have substantially less variability in their carbon emissions and environmental and social ESG ratings compared to brown firms.

We measure the carbon emissions for each firm as its total scope 1 and scope 2 emissions divided by same-year sales. We then divide firms into five quintiles within each fiscal year, with quintile 5 representing firms with the lowest emissions. In subsequent analysis, we refer to firms in quintile 5 as "green," firms in quintile 1 as "brown," and firms in quintiles 2 through 4 as "neutral."

In Figure 1, we show that the difference in carbon emissions between brown firms and neutral or green firms is extremely large. In Panel A, without adjusting for sales, the average brown firm releases more than 1,700 times as much carbon as the average green firm. Of course, these differences in carbon emissions across firms could be due to differences in firm size; it would be natural for larger firms to emit more carbon. Therefore, we use emissions scaled by same-year firm sales as our baseline measure of carbon emissions. In Panel B, we show that, even after scaling by sales, brown firms release 14 times as much carbon as firms in quintile 2, and 261 times as much carbon per unit of sales as green firms in quintile 5.

The dramatic differences in carbon emissions across the five quintiles shown in Figure 1 indicates that any analysis focusing on firm's annual *percentage* change in emissions is unlikely to be informative. Consider a green firm. Even if it doubled or halved its emissions in a single year, its change in behavior would not have a large environmental impact because its baseline level of emissions is several orders of magnitude smaller than the emissions of brown firms. In contrast, if the average brown firm doubled its emissions, the real carbon impact would be equivalent to the average green firm increasing its emission by 26,400%.

Instead of focusing on percentage changes in firm emissions, which suffers from the problem described above, we focus on the annual absolute change in emissions (always scaled by same-year sales). In Figure 2 with detailed results in Table 1, we regress the annual absolute value of the change in emissions on indicators for the firm's emissions quintile, calculated in the previous year. In this and future specifications, brown firms in quintile one represent the omitted reference category. We find a robust pattern in which brown firms exhibit substantially greater variability in their emissions. In the left panel, we present a regression with only fiscal year fixed effects to assess raw differences between green and brown firms. We find that the annual change in absolute emissions by brown firms exceeds that of green firms by approximately 180 tons per dollar of sales. Recall that green firms have a level of emissions intensity of 5, which means the average *variability* in brown firms is about 35 times the average emissions *level* of green firms. Variability in emissions declines monotonically from quintile 1 to 5, but the largest gap lies between firms in quintile 1 (brown) and quintile 2; the change in absolute emissions by brown firms exceeds that of firms in quintile 2 by 163 tons.

In column 2, we find similar patterns after weighting observations by firm market value as a fraction CRSP market value in each year. This shows that the gap in variability of emissions between green and brown firms is not driven by small outlier firms.

In column 3, we test whether the variability gap between brown and green firms holds within industry. We sort firms into quintiles according to their previous year emissions rank within within each SIC2 industry and modify the regression to control for SIC2 industry interacted with fiscal year fixed effects. We continue to find a similar pattern in which brown firms within an industry year exhibit significantly greater variability in emissions than green firms. These within-industry results have the important implication that impact investment that is "adjusted for industry" will nevertheless target green firms within each industry that have substantially lower variability in emissions than brown firms within the same industry.

In supplementary results shown in the Appendix, we examine annual absolute changes in emissions separately for scope 1 (direct emissions from the company's owned or controlled sources) and scope 2 (indirect emissions from purchased energy) emissions. We find significant variability gaps between green and brown firms for both types of emissions. The gap for scope 1 emissions is much larger consistent with the fact that the level of scope 1 emissions is much larger than the level scope 2 emissions. We also find similar patterns using the absolute level of emissions, without scaling by firm sales.

So far, we have shown a large difference in the variability of carbon emissions across green and brown firms. Focusing on carbon emissions has the benefit of using a standardized measure of environmental impact that factors into the decision-making of most impact investment funds and is directly related to the aggregate risk of global warming. However, one can also look at ESG ratings themselves. ESG ratings are likely to be very noisy proxies for the true environmental, social, and governance impact of firms (Berg et al., 2019). However, they have the benefit of capturing a large number of avenues through which firm activity could impact society. In addition, one might be concerned that carbon emissions only measure the extent to which firms can harm the environment. ESG environmental ratings are two-sided; they should also capture the positive impact of firms on society, such as through the development of green energy or waste-saving technology.

In Figure 3, we examine how the absolute change in the firm ESG percentile (overall, environmental, social, or governance) varies with the firm's ESG quintile of the same rating measured in the previous year. We again refer to firms in quintile 1, 2-4, and 5 as brown, neutral, and green, respectively. We find that green firms experience significantly greater absolute annual changes in environmental, social, and overall ESG ratings compared to brown firms. The largest gap occurs for the environmental rating: green firms have a 5 percentage point greater annual absolute change in ratings than brown firms. The one exception is the governance ratings: green and brown firms are associated with equal expected annual absolute changes in governance percentiles.

Compared to our earlier analysis of carbon emissions in Figure 2, we do not observe a clear monotonic decline in the variability of environmental and social ratings decline as we progress from from quintile 1 to 5. For example, neutral firms in terms of social ratings appear to experience greater absolute changes in future social ratings than green firms. Nevertheless, brown firms have significantly greater variability than green firms, indicating that impact investors who wish to encourage firms to improve their environmental and social impact would be better served by focusing on brown rather than green firms.

In panels B and C of Figure 3, we find similar patterns within SIC2 or Refinitiv industry classifications. Specifically, we sort firms into quintiles according to their previous year percentile ranking of each type of ESG score within each SIC2 industry and modify the regression to control for SIC2 industry interacted with fiscal year fixed effects. We continue to find a similar pattern in which brown firms within an industry-year exhibit significantly greater variability in overall, environmental, and social ratings than green firms. These within-industry results gain imply that impact investment that is "ad-

justed for industry" (whether by SIC2 or the broader Refinitiv industry categories) will nevertheless target green firms within each industry that have substantially lower variability in environmental and social impact than brown firms within the same industry.

B. Elasticity of firm impact

Conceptually, an impact investor should want to know how much a firm's impact will change for a given incentive level. While the variability we explore so far is suggestive that brown firms are much more sensitive then green to such an incentive, variability likely includes not only shocks to firm financing. For example it also likely contains changes exogenous to such concerns and also many firms that do not experience any meaningful shocks. Thus, in this section, we directly examine the elasticity of the firm's environmental impact with respect to shocks to its ease of financing.

An increase in the firm's cost of capital should cause the firm to prefer investment projects that deliver front-loaded cash flows over those with back-loaded cash flows. In particular, a firm that is facing a liquidity crisis or at high risk of bankruptcy faces a high discount rate, such that the firm will favor investments offering short term gains (Eisfeldt and Rampini, 2007). We hypothesize that on average brown firms can choose between a high-pollution dark-brown project that delivers front-loaded cash flows, and a low-pollution light-brown project that delivers back-loaded cash flows. Indeed, Gilje et al. (2020) show that highly levered firms in the oil and gas industry pull forward investment by drilling existing oil wells at the expense of long-run project returns. Meanwhile, the light-brown project likely requires R&D and development of greener production methods, leading to a delay in cash flows. We further suppose that green firms operate in a line of business where pollution is effectively equal to zero regardless of which investment project it chooses to pursue, short term or long term. In this simple illustrative model, brown firms have a greater elasticity of their environmental impact with respect to changes in their cost of capital.

