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# TO STARVE OR TO STOKE? UNDERSTANDING WHETHER DIVESTMENT VS. INVESTMENT CAN STEER (GREEN) INNOVATION

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**ABSTRACT**

More than 1,500 organizations and investors representing over $40 trillion in assets have committed to fossil fuel divestment to combat climate change. Will it work? This chapter explores whether divestment might induce green innovation, a critical component of transitioning to a cleaner economy. Divestment could theoretically steer innovation by increasing the cost of capital for "dirty firms," but it is unclear whether the effects will be large enough to significantly reduce investment opportunities. I argue that continuing to invest in dirty industries could drive green innovation conditional on investors being socially-conscious and governing through "voice." This hinges upon understanding which firm strategies actually foster green innovation, though, and the commonly-used ESG indicators come with several limitations. I demonstrate how decomposing them and using alternative approaches to measuring environmental performance can improve investment, strategy, and management decision-making and policy design. I examine the relationship between 14 specific practices and whether large firms in 16 pollution-intensive sectors are on track for meeting the Paris Agreement emissions targets ("carbon performance"). I find no correlation between carbon performance and the most basic practices, like disclosing emissions, but a positive correlation for five more explicit strategies: setting long-term quantitative emissions targets, having a third party verify emissions data, incorporating environmental performance into executive remuneration policies, supporting governmental climate change efforts, and setting an internal price of carbon. I construct a new best practices score based on these results and find that it has a much higher correlation with carbon performance than some other composite measures.

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# 1 Introduction

Climate change is arguably one of today's greatest threats to the economy, the environment, and humanity. As sea levels rise to dangerous levels and extreme weather events like droughts and hurricanes intensify, the effects are damaging ecosystems, harming human health, and hampering economic activity. Scientific evidence suggests that warming must not exceed 1.5°C above pre-industrial levels to avoid the most catastrophic consequences, and reaching this goal will require deep and immediate cuts to global greenhouse gas emissions (IPCC 2018).[1]

But the policies and regulations that could help achieve such reductions tend to be controversial and uncertain. Although climate change policy in the U.S. recently made remarkable progress when President Biden signed the Inflation Reduction Act into law—a sweeping climate bill that allocates more than $300 billion for energy and cliamte reform, the largest single investment in climate in U.S. history—such policy action is unprecedented.[2] Brewing frustrations around inaction have thus motivated a search for additional approaches to mitigating climate change, and a global movement towards divesting from fossil fuels and industries that rely upon them has emerged. The idea is that, if investors reduce the supply of capital to firms in pollution-intensive industries, and if consumers reduce demand for their goods and services, "dirty firms" might become less competitive and eventually shutdown. More than 1,500 organizations and investors representing over 40 trillion in assets have committed to some form of fossil fuel divestment as a means towards combating climate change as of August 2022.

Will it work? In this chapter, I explore whether divestment could be an effective tool for inducing innovation in cleaner technologies, practices, and processes (henceforth "green innovation"), which will be critical for transitioning to a cleaner economy. I discuss how the main mechanism through which starving dirty firms of finance could play such a role is by increasing their cost of capital, which then might, at least in theory, reduce their investment opportunity sets. This could change the composition of innovation

[1] For example, IPCC (2018) found that global net $CO_2$ emissions must decline by about 45 percent from 2010 levels by 2030 and reach net zero around 2050 to limit warming to below 1.5° C.

[2] President also recently signed the CHIPS and Science Act into law, providing $50.3 billion to the U.S. Department of Energy's (DOE) Office of Science for R&D.

activities throughout the economy and increase demand for clean companies.

Whether divestment will impact the cost of capital substantially and quickly enough to induce green innovation and help meet the Paris Agreement emissions reduction targets remains unclear, though. Divestment could even dampen investments in green solutions if firms would have otherwise allocated such capital to improving their environmental performance or developing clean technologies. And divesting shareholders forgo the opportunity to reshape firms' strategies and innovation pursuits if they sell and lose their seat at the table. Could investing in polluting industries therefore more effectively steer the direction of innovation than divesting? How can investors help guide firms such that they improve their environmental performance? Are there specific management practices and strategies that are more likely to foster green innovation than others? How is green innovation and environmental performance measured in the first place?

The aim of this chapter is to provide insight into these questions. To limit the scope, I focus on firms in polluting industries (e.g., oil and gas, transportation, manufacturing, utilities, etc.) as opposed to innovation by firms in clean industries (e.g., those that are strictly focused on developing clean technology). So-called "dirty" firms can innovate in their processes and practices to reduce their environmental footprint, such as improving operational efficiency and using cleaner fuels, or they could adopt or develop clean technologies. The type of innovation will not be relevant for this chapter, but it is important to keep in mind that I am focusing on firms in dirty industries as opposed to cleantech even when referring to investment.

Note that this type of investment differs from what is often referred to as "impact investing." The latter frequently refers to investing in firms that are already socially-conscious (e.g., those making efforts to improve their environmental performance or claiming to do so) or companies that are strictly focused on developing pollution-reducing innovations. In this paper, I am referring to investments even in firms that score poorly on measures of environmental performance like environmental, social, and governance (ESG) indicators.

The first part of this chapter provides background on the divestment movement and considers how divestment versus continued investment in polluting industries could induce green innovation. I start by discussing the unique characteristics of green innovation that can theoretically dampen the incentive for firms to invest in Section 2. Green innovation is characterized by a unique "double-externality" challenge (Jaffe, Newell and Stavins 2005). First, as is the case for innovations of all types, imperfect appropriability leads to knowledge spillovers, and this can dampen the incentive for firms to invest because they cannot fully capture the value of their innovations. Second, though, environmental externalities also lead to prices not reflecting the true social cost of production, which can further dampen the incentive to invest in green innovation specifically. These market failures are often invoked to justify government intervention, but as noted, climate policy has been historically controversial and uncertain. Furthermore, while mechanisms implemented around the world so far—like putting a price on carbon—have been shown to increase innovation to some degree, whether they do so substantially and quickly enough remains unclear. I discuss this literature in Section 2.

In Section 3, I discuss recent divestment trends and the rationale behind why they might continue. Investors are not just motivated by a sense of moral obligation. Rather, there are climate-related risks that impact firm performance and thus the value of financial assets, such as the physical effects of climate change on production, increasing stringency in environmental policy, changing consumer preferences, and labor supply risk.

Section 4 then explores how reducing the supply of capital for dirty firms could induce green innovation. I discuss how the main mechanism through which it might do so is by increasing the cost of capital for dirty firms. When investors sell, they lower share prices to attract buyers, which reduces the value of the firm and its future cost of capital. This can theoretically reduce the firm's investment opportunity set and thus its status quo pursuits that sustain pollution-intensive industries, like the exploration and extraction of new oil and gas resources.

After reviewing the evidence in the (relatively thin) literature, I conclude that divestment will likely not have a substantial enough impact on the cost of capital to significantly reduce investment opportunities for firms in polluting industries. The most comprehensive study to date is Berk and van Binsbergen (2021), who find that the cost of capital only increases by less than 20 basis points even when ESG investors hold 50% of wealth, and more than 85% of investors must be socially conscious to impact the cost of capital by at least 1%. Whether this could sufficiently redirect investment activity is unclear without further research, but it seems unlikely, especially if the demand for fossil-related goods and services continues to generate enough revenue for firms to remain profitable.

Instead, I argue that, conditional on shareholders being socially conscious and effectively engaging with leadership, continuing to *invest* in pollution-intensive industries might be an effective avenue for promoting green innovation. Investors can steer innovation and business activities by governing through "voice," engaging with managers to inform their decision-making and shape their strategies. On the other hand, they lose their seat at the table when they sell their shares. They transfer their control rights to the buyer. The buyer is also less likely to be socially conscious if the sell is motivated by environmental objectives, so the new owners might be even less likely to encourage the firm to improve its environmental performance or invest in green innovation.

Successfully steering innovation by governing through voice, though, hinges upon understanding which management practices and strategies actually foster green innovation and improve environmental performance. There is surprisingly little evidence in the literature so far, which I explore in the second part of the chapter (Section 5). I first discuss the measures most commonly relied upon for assessing a firm's "greenness," like ESG indicators, and how they come with many limitations for effectively guiding investment and management decision-making. The limitations can be broadly categorized as related to 1) inconsistencies across indicators from different ratings providers, 2) aggregation methods that mask important details and conflate inputs (i.e., management practices and strategies) with outcomes (i.e., actual environmental performance), and 3) lack of comparability between environmental performance across industries.

I then bring these critiques to the data and examine the relationship between environmental performance and specific firm strategies and management practices for large public firms in 16 pollution-intensive sectors. I use data capturing the responses to individual questions that go into the creation of many ESG indicators, focusing on those related specifically to environmental management, and complement these with a new measure of "carbon performance" developed by the Transition Pathway Initiative (TPI) that evaluates whether companies are on track for reducing their pollution levels such that they are aligned with the Paris Agreement emissions reduction targets. Using this alternative methodology allows for a scientifically-based definition of “good” carbon performance and comparison of firms across industries.

Taking a descriptive approach, I examine the relationship between 14 specific management practices and strategies with the likelihood that firms are aligned with the Paris Agreement targets. I find little to no correlation between carbon performance and the most basic practices, like simply disclosing emissions or acknowledging climate change as a risk to the business. On the other hand, there is a positive correlation between carbon performance and five arguably stronger and more explicit versions of such practices: having emissions information verified, setting long-term quantitative targets, incorporating ESG performance into executive remuneration policies, supporting domestic and international climate change efforts, and setting an internal price of carbon. Lastly, I construct a new “best practices” measure based on these results that is highly correlated with carbon performance—much more so than it is for some aggregate measures.

Although the results of these analyses should not be interpreted as causal, and they should not be applied to other settings without further research given the small sample size and select set of industries that I study, the exercise provides three insights that might be of interest to investors and managers. First, decomposing measures like ESG indicators is important for developing an understanding of which practices and strategies foster green innovation, and it is particularly important to not conflate inputs (like firm strategies) with outcomes (realized environmental performance). Second, some practices and strategies can be implemented with varying degrees of strength, which reinforces the importance of decomposing these measures. For example, disclosing pollution levels or simply stating that the firm aims to reduce emissions might not be effective unless targets are long-term and quantitative. Third, if constructing and using an aggregated management quality measure to inform decision-making is of interest, analyzing which specific practices and strategies are most effective first (i.e., the “best practices”) might be an effective approach to determine appropriate weights for each component.