To the extent that impact investing can change firm's financing constraints or alter their cost of capital, we test whether green firms have a greater elasticity with respect to changes in their ease of financing.

In Table 2, we examine how firms change their emissions behavior when experiencing the threat of financial distress. We measure financial distress in two ways. First, we examine an indicator for low interest coverage which is a proxy for whether the firm is likely to face challenges in making interest payments on its existing debt. The indicator is equal to one if firms have positive interest payments

and negative earnings, or the firm has an earnings to interest ratio that is in the bottom decile within our sample. Second, we measure each firm's Altman Z-score (a commonly-used predictor of the firm's probability of bankruptcy), and set the low Z-score indicator equal to one if the firm has a Z-score in the bottom decile within our sample.

Table 2 columns 1 and 2 shows that, when brown firms experience low interest coverage in the previous year, brown firms increase their carbon intensity by 20 to 30 tons. In contrast, when green or neutral firms experience low interest coverage, they actually reduce their emissions intensity by approximately 5 tons. A p-value test of equality shows that we can reject the null that brown and green firms have equal changes in emissions after experiencing low interest coverage. Columns 3 and 4 show that, after experiencing a low Altman Z-score in the previous year, brown firms increase emissions intensity by approximately 40 tons while neutral firms slightly reduce emissions intensity and green firms make no significant change. The p-value test of equality of coefficients can reject equality of behavior for green and brown firms with a high degree of statistical confidence. These results are consistent with the view that brown firms shift toward the high-pollution dark-brown investment after experiencing financial distress, while green firms do not have the option to pursue a high-pollution project, and instead slightly cut back on production in general, leading to a small decline in carbon intensity.

Next we examine the relation between emission intensity and firm performance. A positive performance shock is likely to ease the firm's access to financing. Likewise, a negative performance shock should increase the firm's shadow cost of capital. If brown firms have greater scope to change their environmental impact than green firms in response to changes in the ease of financing, we expect that brown firms will reduce their emissions more following stronger performance.

One limitation of simply looking at the relation between firm emissions and firm performance is that any measured correlation could be driven by reverse causality (if becoming more green causes the firm to perform differently), or by omitted variables bias (e.g., if the arrival a talented new green-oriented CEO causes both a shift in green strategy and firm performance). To better estimate the causal impact of firm performance on firm emissions, we examine the relation between firm emissions and the firm's industry average performance, calculated excluding the focal firm. The intuition is that industry performance shocks strongly impact firm-level performance, but individual firm choices should not have a strong impact on the industry average performance calculated excluding the focal firm.

In Tables 3 and 4, we find that brown firms are significantly more elastic to shocks to firm performance than green firms across a variety of specifications. The pattern holds regardless if we examine real performance (measured as return on assets) or financial performance (measured using equity returns). The pattern remains similar after replacing firm-level performance with the value-weighted industry level performance calculated excluding the focal firm. The pattern also holds if we replace a continuous measure of performance with an indicator for performance being in the bottom 10% of the sample. This specification captures the possibility that very bad performance may have an especially strong negative impact on the firm's ease of financing.

In all cases, brown firms pollute less following positive performance shocks and pollute more following negative performance shocks. In contrast, green firms have smaller and less statistically significant elasticities with respect to performance. In some specifications, green firms even exhibit the opposite relation; they increase emissions intensity following positive performance shocks. These empirical patterns are consistent with the notion that impact investment that rewards green firms by lowering their cost of capital and punishes brown firms by raising their cost of capital would have the counterproductive effect of increasing global emissions intensity. Brown firms would respond to their punishment by becoming more brown while green firms would not become meaningfully more green.

So far, we have explored the relation between a firm's environmental impact and various proxies for the firm's ease of access to capital, such as bankruptcy risk and firm and industry performance. We can also attempt to directly measure the implied cost of capital (ICC) for each firm-year. Before proceeding, we stress that these tests should be viewed as a complement rather than as a replacement for our previous results because direct estimates of a firm's cost of capital have been shown to be very noisy. Lack of unique solutions along with small differences in the timing of measurement and assumptions regarding the path of future cash flows can lead to large differences in estimates of the ICC (for more details, see Lee et al. (2021)).

The ICC is the internal rate of return that equates the firm's market value to the present value of its expected future cash flows, based on a valuation model that can vary depending on the researcher's chosen set of assumptions. Thus, the ICC represents the expected return to investors of the firm and the firm's cost of raising capital from the same investors. We use estimates of firm ICCs generously shared by Lee et al. (2021). As our baseline, we follow the recommendations of Lee et al. (2021) and use ICCs estimated following the Gebhardt et al. (2001) method where the inputs for future cash flows

consist of mechanical forecasts from the cross-sectional forecast model of Hou et al. (2012). In additional analysis presented in the Appendix, we find qualitatively similar results using a composite ICC that is the equal-weighted average for four ICC variants. We also find similar, albeit less statistically significant results, when using a smaller sample of analyst-forecasts of future earnings and earnings grown instead of mechanical forecasts.

In Table 5, we regress the firm's change in emissions intensity on the firm's change in implied cost of capital over the previous year, interacted with indicators for whether the firm is brown, neutral, or green. We also control for the direct effects of the firm type indicators (brown, green, or neutral), fiscal year fixed effects, and in some specifications, we also control for SIC2 industry fixed effects. In addition to the equal-weighted regressions in Panel A, we also present value-weighted regressions where each observation is weighted the firm's market capitalization as a fraction of total CRSP market size in the same year. Value-weighted regressions ensure that our results are not driven by possibly anomalous ICC estimates for small firms.

We find that brown firms have a high significant elasticity with respect to their implied cost of capital. This is true both using equal-weighted regressions in Panel A and value-weighted regressions in Panel B. These results imply that brown firms pollute more following an increase to their implied cost of capital and pollute less following a decline in their cost of capital. In contrast, neutral and brown firms experience smaller, less significant, and inconsistently signed changes in their emission intensity following changes to their cost of capital.

Similar to our earlier analysis of firm performance shocks, a limitation of looking at the relation between firm emissions and firm ICC is that any measured correlation could be driven by reverse causality (if becoming more green causes the firm to have a lower cost of capital), or by omitted variables bias (e.g., if the arrival a talented new green-oriented CEO causes both a shift in green strategy and cost of capital). To better estimate the causal impact of firm cost of capital on firm emissions, we examine the relation between firm emissions and the firm's industry value-weighted average ICC, calculated excluding the focal firm. The intuition is that industry cost of capital shocks strongly impact firm-level cost of capital, but individual firm choices should not have a strong impact on the industry average cost of capital calculated excluding the focal firm.

We also find a similar large elasticity of brown firm emissions intensity with respect to industry ICC, and an smaller and insignificant relation for neutral and green firms. In supplementary results presented in Tables 6 and 7, we find that these patterns are robust to using the equal-weighted average

for four ICC variants or analyst-forecasts of future earnings and earnings grown instead of mechanical forecasts.

C. Holdings by green funds

In this section, we confirm that our measures of whether a firm is considered green or brown aligns with the views of impact investment funds active in US markets in the past two decades. Using data generously shared by Cohen et al. (2020), we classify funds as green if the fund name contains "ESG" or "Green" or if the fund is classified as an impact investment by either the Forum for Sustainable and Responsible Investment (USSIF) or Charles Schwab.

To assess whether a firm is favored by green funds, we compare the holdings of three portfolios: the aggregated holdings of all green funds within a year, the aggregated holding holding of all non-green funds within a year, and the holdings of a hypothetical market portfolio that holds all firms in CRSP in proportion to their market value as of the beginning of the year. We consider a firm as favored by green funds if (1) it is overweighted in the aggregate green fund portfolio relative to the market portfolio, or (2) if it is overweighted in the aggregate green fund portfolio relative to the non-green fund portfolio.

In Table 8, we regress indicators for whether the firm is overweighted by green investment funds on the firm's same year ESG rating and emissions intensity. We find that higher ESG ratings and lower emissions intensity are strong predictors of whether the firm is overweighted by green investment funds. These results imply that impact investment funds are more likely to hold firms that we classify as green according to their carbon emissions intensity or ESG ratings.

In Table 9, we show that firms that are overweighted by green investment funds also exhibit lower variability in the environmental and social ESG ratings as well as in their emissions intensity. These results again support the view that impact investment has so far targeted the wrong set of firms. Impact investment funds tend to hold green firms with little scope to change their environmental and social impact. At the same time, green investment funds divest from brown firms, which have the greatest scope to change their environmental and social impact.

IV. Conclusion

It is unclear whether the growth of green investing has rewarded green firms by lowering their cost of capital and punished brown firms by raising their cost of capital. Our paper suggests that the best case scenario for aggregate green outcomes is the one where green investing has not yet successfully shifted

firm's cost of capital (e.g. Lindsey et al. (2021); Berk and van Binsbergen (2021)). To the extent that impact investing succeeds in changing firm's cost of capital, such changes have the counterproductive effect of lowering the overall green impact of firms on society. This occurs because firms that are already green have little scope to improve while firms that are brown produce social externalities that are highly elastic to their cost of capital.

Our paper shows that if investors can incentivize firms to achieve certain green investing goals, it is typically the brown firms that are most capable of achieving them. This is due to the elasticity of a green outcome with respect to these goals. Green firms often have little scope to improve or get worse, so the level of incentive does not matter much. On the other hand, brown firms are quite elastic. When punished they can pollute at much higher levels and when incentivized they can meaningfully decrease this pollution.

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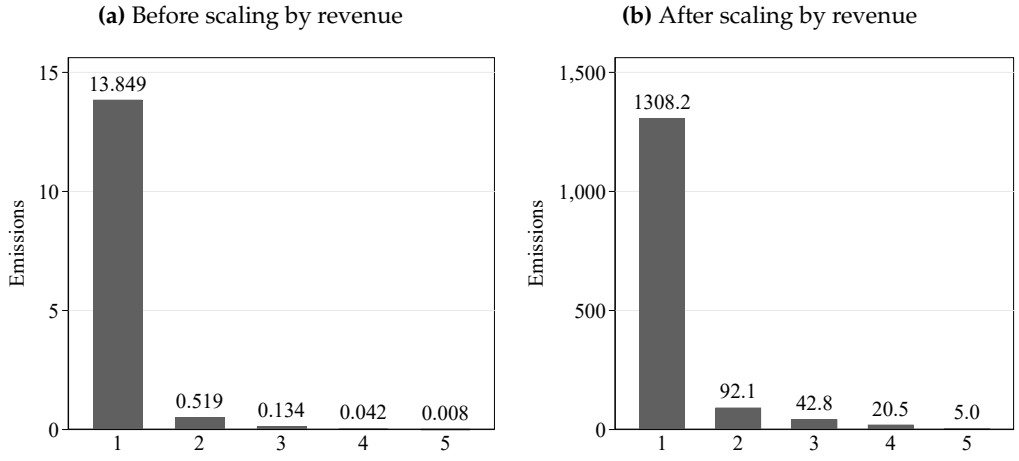
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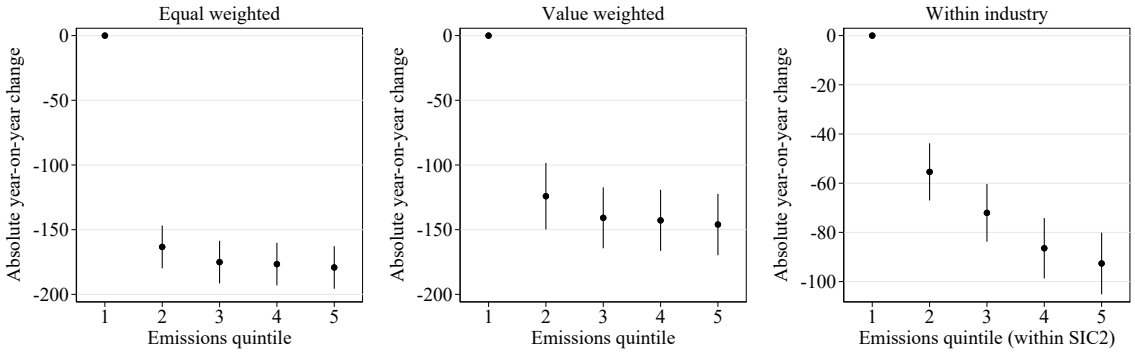
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Figure 1: Average carbon emission in each quintile