The results also may be of interest to policymakers and regulators given the growing recognition that energy and environmental innovation will be critical for transitioning to a cleaner economy. Stakeholder capitalism and encouraging firms in pollution-intensive industries to reduce their environmental footprint is also at the forefront of the public discourse. The Securities and Exchange Commission recently proposed a new rule that would require public companies to provide reports on their emissions, climate-related risks, and plans for reaching net-zero. My findings highlight how the potential for such practices to drive change likely depends on their specificity and how well they are integrated into the firm's overall strategy.

## 2 The "Double-Externality" Challenge

It has long-been known that innovation fuels economic growth (Aghion and Howitt 1992; Romer 1990). But not all innovations are created equal. While most generate both private and social value, some contribute more to social progress—improvements in society's capacity to meet basic human needs and create conditions that empower people to improve their quality of life—than others. Clean energy technologies that reduce pollution, for example, or innovation that improves healthcare and education services, surely contribute more to social welfare than a new payment processing app.

Innovation for social progress faces a "double-externality" challenge, though, that introduces unique implications for the incentives that inventors and firms face to invest in such pursuits. Innovation of all types can generate value that the creator cannot fully capture, like some benefits to users or knowledge spillovers that other firms can build upon, and this imperfect appropriability might lead to under-investment in new ideas (Arrow 1962; Nelson 1959).[3] When there are also production and consumption externalities, as there are in the energy and industrial sectors, prices tend to not reflect the true costs and benefits of the good or service. Prices for, say, electricity from fossil fuel sources might be "under-priced" in the sense that they do not incorporate the harm that producing and consuming it creates, dampening the incentive to invest in alternatives.

[3] This could be offset by firms needing to invest in R&D to absorb the ideas produced by the original innovator and to build upon them, though (Cohen and Levinthal 1989). Business-stealing can also lead to over-investment (Aghion and Howitt 1998).

These market failures are often invoked to justify government intervention, like carbon taxes to address environmental externalities and direct funding or fiscal incentives that reduce the cost of research and development (R&D) to address the appropriability challenge, and there is indeed growing evidence that some mechanisms increase innovative activity. For example, Popp (2002), Martin, De Preux and Wagner (2014), Aghion, Dechezlêpretre, Hemous, Martin and Van Reenen (2016), Calel and Dechezlêpretre (2016), and Calel (2020) find that putting a price on carbon induces green innovation. Research is also increasingly showing that direct grants and tax credits for R&D have positive effects on innovation inputs and outcomes in various settings.[4] There is little work so far on how they impact energy and environmental innovation specifically or on the effects of energy-specific funding, though. One recent exception is Dugoua, Gerarden, Myers and Pless (2022), who find that funding from the U.S. Department of Energy increases the supply of energy scientists.[5] More research is also needed on the optimal policy mix and the ways in which these mechanisms interact.

Why is this relevant in the context of fossil fuel divestment? Because while recent climate policy is making unprecedented progress, it has been historically controversial and uncertain. Supporters of the divestment movement argue that reducing the supply of capital for firms in polluting industries and the demand for their products and services could offer a complementary tool for transitioning to a cleaner economy and driving green innovation. However, whether divestment has or will have such effects remains unclear. Continuing to invest even in the dirtiest industries also has the potential to direct innovation. I explore this tension and the underlying mechanisms in Section 4.

[4]For example, Bloom, Griffith and Van Reenen (2002), Rao (2016), Guceri and Liu (2019), Dechezleprêtre, Einiö, Martin, Nguyen and Van Reenen (forthcoming), and Agrawal, Rosell and Simcoe (2020) find that tax incentives increase R&D, and Bronzini and Piselli (2016), Howell (2017), Azoulay, Graff Zivin, Li and Sampat (2018), and Myers and Lanahan (2022) find that grants have positive effects on patenting. Pless (2022) also finds that the two instruments have complementary effects on R&D for small firms.

[5]Pless and Srivastav (2022) also examine the interaction of carbon pricing and R&D tax credits on energy and environmental innovation but the R&D policy is not energy-specific.

# 3 The Divestment Movement

The fossil fuel divestment movement dates back to at least a decade ago when students at Swarthmore College urged their administration to move its money out of dirty industries. Advocates argue that, by no longer financing the fossil fuel industry, investors can help address climate change by driving polluting firms out of business. Recent trends are cultivating a renewed optimism about its potential. More than 1,500 organizations and investors—including universities, foundations, governments, private equity firms, and individuals—with a total of about $40 trillion in assets under management made public commitments to divest to some degree as of August 2022, which is more than a 75,000 percent increase in total assets under management since 2014 (Invest-Divest 2021).

These figures can be misleading, though, if one is interested in tracking divestment trends. The total assets under management totals are only equal to actual divestment if the investor currently has 100 percent of its assets in fossil fuels and if it it commits to fully divesting. Many have made only partial commitments such that they promise to divest from some types of fossil fuels and not others, and they may not divest from non-energy industries that are still high-polluting because they rely on fossil fuels as inputs, such as manufacturing.

Promised divestment also does not represent actual or current divestment and the timelines over which commitments will occur can be opaque. Significant amounts of funds are still flowing into heavy-polluting industries. Recent analyses have shown that energy holdings of the world's ten largest alternative asset managers, making up $3 trillion in assets combined, own more than 300 portfolio companies in the energy sector, and 80% of their energy assets go towards fossil fuels (PESP 2021).[6]

## 3.1 Climate-Related Risks

There are several reasons to think that shareholders might continue divesting, though. Divestment is not just driven by a sense of moral obligation. Companies and investors are increasingly recognizing that climate change creates real risks that threaten their oper-

[6] These calculations are made by PESP (2021) using data from Pitchbook.

ations and financial performance. For example, nearly all respondents to Deloitte (2021)'s survey of 750 executives around the world indicated that climate change has negatively impacted their business already. I discuss the risks firms and investors face in this section.

**Physical Risk.** For many industries, the physical effects of climate change can be economically costly because of how they can impact operations and asset values. Increasingly frequent and extreme weather events like hurricanes, blizzards, high temperatures, and droughts can disrupt operations as well as the interdependent global supply chains that firms rely upon. They interrupt production, reducing revenues while also raising costs (and prices) associated with needing to repair damages. Severe weather also can be dangerous for workers. For example, many manufacturing industries involve combustible and flammable materials, so lightening can cause injuries and death. Operations must be shut down to protect workers' safety.

In Deloitte (2021)'s survey of executives, the operational impact of climate-related disasters was identified as the leading environmental sustainability challenge. Because physical risks impact firms' output, productivity, and financial performance, they also can reduce long-term returns on investments and thus the value of financial assets. Dietz, Bowen, Dixon and Gradwell (2016) demonstrate examine the impact of climate change on the present market value of global financial assets and find that the expected "climate value at risk" is 1.8% when considering business-as-usual, amounting to $2.5 trillion.[7] Investors may consider these risks in their investment decisions.

**Policy Risk.** More stringent climate policies also impose costs for fossil fuel companies and the industries that rely upon them, which ultimately impacts asset values. Furthermore, costs are passed through to prices, which puts downward pressure on demand. Although the prospects and consistency of policies aiming to tackle climate change have been historically uncertain, recent activity is suggesting that this is changing. Increasingly salient extreme weather events along with the scientific evidence on the consequences of global warming are bringing climate change to the forefront of public discourse, and the

[7] They also show that the present value of global financial assets is an expected 0.2% higher when limiting warming to no more than 2°C even when including mitigation costs.

Inflation Reduction Act that President Biden recently signed into law includes unprecedented measures for addressing climate change.

**Demand Risk.** Relatedly, changing consumer preferences creates demand risk. Consumers are increasingly boycotting fossil fuels and the goods and services that rely upon them in their production processes, or "exiting" from the fossil fuel market more generally by seeking alternatives (e.g., electric vehicles), which can dampen long-run returns to investments and threaten the survival of the firm. Reduced demand, or the threat thereof, may contribute to continued divestment moving forward.

**Labor supply risk.** Shifting preferences and increasing stigma associated with polluting companies also creates labor supply risk such that it could be increasingly difficult for dirty firms to attract workers. Human capital is an important input into firm productivity. A reduction in the supply of workers willing to work for dirty firms, and especially high-skilled labor, poses financial risks for investors as well.

# 4 How Can Divestment vs. Investment Steer Innovation?

Can divestment induce green innovation and do so quickly enough to meet the Paris Agreement goals? On the one hand, divestment reduces the supply of capital for polluting industries (and those relying upon them in their production processes), making it more difficult for them to invest in new polluting activities or projects that advance their status quo "dirty" activities. On the other hand, providing capital could enable them to pursue innovations that reduce their environmental impact. Investing also provides shareholders with a seat at the table so that they can influence management decision-making and strategy. This section explores how these opposing strategies might (or might not) steer innovation.

## 4.1 Cost of Capital Channel

The primary mechanism through which divestment can induce green innovation (and contribute towards the transition to a less pollution-intensive economy more generally) is by increasing the cost of capital for dirty firms. When investors sell their shares in a company, they lower the price to attract buyers, implying that the firm will then face a higher cost of capital. In theory, this should reduce their investment opportunity set, dampening dirty innovation if they would have otherwise allocated capital to expanding their status quo activities (e.g., further oil and gas exploration) and lowering their growth rates. It also could induce dirty firms to exit and increase demand for clean companies, changing the composition of firms within the economy and enhancing green innovation investments.[8]

For these dynamics to have a meaningful effect on the direction of innovation, the change in the cost of capital must be substantial enough to actually reduce dirty firms' investment opportunity set, and the effect probably must be immediate to be on track for achieving the pollution reduction targets laid out in the Paris Agreement. Polluting firms must have an incentive to promptly improve their environmental performance (or exit), especially given the uniquely long innovation cycles in capital-intensive industries.[9]

The literature on how divestment impacts the cost of capital for dirty firms is relatively thin, but evidence from one of the more comprehensive studies to date suggests that its effects would likely be far too small to significantly redirect innovation. Berk and van Binsbergen (2021) show how the change in the cost of capital can be derived from a simple formula based on the fraction of the economy that socially conscious investors choose to target and their correlation with the rest of the market.[10] They then bring their theory to the data to study how socially-conscious investment strategies have impacted the cost of capital in the United States in recent years using the largest social index fund in the world—the Vanguard FTSE Social Index Fund—to identify the subset of clean stocks in the FTSE USA 4 Good index.