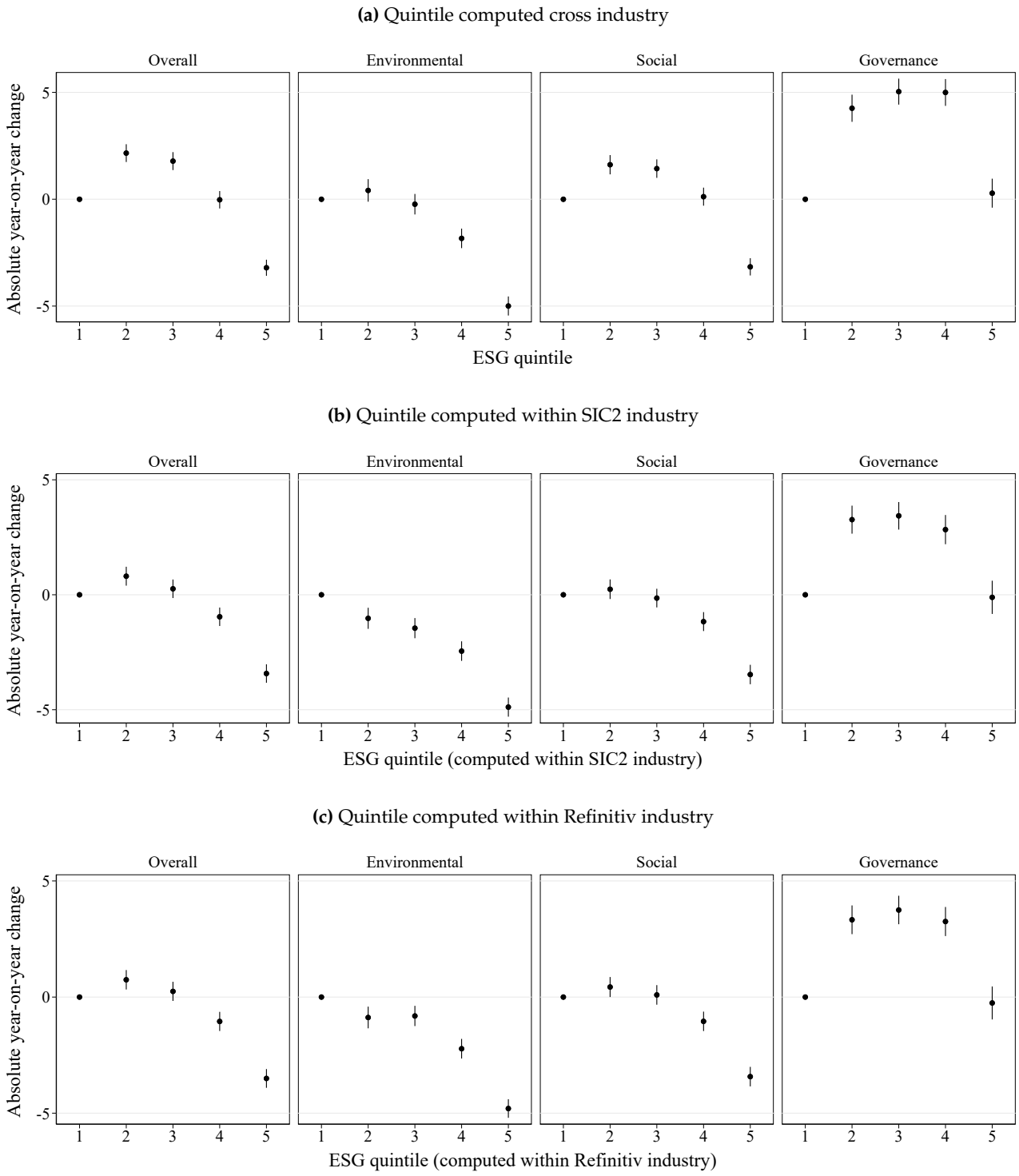
Note: This figure plots the average emissions of scope 1 and scope 2 green house gases by firms, sorted into quintiles. In Panel (a), emissions are measured as million tons of CO_2 equivalents. In Panel (b), emissions are measured as tons of CO_2 equivalents emitted per million dollars of revenue.

Figure 2: Variation of emissions by quintile



Note: This figure plots time variation of emissions by quintile. The dependent variable is absolute year-on-year change of scope 1 and scope 2 greenhouse gases emissions, after scaling by current year revenue. We regress the dependent variable on quintile dummies of scope 1 and scope 2 carbon emissions (scaled by revenue), estimated coefficients are presented along with 95% confidence intervals. Standard errors are clustered at the firm-level. In the regressions of the left and middle panels, quintiles are computed within each fiscal year, while in the regression of the right panel, quintiles are computed within each fiscal year separately for each SIC2 industry. In the regressions of left and middle panels, we control for year fixed-effects, while in the regression of the right panel, we control for year$\times$industry fixed-effects. In the regression of the middle panel, we use the ratios of firms' market values over the total market value within each year as weights.

Figure 3: Variation of ESG scores by quintile



Note: This figure plots time variation of ESG scores by quintile. Within each panel, we regress absolute year-on-year score change on quintile dummies of the corresponding score, estimated coefficients are presented along with 95% confidence intervals. Standard errors are clustered at the firm-level. In Panel (a), quintiles are computed within each fiscal year, and the regression controls for year fixed-effects. In Panel (b) and (c), quintiles are computed within each fiscal year separately for each industry, according to the SIC2 industry classification and the Refinitiv industry classification respectively. Regressions control for year$\times$industry fixed-effects. Observe that for all ESG scores, highest quintiles exhibit the least variation, and variation generally decreases in quintile.

Table 1: Variation of emissions intensity by quintile

	Absolute changes in emissions		
	(1)	(2)	(3)
Quintile 2	-163.3***	-124.1***	-55.39***
	(8.448)	(13.11)	(5.934)
Quintile 3	-175.1***	-140.8***	-72.06***
	(8.409)	(12.01)	(5.988)
Quintile 4	-176.6***	-142.8***	-86.44***
	(8.393)	(12.04)	(6.258)
Quintile 5	-179.2***	-146.0***	-92.64***
	(8.390)	(12.09)	(6.401)
Year FE	Yes	Yes	No
Year $\times$ SIC2 FE	No	No	Yes
Value-weighted	No	Yes	No
Within SIC2 industry	No	No	Yes
N	24345	24330	24280
R^2	0.262	0.259	0.372

Note: This table shows the time variations of greenhouse gases emissions by quintile. The dependent variable is annual absolute changes in scope 1 and scope 2 greenhouse gases emissions, measured in tons of CO_2 equivalents emitted per million dollars of revenue. We regress the dependent variable on quintile dummies of scope 1 and scope 2 greenhouse gases emissions (scaled by revenue). In the regressions of columns (1) and (2), quintiles are computed within each fiscal year, while in the regression of column (3), quintiles are computed within each fiscal year separately for each SIC2 industry. Columns (1) and (2) include year fixed effects, and column (3) includes year $\times$ SIC2 industry fixed effects. In column (2) regressions are value-weighted where each observation is weighted by the firm's market capitalization as a fraction of total CRSP market size in the same year. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Standard errors are in parentheses and are clustered at the firm-level.

Table 2: Emissions and bankruptcy risk

	Changes in emissions			
	(1)	(2)	(3)	(4)
Brown × Low interest coverage	29.47*	24.40		
	(15.07)	(15.29)		
Neutral × Low interest coverage	-5.533***	-6.107***		
	(1.047)	(1.298)		
Green × Low interest coverage	-4.167***	-4.117***		
	(1.489)	(1.414)		
Brown × Low Z-score			43.68***	37.30***
			(13.77)	(14.46)
Neutral × Low Z-score			-4.431***	-5.392***
			(1.077)	(1.389)
Green × Low Z-score			1.523	0.443
			(2.791)	(2.606)
p-value: Brown × X = Green × X	0.026	0.063	0.003	0.012
Type FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
SIC2 FE	No	Yes	No	Yes
N	19747	19747	19069	19069
R^2	0.0270	0.0402	0.0283	0.0424

Note: This table shows changes in firms' emissions following financial distress. The dependent variable is the annual change in scope 1 and scope 2 greenhouse gases emissions, measured in tons of CO_2 equivalents emitted per million dollars of revenue. We regress the dependent variable on the interactions between indicators for financial distress in the previous year and indicators for whether the firm is brown, neutral, or green. In particular, the low interest coverage indicator is equal to one if firms have positive interest payments and negative earnings, or the firm has an earnings to interest ratio that is in the bottom decile within our sample. The low Z-score indicator is equal to one if the firm has an Altman Z-score in the bottom decile within our sample. All columns include year fixed effects and indicators for whether the firm is brown, neutral, or green, and columns (2) and (4) further include SIC2 industry fixed effects. Below each regression, we report the p-value obtained from testing whether coefficients on the interaction with brown firms and the interaction with green firms are equal. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Standard errors are in parentheses and are clustered at the firm-level.

Table 3: Emissions and real performance

	Changes in emissions			
	(1)	(2)	(3)	(4)
Brown × ROA	-61.97*			
	(32.54)			
Neutral × ROA	8.920***			
	(2.248)			
Green × ROA	6.352*			
	(3.279)			
Brown × Low ROA		44.22***		
		(16.08)		
Neutral × Low ROA		-5.805***		
		(1.175)		
Green × Low ROA		-4.003***		
		(1.346)		
Brown × Industry ROA			-220.0***	
			(72.36)	
Neutral × Industry ROA			-122.1***	
			(23.55)	
Green × Industry ROA			-124.3***	
			(20.90)	
Brown × Low industry ROA				48.20*
				(25.09)
Neutral × Low industry ROA				2.941
				(3.410)
Green × Low industry ROA				4.985***
				(1.388)
p-value: Brown × X = Green × X	0.036	0.003	0.168	0.084
Type FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
SIC2 FE	Yes	Yes	Yes	Yes
N	22569	22569	24292	24292
R^2	0.0401	0.0405	0.0398	0.0391

Note: This table shows the elasticity of firms' emissions in response to shocks to real performance. The dependent variable is the annual change in scope 1 and scope 2 greenhouse gases emissions, measured in tons of CO_2 equivalents emitted per million dollars of revenue. We regress the dependent variable on the interactions between firm- or industry-level ROA in the previous year and indicators for whether the firm is brown, neutral, or green. Industry-level ROA is calculated as the average ROA within the corresponding SIC2 industry excluding the focal firm, weighted by the firm's market capitalization as a fraction of total CRSP market size in the same year. Low ROA (low industry ROA) indicator is equal to one if the firm has an ROA (industry ROA) in the bottom decile within our sample. All columns include year fixed effects, SIC2 industry fixed effects, and indicators for whether the firm is brown, neutral, or green. Below each regression, we report the p-value obtained from testing whether coefficients on the interaction with brown firms and the interaction with green firms are equal. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Standard errors are in parentheses and are clustered at the firm-level.

Table 4: Emissions and financial performance

	Changes in emissions			
	(1)	(2)	(3)	(4)
Brown × Annual return	-49.46***			
	(8.120)			
Neutral × Annual return	1.267			
	(0.941)			
Green × Annual return	1.258			
	(1.095)			
Brown × Low annual return		61.30***		
		(10.71)		
Neutral × Low annual return		-5.141***		
		(1.394)		
Green × Low annual return		-4.568***		
		(1.772)		
Brown × Industry annual return			-75.03***	
			(17.09)	
Neutral × Industry annual return			-1.503	
			(5.321)	
Green × Industry annual return			0.231	
			(5.769)	
Brown × Low industry annual return				43.11***
				(11.42)
Neutral × Low industry annual return				-1.476
				(3.433)
Green × Low industry annual return				-1.443
				(3.341)
p-value: Brown × X = Green × X	0.000	0.000	0.000	0.000
Type FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
SIC2 FE	Yes	Yes	Yes	Yes
N	23818	23818	24299	24299
R^2	0.0492	0.0453	0.0434	0.0419

Note: This table shows the elasticity of firms' emissions in response to shocks to financial performance. The dependent variable is the annual change in scope 1 and scope 2 greenhouse gases emissions, measured in tons of CO_2 equivalents emitted per million dollars of revenue. We regress the dependent variable on the interactions between firm- or industry-level annual return in the previous year and indicators for whether the firm is brown, neutral, or green. Industry-level annual return is calculated as the average annual return within the corresponding SIC2 industry excluding the focal firm, weighted by the firm's market capitalization as a fraction of total CRSP market size in the same year. Low annual return (low industry annual return) indicator is equal to one if the firm has an annual return (industry annual return) in the bottom decile within our sample. All columns include year fixed effects, SIC2 industry fixed effects, and indicators for whether the firm is brown, neutral, or green. Below each regression, we report the p-value obtained from testing whether coefficients on the interaction with brown firms and the interaction with green firms are equal. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Standard errors are in parentheses and are clustered at the firm-level.

Table 5: Emissions and changes in implied cost of capital

Panel A: Equal weighted

	Changes in emissions			
	(1)	(2)	(3)	(4)
Brown × ICC	712.6***	675.9***		
	(140.2)	(139.9)		
Neutral × ICC	-5.998	-14.34		
	(18.97)	(18.99)		
Green × ICC	-14.45	-18.34		
	(16.57)	(16.72)		
Brown × Industry ICC			460.2*	349.0
			(246.1)	(245.1)
Neutral × Industry ICC			17.23	-22.87
			(65.12)	(65.49)
Green × Industry ICC			-15.17	-38.16
			(58.85)	(59.09)
p-value: Brown × X = Green × X	0.000	0.000	0.054	0.116
Type FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
SIC2 FE	No	Yes	No	Yes
N	15978	15978	24247	24246
R^2	0.0346	0.0521	0.0254	0.0387

Panel B: Value weighted

	Changes in emissions			
	(1)	(2)	(3)	(4)
Brown × ICC	1315.8***	1211.2***		
	(353.3)	(319.0)		
Neutral × ICC	-33.06	-37.38		
	(40.06)	(39.41)		
Green × ICC	11.41	5.057		
	(31.66)	(29.64)		
Brown × Industry ICC			575.6**	388.9*
			(242.0)	(228.9)
Neutral × Industry ICC			96.20	44.73
			(80.37)	(83.50)
Green × Industry ICC			72.07	39.75
			(56.28)	(54.58)
p-value: Brown × X = Green × X	0.000	0.000	0.038	0.137
Type FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
SIC2 FE	No	Yes	No	Yes
N	15976	15976	24234	24233
R^2	0.0615	0.0994	0.0530	0.0767

Note: This table shows the elasticity of firms' emissions in response to shocks to the implied cost of capital (ICC). We use ICCs estimated following the Gebhardt, Lee, and Swanminathan (2001) method. The dependent variable is the annual change in scope 1 and scope 2 greenhouse gases emissions, measured in tons of CO_2 equivalents emitted per million dollars of revenue. In each panel, we regress the dependent variable on the interactions between firm- or industry-level ICC in the previous year and indicators for whether the firm is brown, neutral, or green. In panel A, regressions are equal-weighted, and in panel B, regressions are value-weighted where each observation is weighted by the firm's market capitalization as a fraction of total CRSP market size in the same year. Industry-level ICC is calculated as the average ICC within the corresponding SIC2 industry excluding the focal firm, weighted by the firm's market capitalization as a fraction of total CRSP market size in the same year. All columns include year fixed effects and indicators for whether the firm is brown, neutral, or green, and columns (2) and (4) further include SIC2 industry fixed effects. Below each regression, we report the p-value obtained from testing whether coefficients on the interaction with brown firms and the interaction with green firms are equal. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Standard errors are in parentheses and are clustered at the firm-level.