Using data for December 2015 through December 2020, the authors first find that a lit-

[8]On the other hand, if dirty firms would have otherwise allocated the divested capital towards efforts that reduce their environmental impact, such as by increasing the efficiency of their operations, divestment could dampen their own green innovation investments.

[9]It can sometimes take a decade for an initial idea developed through research is translated into a patented innovation in the energy sector (Popp 2016), for example, let alone the time it takes to bring these technologies to market.

[10]Their derivation applies the common assumptions behind the standard Capital Asset Pricing Model (CAPM).

tle under half of US market capitalization fell in the dirty portfolio. They then show that, when applying their formula and assuming a market risk premium of 6%, the cost of capital increases by only 0.35 basis points. This is very small and it is highly unlikely that this would be enough to meaningfully influence investment decision-making. Strikingly, when calibrating their model to study what it would take to have such an impact, they find that the cost of capital still only increases by less than 20 basis points even when ESG investors hold 50% of wealth, and more than 85% of investors must be socially conscious to affect the cost of capital by at least 1% according to their study. Lastly, the authors test these theoretical predictions empirically by exploiting changes in firms' ESG classifications and find that inclusion in the 4 Good index has no effect on the cost of capital.[11] The main implication from this analysis is that, even if divestment continues to rise, the effects on the cost of capital will likely be very small.

#### 4.1.1 Trends in the Cost of Capital

At the same time, while it is not likely that divestment is a central driver, recent trends in the cost of capital for various energy technologies suggest that it is increasingly expensive to finance investments in dirty energy. In Figure 1, I examine the cost of capital for dirty and clean energy projects by plotting the required rate of return for top dirty and clean energy projects calculated by Goldman Sachs (2020), which measures the average internal rate of return for fossil fuel and renewable energy projects by year of project sanction.[12] There appears to be a premium emerging for borrowers investing in fossil fuel projects, as the cost of capital for dirty energy and renewables is diverging. Justifying investments in new offshore oil projects required more than a 20 percent projected return in 2020 over a project's lifetime relative to somewhere around 3 to 5 percent for renewables according to these calculations.

[FIGURE 1 HERE]

[11] The coefficient estimating the effect on the instantaneous price appreciation is 0.24% and it is statistically not distinguishable from zero.

[12] The specific Goldman Sachs (2020) values were extracted from Quinson (2021).

It is also important to consider the cost of capital for firms in other high-polluting sectors that use dirty fuels in their production processes, though, as their continued demand can keep the fossil fuel industry alive. In Figure 2, I plot the weighted average cost of capital (WACC) calculated by IEA (2021) for the cement, iron and steel, and chemicals industries in advanced economies (Panel A) and China (Panel B). It has been decreasing for all three industries in advanced economies. In the chemicals industry, for example, it fell sharply from about 8% in 2018 to 4% in 2020. In China, it has remained mostly flat for the chemicals and cement industries, while it has declined for iron and steel since 2018.

[FIGURE 2 HERE]

#### 4.1.2 Is Divestment Driving These Trends?

While divestment can, in theory, reduce the cost of capital, there are many other factors at play, and it is difficult to identify the underlying mechanisms without further research. At the same time, the timing of recent trends in the cost of capital suggests that divestment has not been a central driver. The cost of capital for fossil fuels and renewable energy began to diverge in 2014 (see Figure 1), several years before divestment commitments took off. Commitments of some form totaled only about $52 billion in total assets under management in 2014. This has since grown substantially, but a very high proportion of that change occurred more recently. Commitments still only totaled $15 trillion in 2021 and then increased to $39.2 trillion today.

This suggests that some other force(s) are behind the cost of capital divergence. For example, the costs of renewable energy technologies, particularly solar, were falling dramatically during this time period. Initial deployment of solar can be largely attributed to public support mechanisms, like subsidies and tax incentives, and then costs came down over time, most likely due to learning-by-doing as adoption increased. Renewable energy projects thus became more profitable and less risky and could have simply been the more rational investments.

Furthermore, while the climate-related risks discussed in Section 3.1 can drive divestment and thus impact the cost of capital indirectly through the divestment channel, they also can directly affect the cost of capital. Pollution-intensive industries are exposed to climate-related risks, so investors may increase the cost of capital for dirty firms and projects, even if they do not reduce their access to capital. For example, recent work has shown that, as economic policy uncertainty increases, firms face a higher cost of capital and the effects increase in risk exposure (Xu 2020).[13]

## 4.2 Losing (or Gaining) a Seat at the Table

Another way in which investors can influence the direction of innovation is by leveraging their voice. That is, they can actively engage with management to steer a firm's direction rather than divesting. In fact, when Deloitte (2021) surveyed executives around the world about their motivations for increasing sustainability efforts, investor or shareholder demands was the number one driver.

Voice as a form of corporate governance can come in various forms. One common approach is voting in shareholder meetings. For example, in 2021, DuPont lost a vote to more than 80 percent of shareholders who supported a proposal requiring the company to assess its pollution policies and disclose of how much plastic it dumps each year (Crowley 2021). This might not be the most powerful approach, though. It might pressure companies to address issues that are raised, but they are not always bound to meeting the demands of such proposals. Voting also becomes complex when answers to the questions at hand entail more than two options (e.g., yes or no) due to preference aggregation (Arrow 1951).

Investors can take more involved approaches though, such as having direct conversations with managers (Dimson, Karakas and Li 2015). They can propose strategy changes, suggest or block projects, and even directly monitor management. Investors can also vote to elect socially-conscious board members, or back managers who initiate important changes. This was recently executed successfully when the investment firm Engine No. 1 replaced two Exxon board members with its own candidates (and with BlackRock's

[13]There is also a wider literature on how uncertainty affects investment decision-making that focuses on the irreversibility channel as opposed to the cost of capital channel (e.g., Bernanke (1983) and Bloom, Bond and Van Reenen (2007)).

support) who have leadership experience in green energy innovation (Ambrose 2021).

Naturally, influencing management and shaping corporate strategy through active engagement requires continuing to *invest* rather than divesting, as shareholders lose their "seat at the table" when they sell. Divestment is a transfer of control rights—for every seller there must be a buyer—and may even dampen green innovation if the seller is more socially-conscious than the buyer, which is a reasonable assumption when it is socially-conscious organizations that are divesting. The transfer of control rights is only likely to enhance green innovation if the buyer does happen to be more socially-conscious.

Continuing to invest as a means towards enabling the green transition is also the takeaway from Berk and van Binsbergen (2021).[14] They argue that, since divestment will likely not have a sufficiently strong impact on the cost of capital to affect firms' investments, playing an active role in engaging with managers might be more effective. Broccardo, Hart and Zingales (2022) draw a similar conclusion in their theoretical analysis of whether stakeholders (including consumers, workers, and shareholders) should divest or boycott as opposed to leverage their voice. They find that divestment only achieves the socially optimal outcome if *all* stakeholders are socially responsible whereas achieving it through voice requires the majority of investors to be just slightly socially responsible.

Note that continuing to invest as discussed here—that is, investing in dirty industries—is distinct from what is often referred to as "impact investing." The latter usually refers to assessing a company's environmental performance and its efforts to improve it, or at least their claims of doing so, and investing in those that perform better on metrics like ESG indicators. It also tends to include investments in companies that are directly developing clean technologies and other innovations that can reduce pollution. In this paper, I am referring to continued investments in dirty industries even if they score poorly on ESG indicators, and then influencing the firm's innovation investment decisions by governing through voice and actively engaging with management.

[14] Their focus is more so on firm exit and composition of industries as opposed to innovation.

## 4.3 Corporate Governance and Managerial Incentives

For voice to play a meaningful role in steering innovation, it is important that investors actually exert pressure and engage with management, and the degree to which they can do so will likely depend on the type of investor and whether they are majority shareholders. Managers have a stronger incentive to meet investor demands when the lender owns large positions. Lenders owning only a small share of a company also have less of an incentive to dedicate time for monitoring managers (Shleifer and Vishny 1986; Kerr and Nanda 2015). Their stakes are lower.

Furthermore, while companies might benefit from spreading risk, concentrated ownership can provide the stability and assurance needed to take risks if they are backed by long-term commitments (Bushee 1998; Dimson et al. 2015; Aghion, Van Reenen and Zingales 2013). Institutional investors might therefore play a particularly important role given their long-term holdings and substantial degrees of ownership. Their engagement also can help mitigate a moral hazard challenge that otherwise dampens the incentives for firms to invest in innovation. While innovation can take many years to pay off, managers often face short-term performance expectations (e.g., quarterly reporting) and lack incentives to make long-term investments, and they might be particularly reluctant to pursue innovation activities if they are risk averse. The separation between ownership and management can lead to conflicting goals and investment strategies that do not maximize firm value in the long run, thwarting R&D projects. Institutional investor engagement can help reduce these managerial agency costs (Hall and Lerner 2010).

There is indeed some evidence that greater institutional ownership increases firm innovation outcomes (Aghion et al. 2013). Recent work has also shown that institutional investor engagement with managers might be an important channel for improving environmental performance specifically. In an analysis of the "Big Three" (i.e., BlackRock, Vanguard, and State Street Global Advisors), Azar, Duro, Kadach and Ormazabal (2021) find a strong association specifically between engagement by the Big Three with large pollution-intensive firms and carbon emissions reductions. Dyck, Lins and Wagner (2019) also find that institutional investors improve environmental and social performance.

# 5 Improving Investment and Management Decision-Making

Successfully allocating capital and governing through voice such that investments help foster and steer innovation hinges upon knowing which organization strategies, processes, and practices actually lead to successful innovation outcomes. Not all companies are equally likely to engage with investors, and conditional on engagement, not all companies have the human (and physical) capital to innovate.[15] Whether a company has the potential to then achieve environmental innovation objectives is a function of characteristics that are often difficult to observe, such as management quality and innovation activities that could improve environmental performance, and this requires not only having accurate and reliable measures of such factors but also understanding which management practices help achieve the intended outcomes.

Impact investors and divesting organizations often use ESG indicators to assess whether a company is socially-conscious and to guide their decision-making. However, these measures come with a number of limitations and are increasingly controversial. Furthermore, empirical evidence pointing to the management practices and firm strategies that actually foster environmental performance improvements or innovation is sparse. In this section, I discuss these issues and recent efforts to address them, and I conduct an empirical analysis using new data and methods for measuring environmental performance and management quality to illustrate the challenges with current approaches and to shed new light on which practices and strategies are correlated with higher environmental performance.

## 5.1 Strategy, Management Practices, and Firm Performance

Understanding the importance of strategy and management practices for organizational performance has been of interest to economics, management, sociology, and policy scholars for more than a century. Much of the earliest work provides case studies or uses data on small samples of firms (e.g., Ichniowski, Shaw and Prennushi (1997)). More recently, access to larger data sets and systematic measurement of practices are enabling more ro-

[15] For example, Dimson et al. (2015) find that firms with weak governance and those that are large, mature, performing poorly, and concerned about their reputation are more likely to engage.

bust empirical analyses. The World Management Survey (WMS) has been a key data source as the largest cross-country dataset of organizations such as manufacturing and retail firms as well as schools and hospitals dating back to 2002. It focuses on managerial structures (as opposed to talent) like whether firms monitor operations, set targets, and provide worker incentives, scoring them between 1 ("weak practices," or not structured) to 5 ("best practices," or well-structured).[16]

With this data in hand, the economics literature studying how management practices impact organizational performance has grown dramatically over the past 20 years or so. For example, there is now ample evidence that management practices are key determinants of productivity. Enormous and persistent differences in firm productivity, even within the same industries, have been documented extensively (Schmalensee 1985; Dunne, Roberts and Samuelson 1989; Syverson 2004 2011; Yang 2021).[17] Although this is quite puzzling from an economic theory perspective, since productivity differences should narrow as competition increases, researchers have long-suspected and increasingly are showing that management quality and practices can explain a lot. A consensus is emerging around how they are positively related to outcomes such as productivity, operating profit, output growth, exports, and R&D expenditures in many sectors (Bloom et al. 2007; Bloom, Mahajan, McKenzie and Roberts 2013; Bloom, Brynjolfsson, Foster, Jarmin, Patnaik, Saporta-Eksten and Van Reenen 2019a; Scur et al. 2021).[18]

At the same time, there are several knowledge gaps that are important to fill for understanding which strategies and practices lead to better innovation outcomes. Relatively little is known about the effects on innovation broadly let alone the direction of innovation.[19] The types of management practices that foster innovation could be different than

[16]See Scur, Sadun, Van Reenen, Lemos and Bloom (2021) for a more comprehensive overview of the methodology and data. While defining what makes a practice "good" can be subjective, their selection of practices ex-ante were informed by discussions with industry experts and have been shown empirically in the literature to be important factors.

[17]For example, Syverson (2004) finds that U.S. manufacturing plants at the 90th percentile of the productivity distribution transforms the same inputs into almost twice as much output as firms in the bottom decile, and the dispersion is even larger in China and India (Hsieh and Klenow 2009).

[18]See Quinn and Scur (2021) and Scur et al. (2021) for a more comprehensive overview of the literature. Also, the focus of this section is on management practices, but there is a broader literature studying how other factors contribute to productivity differences as well, like competition, organizational structures, and human capital.

[19]One exception is Bloom, Van Reenen and Williams (2019b), who find positive effects on R&D and

those enhancing a firm's performance, and understanding what matters for green innovation specifically requires knowing whether and how such practices are applied specifically to sustainability efforts. For example, firms can set targets and provide worker incentives with a variety of objectives in mind—like increasing sales or output—that might not align with the types of targets and incentives required for improving environmental performance (e.g., reducing emissions). The empirical evidence of whether corporate social responsibility (CSR)-style efforts enhance or dampen firm performance is limited and mixed, and firms traditionally seek to maximize private value as opposed to social value.

## 5.2 Challenges with Using ESG Indicators

Investors and researchers often rely upon ESG indicators to assess a company's environmental performance as well as performance on other social and governance criteria, which are composite ratings constructed from responses to hundreds of questions in each category. These measures come with several weaknesses that make it difficult to tease out what types of environmental management practices and firm strategies can actually help foster innovation. There are also challenges that are less frequently discussed but important to address if managers and investors want to use the information to understand what management practices help foster green innovation. Taken together, the challenges can be broadly categorized as being related to (1) inconsistencies across indicators, (2) aggregation masking important details and conflating inputs with outcomes, and (3) difficulties with measuring and comparing environmental performance.

### 5.2.1 Inconsistencies Across Indicators

There are numerous providers of ESG ratings, each with their own sets of (often proprietary) evaluation criteria and methodologies. They aggregate information from responses to hundreds of questions and assign weights to each category and/or sub-categories to produce a weighted average as the overall score. The questions asked can be different across providers and what constitutes a good or bad score can be subjective, while the

patents but do not study green innovation specifically.

weight choices also vary across providers and the reasoning behind the ways in which they are determined is not always transparent.[20]

Unsurprisingly, this leads to significant divergence in ESG ratings across providers with little known about what might be "correct." By studying data from six of the most prominent rating providers, Berg, Koelbel and Rigobon (2022) document this lack of agreement, finding that the correlations between them range from 0.38 to 0.71. They show that 56% of the divergence can be explained by measurement, 38% by scope, and 6% by weights. Chatterji, Durand, Levine and Touboul (2016) also find significant lack of consistency across ratings and point to the choice of what ESG raters measure and whether it is measured consistently as two key explanations.

The divergence between indicators across providers raises questions around not just which one most accurately reflects the degree to which a firm is socially responsible but also the validity of all of them. This can ultimately reduce welfare if investors and firms use them to inform their capital decision-making (Chatterji et al. 2016). That is, in the traditional divestment and impact investing context, relying on ESG metrics will not direct capital as intended. Likewise, if investors are aiming to target dirty firms that are currently performing poorly so that they can invest in them and exert influence, they will also be misled.

#### 5.2.2 Aggregation Masks (and Sometimes Conflates) Important Details

One particularly important limitation to using ESG indicators is that they mask the details required for understanding the management practices, governance, and strategies that can improve outcomes. There are several ways in which common aggregation approaches limit their usefulness, but there are two that are particularly important for understanding "what works" when it comes to improving environmental performance.

First, the E of ESG conflate *inputs* into improving environmental outcomes (i.e., firm strategies and management practices) with *outcomes* (i.e., measures of actual environmental performance). For example, in many cases, the E component includes both reported

[20] For example, the description used by one major provider states "we have applied an automated, factual logic" and it is difficult to find a more detailed explanation.

pollution levels and resource use (i.e., outcomes) as well as information on how the company manages its environmental risks and opportunities, such as whether the company has a policy to improve emissions reductions, sets emissions reduction targets, and if the firm has a management team specifically responsible for carrying out the firm's environmental strategy (i.e., the inputs).[21] Understanding the strategies and practices that improve environmental performance therefore requires decomposing these indicators to a much more granular level.

Second, some questions related to environmental management practices, governance, and strategy are often included in the G and S components rather than the E. For example, the G component of some indicators includes whether the firm has a CSR committee and whether ESG-related performance is incorporated into compensation policies for executives. But the aggregated G is not necessarily a good proxy for environmental management practices, governance, and strategy since it also incorporates many practices that may not necessarily be related to environmental management.[22]

#### 5.2.3 Measuring and Comparing Environmental Performance

A final important limitation is that, even if one did decompose the indicators entirely, the information still would not enable a comparison of firms' emissions and other pollution-related information across sectors. Doing so is important if investors are interested in directing capital towards firms in any industry such that they have the greatest impact. Production across industries generates different types of pollution, which is measured using different units. Improving environmental performance also entails different types of activities and investments across industries. Standardization in environmental performance measurement is needed for cross-industry comparisons.

In fact, evaluating environmental performance even within industries with these measures can be misleading, since what constitutes "good" environmental performance can be subjective. Tracking specific firms' or industries' progress is straightforward if out-

[21] They also break down the E into three sub-categories but these examples are all still included in the "emissions" sub-category.

[22] They also provide a sub-category within G that focuses on CSR strategy, but questions in the other sub-categories ("management" and "shareholders") might be relevant as well.

comes are measured consistently over time, but what is the threshold for, say, the emissions level that determines whether a firm is environmentally responsible? Some may argue that this is a normative question, but it need not be given the scientific evidence of how pollution contributes to climate change and the known reductions required to address it. More evidence-based methods for defining "good" environmental performance could help firms understand how to set their own emissions reduction targets and to determine whether they are aligned with the pathways laid out by the Paris Agreement. I discuss this further in the next sub-section.

## 5.3 Empirical Analysis Using a New Approach to Analyze Management Quality and Environmental Performance

In this section, I turn to data to explore the correlations between environmental performance and specific management practices and strategies to demonstrate how, with the right data and methods, investors and managers seeking to foster green innovation in polluting industries might be able to improve their decision-making. While ESG indicators come with many challenges, they are packed with a lot of information that could prove useful when decomposed and complemented with other sources and methods. I use information on responses to individual questions that go into the creation of ESG indicators with a particular focus on environment-specific management practices and strategies along with new methods for assessing environmental performance that are being developed in the literature. Using the results from this exercise, I then construct a new "best practices" measure that is highly correlated with environmental performance.