Table 6: Emissions and changes in implied cost of capital

	Changes in emissions			
	(1)	(2)	(3)	(4)
Brown × ICC	432.3***	412.7***		
	(106.3)	(106.4)		
Neutral × ICC	-8.104	-10.60		
	(18.22)	(18.09)		
Green × ICC	-18.14	-22.82		
	(16.31)	(16.58)		
Brown × Industry ICC			454.9***	433.6***
			(121.2)	(121.9)
Neutral × Industry ICC			27.13	23.02
			(25.14)	(25.77)
Green × Industry ICC			53.59**	49.22**
			(23.67)	(24.14)
p-value: Brown × X = Green × X	0.000	0.000	0.001	0.002
Type FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
SIC2 FE	No	Yes	No	Yes
N	6802	6801	23308	23308
R^2	0.0380	0.0638	0.0255	0.0392

Note: This table shows the elasticity of firms' emissions in response to shocks to the implied cost of capital (ICC). We use a composite ICC that is the equal-weighted average of four ICC invariants. The dependent variable is the annual change in scope 1 and scope 2 greenhouse gases emissions, measured in tons of CO_2 equivalents emitted per million dollars of revenue. We regress the dependent variable on the interactions between firm- or industry-level ICC in the previous year and indicators for whether the firm is brown, neutral, or green. Industry-level ICC is calculated as the average ICC within the corresponding SIC2 industry excluding the focal firm, weighted by the firm's market capitalization as a fraction of total CRSP market size in the same year. All columns include year fixed effects and indicators for whether the firm is brown, neutral, or green, and columns (2) and (4) further include SIC2 industry fixed effects. Below each regression, we report the p-value obtained from testing whether coefficients on the interaction with brown firms and the interaction with green firms are equal. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Standard errors are in parentheses and are clustered at the firm-level.

Table 7: Emissions and changes in implied cost of capital

	Changes in emissions			
	(1)	(2)	(3)	(4)
Brown × ICC	434.7*	387.7		
	(249.6)	(239.4)		
Neutral × ICC	-36.46	-41.61		
	(31.99)	(31.46)		
Green × ICC	-40.53	-37.02		
	(39.68)	(39.95)		
Brown × Industry ICC			61.33	-106.8
			(225.0)	(224.0)
Neutral × Industry ICC			-42.44	-76.85
			(55.47)	(57.55)
Green × Industry ICC			35.68	7.462
			(70.17)	(70.89)
p-value: Brown × X = Green × X	0.056	0.077	0.915	0.636
Type FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
SIC2 FE	No	Yes	No	Yes
N	12683	12682	24191	24191
R^2	0.0319	0.0524	0.0245	0.0382

Note: This table shows the elasticity of firms' emissions in response to shocks to the implied cost of capital (ICC). ICC is measured as analyst-forecasts of future earnings and earnings growth. The dependent variable is the annual change in scope 1 and scope 2 greenhouse gases emissions, measured in tons of CO_2 equivalents emitted per million dollars of revenue. We regress the dependent variable on the interactions between firm- or industry-level ICC in the previous year and indicators for whether the firm is brown, neutral, or green. Industry-level ICC is calculated as the average ICC within the corresponding SIC2 industry excluding the focal firm, weighted by the firm's market capitalization as a fraction of total CRSP market size in the same year. All columns include year fixed effects and indicators for whether the firm is brown, neutral, or green, and columns (2) and (4) further include SIC2 industry fixed effects. Below each regression, we report the p-value obtained from testing whether coefficients on the interaction with brown firms and the interaction with green firms are equal. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Standard errors are in parentheses and are clustered at the firm-level.

Table 8: Predictability of ESG and emissions on holdings by green funds

	$Overweight_{GF>mkt}$		$Overweight_{GF>NGF}$	
	(1)	(2)	(3)	(4)
ESG rating	0.00240***	0.00216***	0.00284***	0.00347***
	(0.000142)	(0.000396)	(0.000172)	(0.000632)
Emissions	-0.00240***	-0.00350***	-0.00322***	-0.00569***
	(0.000554)	(0.00119)	(0.000642)	(0.00134)
Year FE	Yes	Yes	Yes	Yes
Value-weighted	No	Yes	No	Yes
N	20108	20099	15566	15564
R^2	0.0629	0.0842	0.0592	0.0474

Note: This table shows the predictability of ESG and emissions on holdings by green funds. We regress indicators for whether the firm is overweighted by green funds on the firm's same year ESG rating and emissions intensity. $Overweight_{GF>mkt}$ ($Overweight_{GF>NGF}$) indicator is equal to one if the firm is overweighted in the aggregate green fund portfolio relative to the market portfolio (the non-green funds portfolio). ESG rating represents the percentile of the overall ESG score, and emissions are measured in tons of CO_2 equivalents emitted per million dollars of revenue. All columns include year fixed effects. In columns (2) and (4), regressions are value-weighted where each observation is weighted by the firm's market capitalization as a fraction of total CRSP market size in the same year. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Standard errors are in parentheses and are clustered at the firm-level.

Table 9: Correlation between the variability of ESG and emissions and green funds holdings

Panel A: Equal weighted

	Absolute change in ESG ratings				Absolute change in emissions
	Overall	Environmental	Social	Governance	
	(1)	(2)	(3)	(4)	(5)
$Overweight_{GF>mkt}$	-0.512***	-0.455**	-0.322*	0.323	-12.46***
	(0.168)	(0.182)	(0.173)	(0.268)	(3.259)
Year FE	Yes	Yes	Yes	Yes	Yes
N	23264	22553	23264	23264	24345
R^2	0.0864	0.0706	0.0966	0.0739	0.00796

Panel B: Value weighted

	Absolute change in ESG ratings				Absolute change in emissions
	Overall	Environmental	Social	Governance	
	(1)	(2)	(3)	(4)	(5)
$Overweight_{GF>mkt}$	-0.595*	-1.045***	-0.185	0.849	-15.35***
	(0.304)	(0.265)	(0.424)	(0.571)	(3.922)
Year FE	Yes	Yes	Yes	Yes	Yes
N	23260	22550	23260	23260	24330
R^2	0.0928	0.105	0.0852	0.129	0.0113