### 5.3.1 Measuring Environmental Performance and Management Quality

Rather than using aggregated ESG indicators to measure environmental performance, economists often hone in on pollution levels and intensity, and such data are increasingly accessible at various degrees of granularity.[23] Such information can be extremely valuable. That said, in its raw form, it comes with some of the same challenges associated

[23] For example, the EPA's National Emissions Inventory publicly provides facility-level information on various pollutants.

with using ESG indicators. It is still difficult to compare firms across industries when the type of pollution and its units differ, and while changes over time can be tracked within-firm and firms can be compared relative to others in their own industries, definitions of what constitutes "good" performance could still vary.

Instead, I use a new measure of "carbon performance" developed by the Transition Pathway Initiative (TPI), a global, asset-owner led initiative, that captures whether companies are on track for reducing their pollution levels relative to those that must be achieved to meet international greenhouse gas emissions targets. Their approach entails translating the targets set by the Paris Agreement into sector-specific benchmarks, and then firms' current and (expected) future emissions intensities can be compared to the benchmark (Dietz, Jahn, Nachmany, Noels and Sullivan 2019).[24] "Good" environmental performance can then be defined as being aligned with the Paris Agreement pathways, which is not only guided by scientific evidence but also allows for comparisons between firms in any industry.

To develop a better understanding of which specific management practices and strategies are associated with better carbon performance, I use detailed responses to questions that are specifically related to environmental protection and frequently used as inputs into the creation of ESG indicators. I also gather this data from TPI, as they extract responses to 19 of the relevant questions.[25] To evaluate a firm's (environmental) management quality, TPI assesses the strength of each specific question on a scale from 0 (weakest) to 4 (strongest), as companies tend to follow a staged progression when implementing carbon management systems. For example, a first step is often publicly acknowledging that climate change is relevant for their business and developing some type of high-level policy. This might be followed by setting short-term pollution reduction targets and then by perhaps defining more precise, longer-term, quantitative targets. Each question is also mapped into being associated with three distinct categories: measurement and target-setting, governance, and strategy.

They then create a composite company-level management quality score that also ranges

[24] They follow what is known as the Sectoral Decarbonization Approach (SDA). See (Dietz et al. 2019) for more detail.

[25] FTSE Russell provides TPI with this data.

from 0 to 4, whereby once companies answer "yes" to all questions in one level, they advance to the next. Level 0 reflects complete unawareness of climate change as a business issue. Level 1 is associated with acknowledging climate change as presenting risks and/or opportunities to the business, and level 2 indicates that the company is in a capacity-building stage (i.e., it is starting to develop management systems and report on practices and performance). Once a company is taking a more integrated approach, like improving its operational practices and assigning specific board responsibilities for improving environmental performance, it moves up to level 3. Finally, if it reaches the point of developing a comprehensive understanding of risks and opportunities, and this is reflected in their expenditure decisions and business strategies, they are assigned a 4. See Dietz et al. (2019) for more detail.

### 5.3.2 Sample Construction and Graphical Analysis

I gather data from TPI's two public databases on management quality and carbon performance, which cover the largest public companies by market value in the most pollution-intensive sectors. As of the end of 2021, the database included assessments of 401 companies representing 16% of global market value across four clusters of sectors (energy, industrial and materials, transport, and consumer goods and services) (Dietz, Bienkowska, Gardiner, Hastreiter, Jahn, Komar, Scheer and Sullivan 2021).[26] TPI applies its environmental performance methodology described above to indicate whether the firm is on track for the Paris Agreement's 1.5 Degrees scenario (strongest carbon performance), the 2 Degrees scenario, or the National Pledges scenario (the weakest). The management practice database contains both TPI's composite company-year level management quality score as described in the previous sub-section as well as the answers to each specific question

Table 1 contains the full list of questions that I use in my analysis categorized as being associated with measurement, targets, and reporting, governance, or strategy, along with the values assigned to capture each management practice's on a scale from 0 to 4.[27] One observation is that there is variation in management practice strength both within and

[26]Specific industries include airlines, aluminum, autos, cement, diversified mining, electric utils, oil and gas, paper, shipping, and steel.
[27]I drop those that are not included over the entire sample period.

across the three categories. For example, whether the company has broadly set greenhouse gas emissions targets is assigned a 2 whereas setting long-term quantitative targets is assigned a 4. Within the governance category, acknowledging that climate change is an issue for the business is assigned a 0, whether the company has nominated a board member or committee with explicit responsibility for oversight of climate change policy is assigned a 3, and whether the company incorporates ESG issues into its executive remuneration policies is assigned a 4. The three strategy-related questions, like setting an internal price of carbon, are all scored as either 3s or 4s, as they reflect integration of climate change risks into operational decision-making and strategy development.

[TABLE 1 HERE]

After merging the management quality and carbon performance databases and dropping duplicates, the resulting unbalanced panel includes 1,780 observations across 492 firms between 2017 and 2022. However, not all firms are included in each set of evaluations, so the sample size decreases significantly when keeping only firm-year observations that match and dropping firms without suitable data for assessing carbon performance. The final dataset that I use throughout the correlation analysis contains 545 observations across 258 firms from 2017 through 2021.[28] Most notably, the main difference in the characteristics of these firms relative to those in the full dataset is that they score higher on the various management practices, which is unsurprising given how those that were dropped were those without suitable disclosed pollution data (and disclosure is one of the management practices).[29]

**Graphical Analysis.—**Before turning to a more formal correlation analysis, I start by visually exploring the raw data using TPI's composite company-level management quality scores and carbon performance assessments. Figure 3 illustrates the percentage of firms within each management quality level that is on track for meeting either the Paris Agreement 2°C pathway requirements or the Paris Pledges as opposed to not being aligned

[28] The data I use to construct the figures in the next sub-section, however, includes 619 observations across 290 firms. Additional observations fall out when running the regressions because of other missing data.

[29] I discuss how my findings turn out to be upper bounds because of this.

with either or not disclosing enough information to be accurately assessed. There appears to be a positive relationship between management quality and whether firms are on track. All of those with a management quality score of zero are either not aligned with any target or pledge or do not disclose suitable emissions data to assess them. When moving from the lowest management quality level to the highest, though, the proportions of firms that disclose such information increases while the proportions meeting either the Paris Pledge or 2°C pathway targets increases. Of those with the highest management quality score of four, only 2 percent do not disclose suitable emissions information while 38 percent are aligned with 2°C or below and 15 percent are aligned with the pledges. At the same time, 45 percent are still not aligned with any of the targets or pledges.

[FIGURE 3 HERE]

In Figure 4, I provide the breakdown of firms that fall within each environmental performance category by industry, which demonstrates the vast amount of heterogeneity. The oil and gas sector performs extremely poorly. While more than 90 percent do report enough information on their emissions to assess their performance, less than 10 percent of those that do report are on track for any of the Paris Agreement targets. On the other hand, electric utilities are performing quite well relative to the others in this set of heavy-polluting industries. Nearly 60 percent are on track for either the strongest or weaker Paris Agreement targets.

[FIGURE 4 HERE]

Another observation to consider is that the proportions of firms that are aligned in many of the other industries are quite low. For example, less than 20 percent of firms are aligned with either the strongest or weaker targets in the aluminum and cement industries. This highlights the importance of applying socially-conscious investment standards beyond the fossil fuel industry itself, as these other industries are also heavy polluters.

Management quality also varies across industries, but perhaps surprisingly, there is less heterogeneity relative to the heterogeneity in environmental performance (see Figure 5. For example, a little over 20 percent of firms fall within the management quality level 4 for all industries except utilities. There are also very few firms that fall within the lowest management quality score, and then there is a bit more variation for the categories in between. The key takeaway is that, even when limiting management practices to only those that are environment-related and categorizing them into five different quality levels, there does not appear to be a strong correlation with environmental performance.

[FIGURE 5 HERE]

There are several potential explanations for this. The lack of (at least visual) correlation could indicate that the information extracted from the ESG indicators is not accurate or that management just does not matter for environmental performance. The importance of managerial ability also tends to vary across industries. It also could indicate that aggregating management practice quality at this level is still too coarse to provide meaningful information of "what works." I explore this further in the next sub-section.

#### 5.3.3 Correlation Analysis

I now turn to examining the correlations between management quality and carbon performance more formally and with increasingly less coarseness in the management quality proxy. First, rather than using TPI's company-year level assessments (henceforth *MQ Level*), which are determined based on firms to responding "yes" to each question that TPI includes in each level before advancing to the next, I construct an additional measure that accounts for the possibility that firms engage in practices with higher ratings without indicating that they also employ practices at lower levels.[30] Instead, I calculate the proportion of total possible "points" that a firm earns, *MQ Score*, by summing the strength values associated with each question across all questions to find the total possible points and just those that the firm indicates that it implements for the points earned. For example, *MQ Score* is equal to 0.5 if a firm earns half of the total possible points when summing TPI's strength scores across all questions.

[30]While most companies presumably do follow a progression towards stronger practices, there is always the change of either real exceptions or simply errors in the data. For example, a firm might incorporate climate change risks and opportunities in their strategy (which is rated as a 4) without having set any form of quantitative target for reducing emissions (which is rated as a 3).

Then, to develop a better understanding of whether practices related to measurement and target-setting, governance, or strategy seem to be most important for improving carbon performance, I create three separate analogous measures for each of the broad categories (*Metrics Score*, *Governance Score*, and *Strategy Score*, respectively). In this case, the number of points earned and total number of points are only for those in each category. Lastly, I entirely decompose these aggregated measures to examine the correlations between carbon performance and each specific practice using indicators equal to one if the firm answers "yes" to a question and zero otherwise. This not only allows me to develop a better understanding of which specific practices seem to matter most but also avoids assuming how strong each practice is *ex ante*. Instead, the data can reveal which ones are most highly correlated with carbon performance.

I proceed by estimating various forms of the following model:

$$CP_{it} = MQ_{it} + \gamma_{st} + \epsilon_{it} \tag{1}$$

where $CP_{it}$ is the carbon performance of firm $i$ in year $t$, which is an indicator equal to one if the firm is on track to meet different Paris Agreement targets and zero otherwise. Management quality, $MQ_{it}$, is either the firm's overall score that I construct, the set of scores for the three broad categories, or a set of indicators for individual questions depending on the specification. When examining each individual question, I estimate three separate models that include indicators only for the questions that fall within each of the broad categories. In all cases, sector-year fixed effects, $\gamma_{st}$, are included to control for how macroeconomic shocks might impact sectors differentially over time, and I cluster the standard errors by country.

### 5.3.4 Results

To be clear upfront, it is important to keep in mind that the coefficient estimates presented in this section should not be interpreted as causal effects. Rather, they are correlations within sector-year, and I leave causal inference approaches for future work.

***Management Quality Level and Scores.*** I start by exploring how management quality as proxied by the more aggregate measures is correlated with carbon performance and present the results in Table 2. For comparison purposes, I first examine the relationship between TPI's company-year management quality level assignment and whether the firm is aligned with the Paris Agreement pathways for limiting global warming to ≤2°C (Column 1). The coefficient estimate of 0.08 is statistically significant at the 1% level, suggesting that moving from one level to the next is associated with an 8% increase in the probability of being aligned. While this begins to demonstrate the importance of implementing stronger management practices, it does not provide a sense of whether there are different effects depending on a firm's initial management quality, making it difficult to understand the importance of basic management practices versus taking a more integrated, strategic approach and how much it pays off to reach the highest level.

In Column 2, I estimate the model using the proportion of total possible "points" earned (*MQ Score*). While this still does not differentiate between effects across the initial management quality distribution, it allows for the assessment of going from the lowest possible score of zero (or doing nothing) to the highest (doing everything), and it also removes the assumption that firms do not implement stronger practices if they have not yet implemented weaker ones based on strength ratings that were determined *ex ante*. I find that this measure's correlation with ≤2°C pathway alignment is 0.29 and statistically significant at the 1% level. In other words, when firms go from doing nothing to indicating that they implement all 15 practices listed in Table 1, the probability of aligning increases by 29%, which is a 100% increase over the sample's mean probability. This finding begins to suggest that taking a fully integrated, strategic approach is particularly valuable.

[TABLE 2 HERE]

Next, I explore whether the *MQ Score* effect appears to be driven by measurement, target-setting, and reporting, governance-related practices, or strategy (*Strategy Score*), measuring each as described in Section 5.3.3. There is variation in practice strength within each category, so these measures still mask important details, but with some of the most commonly-discussed practices mostly being related to those in the metrics category (i.e., public disclosure of pollution information and setting reduction targets), it can provide a sense of whether this is sufficient.

When considering alignment with the ≤2°C pathway (Column 3 of Table 2), the strategy score's coefficient of 0.126 is the only one that is statistically significant (but still only at the 10% level). It suggests that going from engaging in none of the practices in the strategy category to all of them increases the probability of alignment by 12.6%. The magnitude of the coefficient for governance is about the same but just barely not statistically significant. When using the stronger <2°C pathway alignment as the dependent variable instead (Column 4), both the governance and strategy scores are statistically significant at the 10% level and have similar magnitudes. On the other hand, the coefficient for the metrics score is about a third of what it is for governance and strategy and statistically insignificant in both cases. Lastly, when examining the correlations with not being aligned with any Paris Agreement pathways, including the weakest one associated with pledges only, there is a correlation only with the strategy score (Column 5).

***Specific Management Practices and Strategies.*** Still, the category-level scores mask potential heterogeneity in the specific practices, especially in the metrics and governance contexts given how they each include six different practices with varying degrees of strength. I now decompose them into their individual questions and estimate the model of Equation 1 using indicators equal to one if the firm answered "yes" to the question.

The results for the questions included in the metrics category are presented in Table 3. For the two main Paris Agreement scenarios (Columns 1 and 2), two of the practices are in fact correlated with alignment at the 1% statistical significance level: having operational (Scope 1 and/or 2) greenhouse gas emissions data verified and setting long-term quantitative targets for reducing greenhouse gas emissions. The latter is the only question in the metrics category rated as being in level 4 for management practice strength by TPI, and it is also the only one correlated with reducing the probability of not being aligned with any Paris Agreement pledge or pathway. When considering the small and statistically insignificant coefficients associated with the weaker metrics questions—like simply having any quantitative emissions target without long-term objectives or publishing Scope 1 and Scope 2 emissions—the findings highlight the importance of having emissions data verified and being forward-looking.

[TABLE 3 HERE]

A similar pattern emerges for the governance-related practices (see Table 4). The one practice that is correlated with carbon performance as measured by alignment with the $\leq$2°C pathway is incorporating ESG and climate change performance into executive remuneration policies, one of the two strongest governance practices (Column 1). Implementing this practice is associated with a 15% increase in the probability of alignment. It is also associated with being aligned with the <2°C pathway and reduces the chance of no alignment with any pledge or target, maintaining statistical significance at the 1% level.[31]

[TABLE 4 HERE]

Lastly, two of the three practices in the strategy category, both of which can be considered strong practices, as they reflect the most integrated approaches (and are rated as being either a 3 or 4 by TPI), are associated with better carbon performance (see Table 5). When considering the $\leq$2°C case (Column 2), supporting domestic and international efforts to mitigate climate change and setting an internal price of carbon are associated with an 8.3% and 10.7% increase in the probability of alignment, respectively. They are both also associated with reduced probability of no alignment with any pledge or target.

[TABLE 5 HERE]

***A New Proxy for "Best Practices."*** The results presented in Tables 3 to 5 point to a set of specific practices that are correlated with better carbon performance spanning all three categories, and they tend to be those that are "strongest" in the sense that they are either more advanced versions of basic practices (e.g., setting long-term quantitative objectives rather than any general pollution target) or those that involve the most integration into operational decision-making (e.g., providing incentives to executives to implement objectives (and thus engage with lower-level management to do so) by tying environmental

[31] For the <2°C pathway case, two other practices—having a policy to act and incorporate climate change risks and opportunities into the firm's strategy—are also correlated but only at the 10% statistical significance level.

performance to their compensation). While the weaker practices may be correlated with some other measures of environmental performance that I do not study, being on track for meeting the Paris Agreement targets overall is critical for avoiding the most detrimental consequences of climate change, so firms and investors may wish to think of "good" environmental performance as being in line with the pathways for meeting those targets.

With this in mind, I interpret the correlations that are statistically significant at least at the 5% level as potential "best practices" for improving environmental performance, at least for this set of firms and the practices considered, and construct a new proxy for management quality. I use the $<$2°C pathway alignment results—the strongest case—and create a "Best Practices Score" as the proportion of total best practices points earned (i.e., the sum of the points associated with best practices that the firm implements as a proportion of the total number of potential points associated with all best practices). While this is an aggregate measure and still masks details associated with each individual practice, it is arguably a better reflection of a firm's environmental management quality overall than other aggregated measures that incorporate many practices that are not correlated with better environmental performance.

I examine the relationship between this best practices score and carbon performance and I find that the correlation is much higher than any of the other aggregated measures that I study as well as each of the individual questions (Table 6). Going from implementing none of the best practices to all of them is associated with a 60% increase in the probability of being aligned with the $\leq$2°C pathway in comparison to 29% correlation for the overall *MQ Score* shown in Table 2.

[TABLE 6 HERE]

#### 5.3.5 Discussion

Although the results of these analyses do not allow for causal interpretation, and they should not be applied to other settings without further research given the small sample size and select set of industries studied here, the exercise provides three insights that might be of interest to investors and managers.

First, developing an understanding of how firms can improve their environmental performance requires decomposing aggregated measures like ESG indicators. They tend to combine information on both management practices and actual environmental footprint even within the E of ESG, conflating inputs with outcomes. Management practices are the inputs that can improve environmental performance whereas emissions and resource reductions are the realized environmental performance improvements.

Relatedly, it is also important to decompose different categories of practices to capture how some forms of the same practice might be more effective than others. For example, simply setting emissions reduction targets and disclosing pollution levels does not appear to be associated with better environmental performance for the sample of firms that I study unless such targets are long-term and quantitative. This highlights how the strength of the practice has implications for whether a firm might improve its environmental performance moving forward, and assessing this requires detailed information on the ways in which firms carry out practices.

Third, if constructing and using an aggregated management quality measure to inform decision-making is of interest, analyzing which specific practices and strategies are most effective (i.e., the "best practices") might be one way to effectively determine the weights assigned to different practices and strategies. This comes with caveats, though. There is likely heterogeneity in what strategies and practices are most effective across industries and firm characteristics, which future research could explore. Whether aggregated indicators constructed based on such analyses are better predictors of environmental performance than alternatives also should be explored. The best practices approach that I applied in this paper suggests that it offers such potential, but since my results might lack external validity, others may wish to test this when or if they construct similar measures in other settings.

# 6 Conclusion

The objective of this chapter was to explore whether divestment might be an effective tool for inducing green innovation. Evidence from the literature so far suggests it may only have very small effects on the cost of capital for dirty firms, and while further research is needed to draw concrete conclusions, it seems unlikely that this will sufficiently reduce their investment opportunities.

Instead, I argue that investing in dirty industries might be an effective tool for promoting green innovation conditional on shareholders being socially-consciously and actively governing through "voice." Effectively guiding managers to do so, though, requires knowing which practices and strategies actually foster green innovation. Albeit descriptive, I conduct an empirical exercise that demonstrates how leveraging both existing data and new methods for measuring environmental performance can improve management and investment decision-making. A key takeaway is that it requires decomposing the commonly-used aggregate proxies for environmental performance, like ESG indicators. It is also important to develop and use standardized measures of environmental performance so that firms can be compared across industries.

There are many pathways for future research. Whether there are effects of specific environmental management practices and strategies on innovation rather than just environmental performance, for example, remains an open question. Although the ultimate goal of developing pollution-reducing technologies and processes is to improve environmental performance, and finding improvements in environmental performance suggests that innovation might be at play, studying innovation inputs and actual outcomes directly can shed more light on the underlying mechanisms. One could also consider heterogeneity across industries and firm characteristics, as there is likely significant variation in "what works." Lastly, and perhaps most importantly, future work should examine these questions such that the results can be interpreted as causal, including those explored descriptively in this chapter.