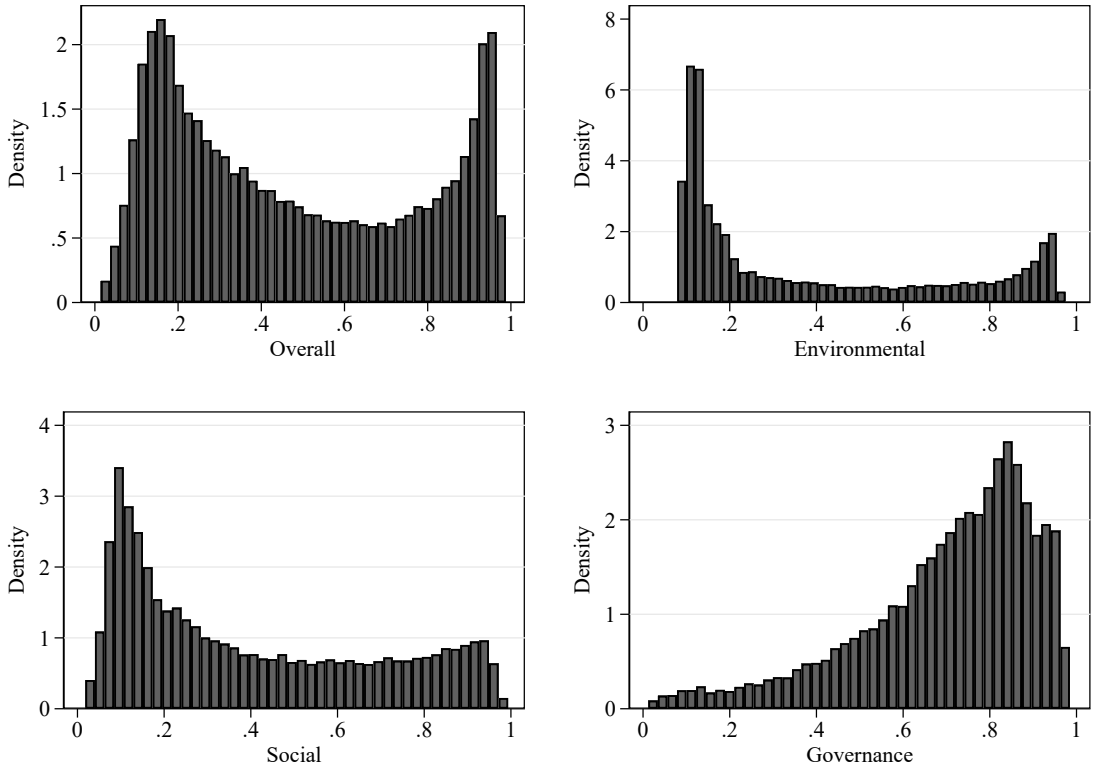
Note: This table shows the correlation between the variability of ESG and emissions and green funds holdings. In each panel, we regress absolute change in the firm ESG percentile (overall, environmental, social, or governance) and emissions on indicators for whether the firm is overweighted by green funds. $Overweight_{GF>mkt}$ indicator is equal to one if the firm is overweighted in the aggregate green fund portfolio relative to the market portfolio. Emissions are measured in tons of CO_2 equivalents emitted per million dollars of revenue. In panel A, regressions are equal-weighted, and in panel B, regressions are value-weighted where each observation is weighted by the firm's market capitalization as a fraction of total CRSP market size in the same year. All columns include year fixed effects. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Standard errors are in parentheses and are clustered at the firm-level.