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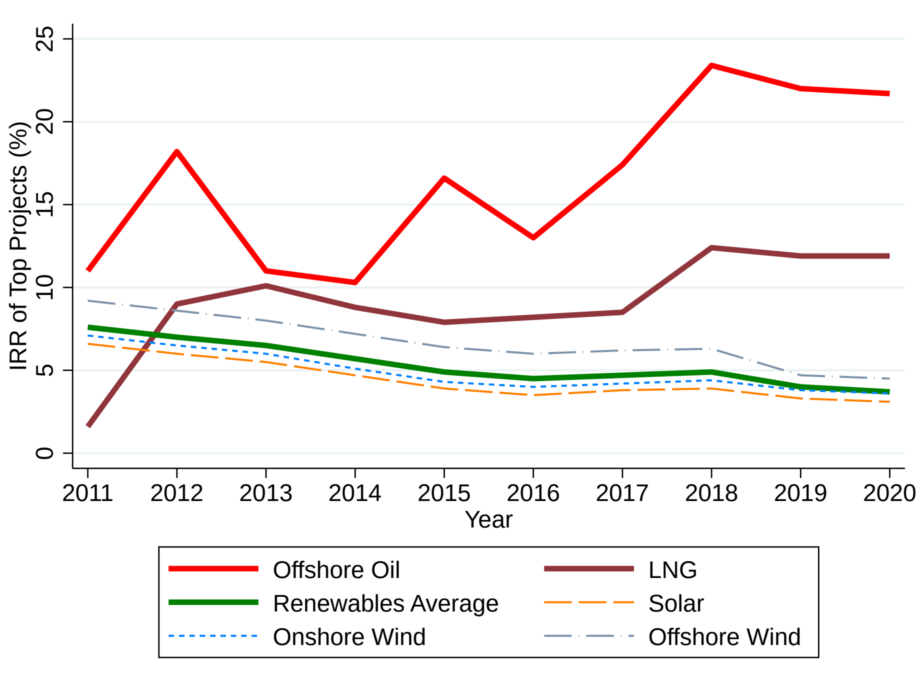
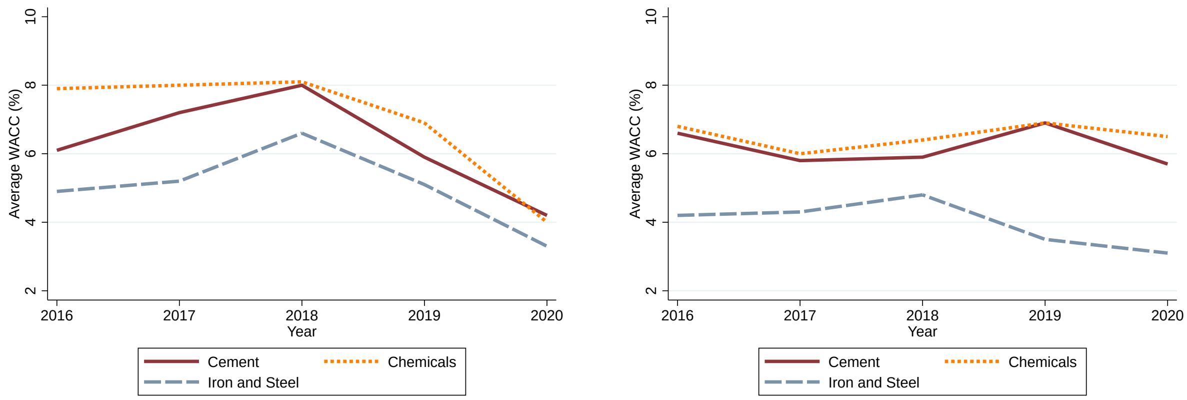
# MAIN TEXT FIGURES

**Figure 1:** Cost of Capital for Energy Projects (2010-2020)




*Note*: Created by author using the IRR calculations in Goldman Sachs (2020). Data for 2020 are estimates.

**Figure 2:** Weighted Average Cost of Capital for Heavy Industry (Company Averages)




(a) Advanced Economies (b) China

*Note*: Created by author using WACC calculations in IEA (2021).

**Figure 3:** Paris Agreement Alignment by Management Quality Level

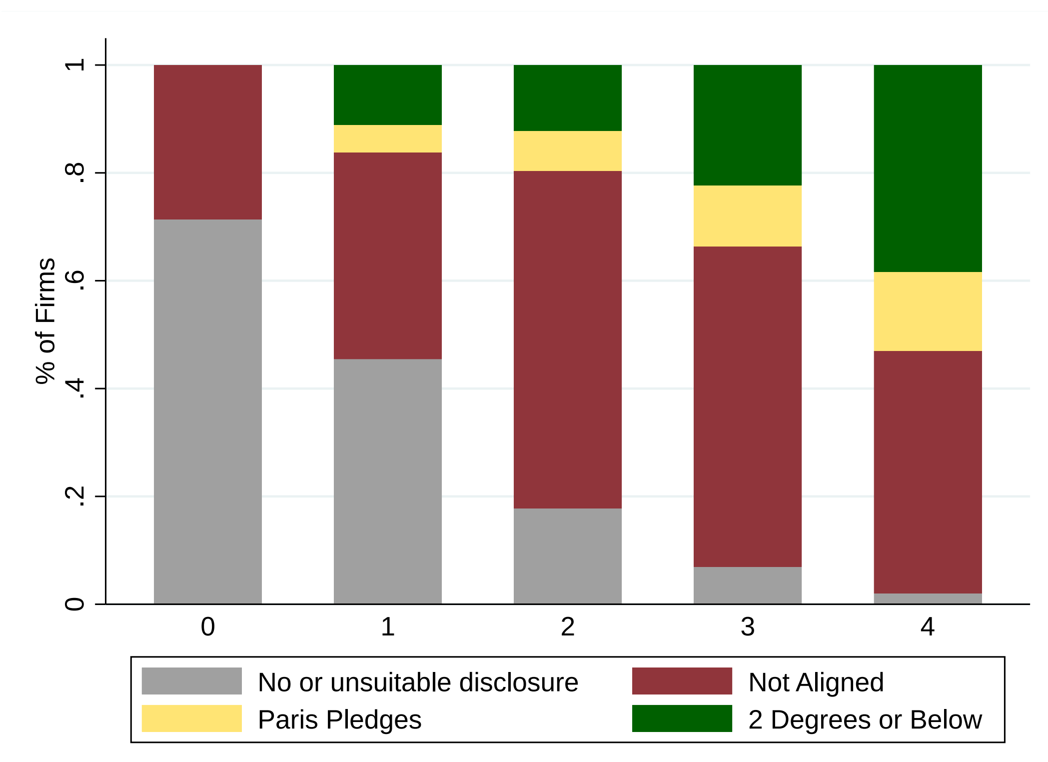


**Figure 4:** Paris Agreement Alignment by Industry

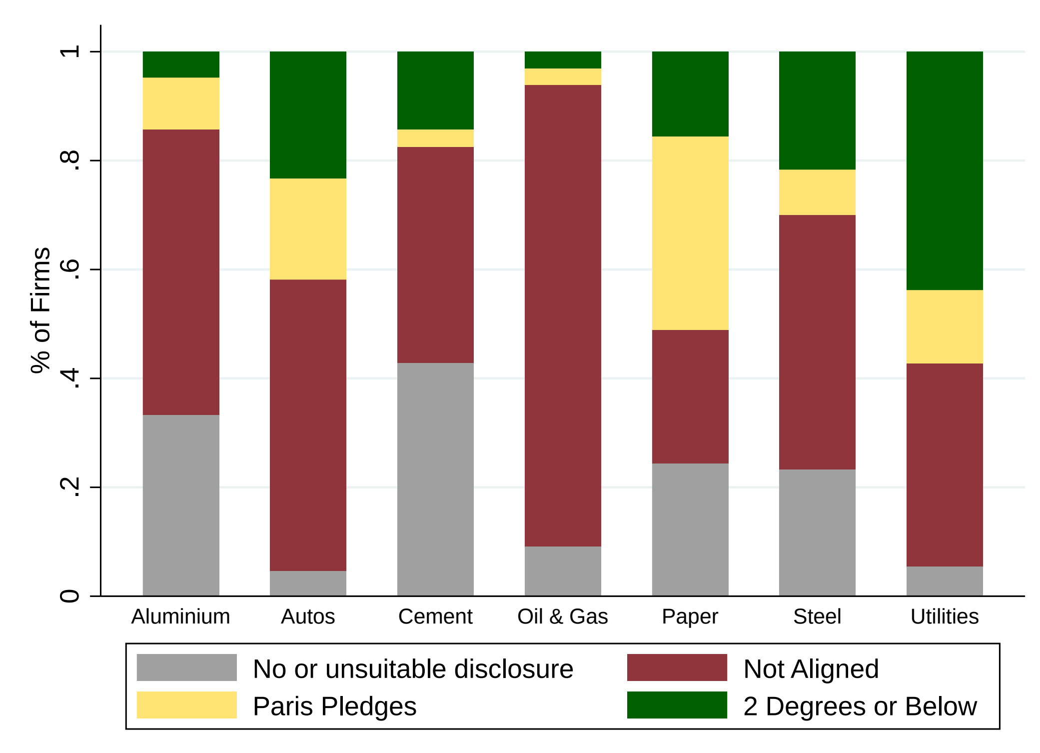
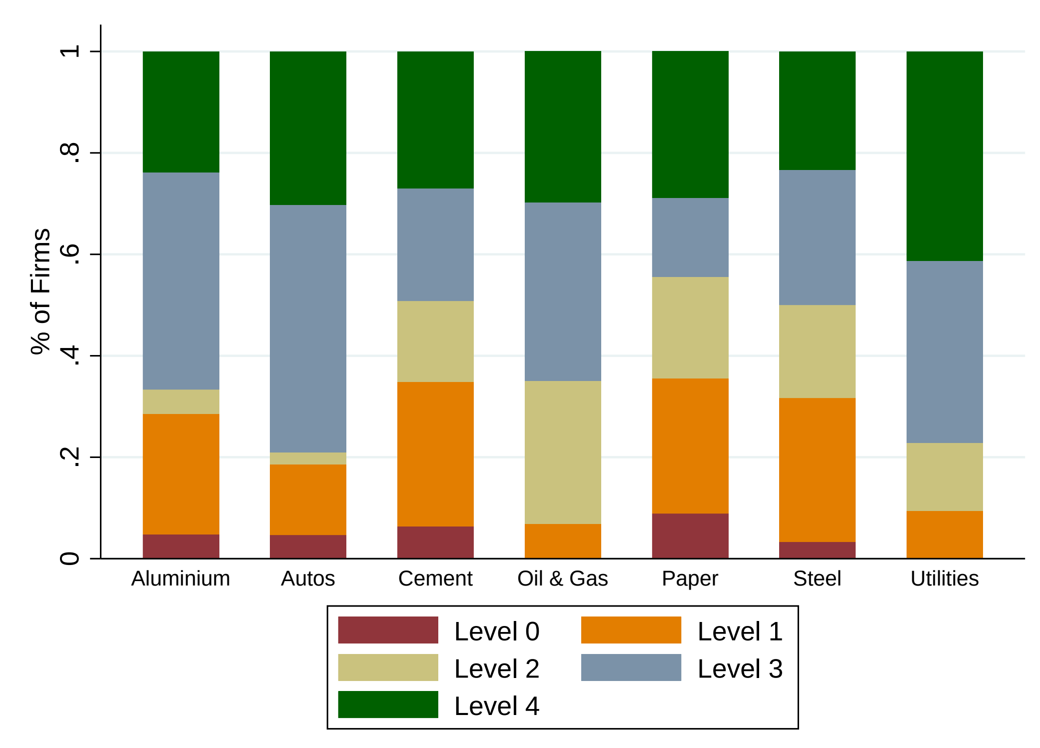



**Figure 5:** Management Quality Level by Industry



# MAIN TEXT TABLES

**Table 1:** Categorization of Metrics, Governance, and Strategy Questions

| | *MQ Level* |
|---|---|
| **Measurement, Targets, and Reporting ("Metrics")** | |
| Has the company set greenhouse gas emission reduction targets? | 2 |
| Has the company published information on its Scope 1 and 2 GHGs? | 2 |
| Has the company set quantitative targets for reducing its GHGs? | 3 |
| Does the company report on Scope 3 emissions? | 3 |
| Has the company had its operational (Scope 1 and/or 2) GHGs data verified? | 3 |
| Has the company set long-term quantitative targets for reducing its GHGs? | 4 |
| **Governance** | |
| Does the company acknowledge climate change as a significant issue for the business? | 0 |
| Does the company explicitly recognise climate change as a relevant risk and/or opportunity to the business? | 1 |
| Does the company have a policy (or equivalent) commitment to action on climate change? | 1 |
| Has the company nominated a board member or board committee with explicit responsibility for oversight of the climate change policy? | 3 |
| Has the company incorporated environmental, social and governance issues into executive remuneration? | 4 |
| Does the company incorporate climate change risks and opportunities in their strategy? | 4 |
| **Strategy** | |
| Does the company support domestic and international efforts to mitigate climate change? | 3 |
| Does the company undertake climate scenario planning? | 4 |
| Does the company have an internal price of carbon? | 4 |

*Notes:* Table contains the questions associated with the management practices and strategies studied in this paper. *MQ Level* is their management quality strength as evaluated by the Transition Pathway Initiative, which I describe in Section 5.3.

**Table 2:** Correlation Between Management Quality and Environmental Performance

| *Dep. Var.:* | ≤2°C | ≤2°C | ≤2°C | <2°C | No Alignment |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| MQ Level | 0.080*** | | | | |
| | (0.015) | | | | |
| MQ Score | | 0.289*** | | | |
| | | (0.047) | | | |
| Metrics Score | | | 0.041 | 0.048 | -0.099 |
| | | | (0.066) | (0.045) | (0.082) |
| Governance Score | | | 0.123 | 0.123* | -0.043 |
| | | | (0.074) | (0.072) | (0.085) |
| Strategy Score | | | 0.126* | 0.117* | -0.234*** |
| | | | (0.065) | (0.063) | (0.082) |
| Observations | 545 | 545 | 545 | 545 | 545 |
| Mean Dep. Var. | 0.264 | 0.264 | 0.264 | 0.207 | 0.583 |

*Notes:* Dependent variables are indicators equal to one if the firm's pollution levels are aligned with the Paris Alignment ≤2°C target in Columns 1-3 and the <2°C target in Column 4. In Column 5, the dependent variable is equal to one if the firm is not aligned with any target or pledge. Independent variables are the firm's management quality level assigned by TPI (Column 1), an overall score that I construct, (Column 2), and category-specific scores that I construct (Columns 3-5) as described in Section 5.3.3. Sector-year fixed effects are included in all regressions. Standard errors are clustered by country. Asterisks denote *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

**Table 3:** Correlation Between Metrics Practices and Environmental Performance

| *Dep. var.:* | ≤2°C | <2°C | No Alignment |
|---|---|---|---|
| | (1) | (2) | (3) |
| Has GHG Targets | -0.017 | 0.022 | -0.025 |
| | (0.106) | (0.105) | (0.101) |
| Publishes Scope 1 and 2 | 0.074 | 0.066 | -0.027 |
| | (0.055) | (0.041) | (0.059) |
| Quantitative GHG Targets | -0.135 | -0.126 | 0.063 |
| | (0.119) | (0.094) | (0.148) |
| Scope 3 Emissions Reported | 0.042 | 0.053 | -0.076 |
| | (0.047) | (0.040) | (0.051) |
| Verifies Emissions Data | 0.124*** | 0.120*** | -0.035 |
| | (0.039) | (0.037) | (0.043) |
| Long-Term Quantitative GHG Targets | 0.132*** | 0.088** | -0.185** |
| | (0.039) | (0.039) | (0.081) |
| Observations | 545 | 545 | 545 |
| Mean Dep. Var. | 0.264 | 0.207 | 0.583 |

*Notes:* Dependent variables are indicators equal to one if the firm's pollution levels are aligned with the Paris Alignment ≤2°C target in Column 1 and the <2°C target in Column 2. In Column 3, the dependent variable is equal to one if the firm is not aligned with any target or pledge. Independent variables are the specific practices related to measuring and reporting GHGs that I use to construct the metrics management score. Sector-year fixed effects are included in all regressions. Standard errors are clustered by country. Asterisks denote **p* <0.10, ***p* <0.05, ****p* <0.01.

**Table 4:** Correlation Between Governance Practices and Environmental Performance

| *Dep. var.:* | ≤2°C | <2°C | No Alignment |
|---|---|---|---|
| | (1) | (2) | (3) |
| Acknowledges CC | 0.183 | -0.099 | -0.252 |
| | (0.179) | (0.076) | (0.164) |
| Acknowledges CC as a Risk | 0.061 | 0.021 | -0.089 |
| | (0.071) | (0.058) | (0.095) |
| Has Policy to Act | -0.211 | 0.067* | 0.017 |
| | (0.172) | (0.034) | (0.188) |
| Board Member Responsible for CC | 0.047 | 0.025 | -0.066 |
| | (0.064) | (0.069) | (0.062) |
| Exec Remuneration Incorporates CC Perf | 0.154*** | 0.122*** | -0.160*** |
| | (0.028) | (0.027) | (0.037) |
| CC Risks and Opps in Strategy | 0.005 | 0.047* | 0.013 |
| | (0.029) | (0.025) | (0.031) |
| Observations | 545 | 545 | 545 |
| Mean Dep. Var. | 0.264 | 0.207 | 0.583 |

*Notes:* Dependent variables are indicators equal to one if the firm's pollution levels are aligned with the Paris Alignment ≤2°C target in Column 1 and the <2°C target in Column 2. In Column 3, the dependent variable is equal to one if the firm is not aligned with any target or pledge. Independent variables are the specific practices related to firm governance that I use to construct the governance management score. Sector-year fixed effects are included in all regressions. Standard errors are clustered by country. Asterisks denote **p* <0.10, ***p* <0.05, ****p* <0.01.

**Table 5:** Correlation Between Strategy and Environmental Performance

| *Dep. var.:* | ≤2°C | <2°C | No Alignment |
|---|---|---|---|
| | (1) | (2) | (3) |
| Supports Domestic and Int'l Efforts | 0.045 | 0.083*** | -0.118*** |
| | (0.033) | (0.027) | (0.042) |
| Undertakes Scenario Planning | 0.047 | 0.022 | -0.068 |
| | (0.042) | (0.034) | (0.047) |
| Sets Internal Price of Carbon | 0.123*** | 0.107*** | -0.128** |
| | (0.045) | (0.040) | (0.052) |
| Observations | 545 | 545 | 545 |
| Mean Dep. Var. | 0.264 | 0.207 | 0.583 |

*Notes:* Dependent variables are indicators equal to one if the firm's pollution levels are aligned with the Paris Alignment ≤2°C target in Column 1 and the <2°C target in Column 2. In Column 3, the dependent variable is equal to one if the firm is not aligned with any target or pledge. Independent variables are the specific practices related to the firm's strategy that I use to construct the strategy management score. Sector-year fixed effects are included in all regressions. Standard errors are clustered by country. Asterisks denote *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

**Table 6:** Correlation Between "Best Practices" Score and Environmental Performance

| *Dep. var.:* | ≤2°C | <2°C | No Alignment |
|---|---|---|---|
| | (1) | (2) | (3) |
| "Best Practices" Score | 0.603*** | 0.585*** | -0.780*** |
| | (0.096) | (0.083) | (0.146) |
| Observations | 545 | 545 | 545 |
| Mean Dep. Var. | 0.264 | 0.207 | 0.583 |

*Notes:* Dependent variables are indicators equal to one if the firm's pollution levels are aligned with the Paris Alignment ≤2°C target in Column 1 and the <2°C target in Column 2. In Column 3, the dependent variable is equal to one if the firm is not aligned with any target or pledge. *"Best Practices" Score* is the proportion of total points earned associated with the practices that I find are correlated with Paris Agreement alignment, which I detail in Section 5.3. Asterisks denote *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.