Online Appendix for

Counterproductive Impact Investing

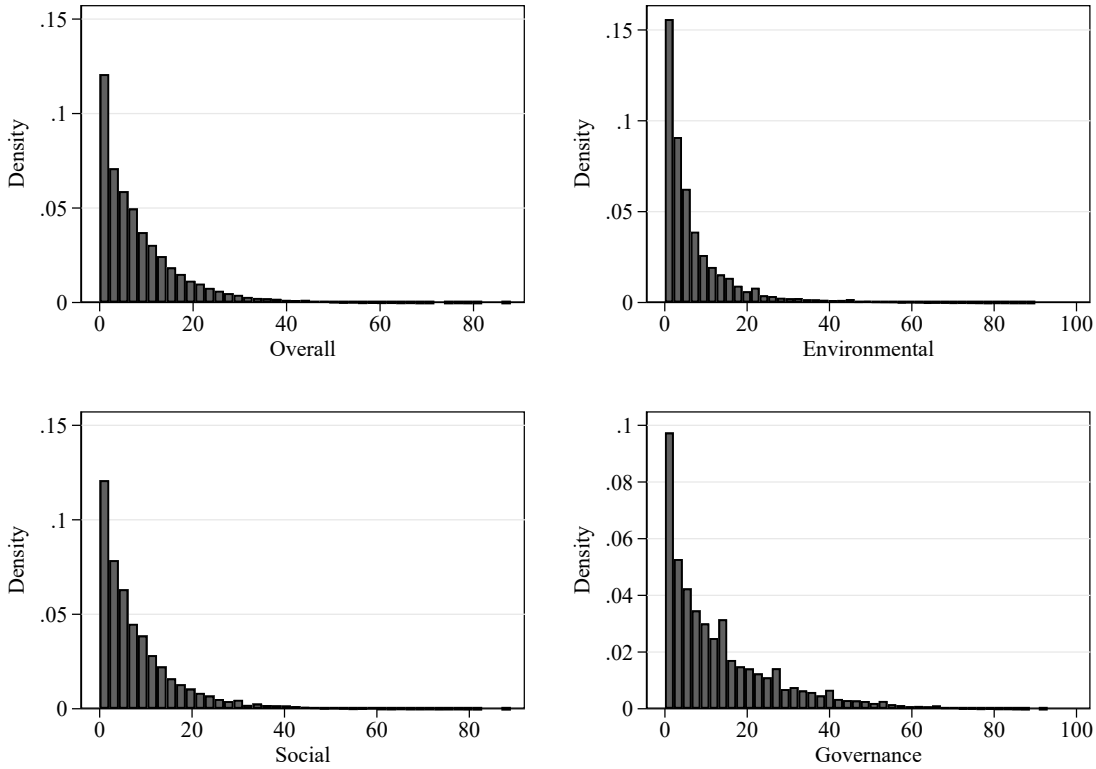
Samuel M. Hartzmark Kelly Shue

Figure A1: Distributions of ESG scores



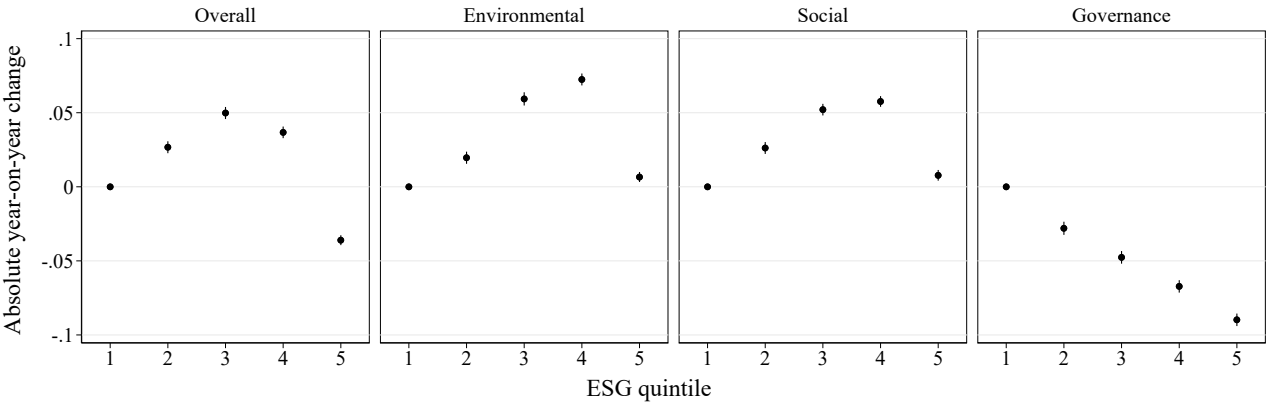
Note: This figure plots distributions of ESG scores. Panel A shows the distribution of overall ESG score and panel B to D show distributions of environmental, social, and governance scores respectively. The sample covers all US listed firms with these scores available. The figures pool data across different years from 2002 to 2022, shapes of distributions in individual years are similar to the pooled distributions. Observe that the distributions of the overall, environmental, and social scores are highly bimodal, while the distribution of the governance score is heavily skewed.

Figure A2: Distributions of absolute year-on-year ESG score change



Note: This figure plots distributions of absolute year-on-year ESG score change. Panel A to D show the distribution of absolute year-on-year change of overall, environmental, social, and governance scores respectively. The sample covers all US listed firms with these scores available. The figures pool data across different years from 2002 to 2022, shapes of distributions in individual years are similar to the pooled distributions.

Figure A3: Variation of ESG scores (not converted into percentiles) by quintile



Note: This figure plots time variation of ESG scores (not converted into percentiles) by quintile. We regress absolute year-on-year score change on quintile dummies of the corresponding score, estimated coefficients are presented along with 95% confidence intervals. Standard errors are clustered at the firm-level. Quintiles are computed within each fiscal year, and the regression controls for year fixed-effects. Observe that estimated coefficients are hump-shaped if we do not convert ESG scores into percentiles.

Table A1: Variation of scope 1 emissions (scaled by revenue) by quintile

	Absolute changes in emissions		
	(1)	(2)	(3)
Quintile 2	-148.8***	-113.9***	-45.30***
	(7.901)	(11.62)	(5.589)
Quintile 3	-156.9***	-126.1***	-61.62***
	(7.880)	(10.84)	(5.633)
Quintile 4	-158.1***	-126.6***	-72.22***
	(7.858)	(10.75)	(5.802)
Quintile 5	-159.1***	-127.9***	-79.87***
	(7.870)	(10.78)	(6.044)
Year FE	Yes	Yes	No
Year $\times$ SIC2 FE	No	No	Yes
Value-weighted	No	Yes	No
Within SIC2 industry	No	No	Yes
N	24345	24330	24280
R^2	0.259	0.253	0.385

Note: This table shows the time variations of greenhouse gases emissions by quintile. The dependent variable is annual absolute changes in scope 1 greenhouse gases emissions, measured in tons of CO_2 equivalents emitted per million dollars of revenue. We regress the dependent variable on quintile dummies of scope 1 greenhouse gases emissions (scaled by revenue). In the regressions of columns (1) and (2), quintiles are computed within each fiscal year, while in the regression of column (3), quintiles are computed within each fiscal year separately for each SIC2 industry. Columns (1) and (2) include year fixed effects, and column (3) includes year $\times$ SIC2 industry fixed effects. In column (2) regressions are value-weighted where each observation is weighted by the firm's market capitalization as a fraction of total CRSP market size in the same year. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Standard errors are in parentheses and are clustered at the firm-level.

Table A2: Variation of scope 2 emissions (scaled by revenue) by quintile

	Absolute changes in emissions		
	(1)	(2)	(3)
Quintile 2	-17.13***	-23.23***	-11.89***
	(1.154)	(3.464)	(0.991)
Quintile 3	-20.05***	-25.71***	-13.83***
	(1.159)	(3.452)	(0.999)
Quintile 4	-20.88***	-26.35***	-14.56***
	(1.164)	(3.522)	(1.005)
Quintile 5	-21.42***	-27.27***	-15.86***
	(1.150)	(3.457)	(1.021)
Year FE	Yes	Yes	No
Year $\times$ SIC2 FE	No	No	Yes
Value-weighted	No	Yes	No
Within SIC2 industry	No	No	Yes
N	24345	24330	24280
R^2	0.156	0.213	0.253

Note: This table shows the time variations of greenhouse gases emissions by quintile. The dependent variable is annual absolute changes in scope 2 greenhouse gases emissions, measured in tons of CO_2 equivalents emitted per million dollars of revenue. We regress the dependent variable on quintile dummies of scope 2 greenhouse gases emissions (scaled by revenue). Columns (1) and (2) include year fixed effects, and column (3) includes year $\times$ SIC2 industry fixed effects. In column (2) regressions are value-weighted where each observation is weighted by the firm's market capitalization as a fraction of total CRSP market size in the same year. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Standard errors are in parentheses and are clustered at the firm-level.

Table A3: Variation of scope 1 & 2 emissions by quintile

	Absolute changes in emissions		
	(1)	(2)	(3)
Quintile 2	-1.257***	-1.769***	-0.536***
	(0.0869)	(0.245)	(0.0620)
Quintile 3	-1.352***	-1.921***	-0.707***
	(0.0871)	(0.249)	(0.0638)
Quintile 4	-1.375***	-1.995***	-0.816***
	(0.0872)	(0.253)	(0.0661)
Quintile 5	-1.384***	-2.036***	-0.890***
	(0.0872)	(0.256)	(0.0676)
Year FE	Yes	Yes	No
Year $\times$ SIC2 FE	No	No	Yes
Value-weighted	No	Yes	No
Within SIC2 industry	No	No	Yes
N	24803	24786	24738
R^2	0.222	0.215	0.365

Note: This table shows the time variations of greenhouse gases emissions by quintile. The dependent variable is annual absolute changes in scope 1 and scope 2 greenhouse gases emissions, measured in million tons of CO_2 equivalents. We regress the dependent variable on quintile dummies of scope 1 and scope 2 greenhouse gases emissions. In the regressions of columns (1) and (2), quintiles are computed within each fiscal year, while in the regression of column (3), quintiles are computed within each fiscal year separately for each SIC2 industry. Columns (1) and (2) include year fixed effects, and column (3) includes year $\times$ SIC2 industry fixed effects. In column (2) regressions are value-weighted where each observation is weighted by the firm's market capitalization as a fraction of total CRSP market size in the same year. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Standard errors are in parentheses and are clustered at the firm-level.