Incentive Diffusion and Decarbonization Rates

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Early draft – please do not share – comments are welcome.

Abstract

We study how the diffusion of decarbonization incentives is related to an organization's decarbonization rate over time. Decarbonization opportunities and knowledge within a firm are spread across multiple departments and often reside with employees across different hierarchies. We find that diffusing incentives across senior executives, middle managers, and all employees, is correlated with a larger decarbonization rate. Importantly, this association is driven by emissions reductions from real decarbonization activities (e.g., energy efficiency, renewable energy), as opposed to emission reductions from organizational structure (e.g., M&A) or carbon accounting measurement changes. We predict and find that the incentive diffusion is more robustly associated with decarbonization rates where employee alignment on decarbonization strategy might be more challenging, such as in firms with higher geographical dispersion of emissions, in countries without environmental disclosure regulation, and in countries with less public concern about climate change.

Keywords: decarbonization, incentive diffusion, climate change, middle managers

JEL classification: Q54, M14, M52

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1 Introduction

A growing number of companies are taking action to reduce their carbon emissions, which require the effort and knowledge of a diverse set of employees across the firm: energy efficiency projects can stem from product design, manufacturing processes, and office maintenance; supply chain emissions reduction require the procurement team to work with suppliers and product development. However, the alignment of employee actions on decarbonization is often challenging when there are mixed signals and beliefs from regulators, customers, and investors, to legitimize the economic case for decarbonization (e.g., Fabrizio, 2013; Engau and Hoffmann, 2011; Zhong and Chen, 2019). In this paper, we study the role of incentives in fostering employee alignment, defined as the alignment in employee beliefs about the firm's decarbonization strategy. Specifically, we examine the relationship between having diffused decarbonization incentives across senior executives, middle managers, and other employees and the organization's decarbonization rate over time. Importantly, we decompose decarbonization rates into several components, reflecting real emission reductions, emission transfers through acquisitions or divestitures, output-driven emission changes, and accounting-driven emission changes.

We hypothesize that the diffusion of incentives could help organizations identify and promote the most effective decarbonization strategies. By offering rewards or recognition for successful emission reduction efforts, organizations can encourage innovation, collaboration, and knowledge sharing among employees (Merriman et al., 2016). This, in turn, can lead to the development and implementation of new technologies, practices, and solutions that contribute to significant emission reductions. Moreover, the diffusion of incentives can help to create a culture of sustainability within organizations. When employees are incentivized to contribute to decarbonization efforts, they are more likely to take ownership of the process and develop a sense of responsibility towards the

environment (Ramus and Steger, 2000; Spreitzer, 2008).

However, the diffusion of incentives might be ineffective in driving higher decarbonization rates or even slowing the decarbonization rates. The low power of those incentives, crowding out intrinsic motivation for pro-social behavior, and conflicts across the incentivized employees that might be competing for rewards and recognition could all lead to diffusion of incentives exhibiting no relation or even a negative relation to decarbonization rates (Frey and Jegen, 2001; Bonner and Sprinkle, 2002; Kunz and Pfaff, 2002; Ioannou et al., 2016). Moreover, it could be more effective to incentivize a champion and diffuse changes in behaviors through informal control mechanisms by instituting new norms and beliefs inside the organization (Bertels et al., 2010; Tayler and Bloomfield, 2011). Additionally, if such incentives are not supported with good governance over carbon emissions, we may observe that incentives are correlated with more emissions reduction through measurement changes as opposed to real decarbonization activities.

We use data from CDP, the largest depository of corporate environmental disclosure, to measure a firm's design of decarbonization incentives and decarbonization rates. Our sample includes 19,118 firm-year observations and 3,535 unique firms between years 2011 and 2022. On average, 43%, 48%, and 48% of firms have incentives for top executives, middle managers, and all employees, respectively. The average firm provides incentives to 0.77 and 0.99 top executives and middle managers, respectively, with some firms providing decarbonization incentives to as many as 10 top executives or middle managers. We focus on the changes in scopes 1 and 2 emissions because firms provide additional disclosure about the sources of these changes (e.g., use of renewable energy, output changes, divestment) and also because scope 3 emissions are estimated with a high degree of uncertainty. On average, firms reduce scopes 1 and 2 emissions by 2 percent each year.

Our main finding shows that providing incentives to all employees, top executives, and mid-

dle managers is each associated with more emissions reductions. Importantly, such reductions in emissions come from real emissions reduction (i.e., efficiency measures or increasing the use of renewable energy) as opposed to through organizational structure changes (e.g., divestment of plants or business units) or carbon accounting methodology changes (e.g., changing firm boundaries). Our estimates suggest that providing incentives to all employees, top executives, and middle managers is correlated with 1.39%, 1.80%, and 0.72% more real emissions reductions. We find little association between incentive diffusion and the output, structure, and accounting-driven decarbonization rates.

Providing comfort to our categorization of emissions changes, we find that firms with a higher growth rate are correlated with emissions increases related to output and structural changes. Additionally, incentive-induced emissions reduction is not achieved by lowering output, in fact, firms with diffuse incentives are more likely to have higher emissions as a result of output changes.

To examine if incentive diffusion helps align employee interests in achieving decarbonization, we conduct three cross-sectional tests. First, we consider firms with emissions dispersed across more geographical locations, where employee alignment in the firm's decarbonization strategy might be lower as managers might hold different beliefs about climate change and be exposed to different pressures by customers and regulators regarding carbon emissions. Using CDP data on the geographical breakdown of scopes 1 and 2 emissions, we create an emissions geographical concentration measure using the Herfindahl-Hirschman Index (HHI). Second, we focus on subsamples where there is likely less employee alignment inside the firm about the pace of decarbonization based on local concern and awareness about climate change. We proxy for local concern and awareness using data from the International Public Opinion on Climate Change, which is a survey co-created by Meta and Yale University based on responses from 108,946 monthly active Facebook users in 192 countries. The survey includes questions like "How worried are you about climate change?" and "How much do you know about climate change?" We assume there is more disagreement and therefore less

employee alignment about decarbonization for firms in countries with lower concern and awareness about climate change. Third, we look at subsamples without regulatory disclosure requirements, acting as an external pressure that could help align the importance of decarbonization within the firm. To the extent that environmental disclosure regulation helps align employee beliefs about the importance of decarbonization efforts, we expect the effect of incentive diffusion to be stronger in the subsample without environmental disclosure regulation. Using data from Krueger et al. (2021), we repeat our main analysis separately for countries with and without environmental disclosure regulations. Across all three tests, we find that the coefficient on middle managers is only significantly related to real emissions reduction in the subsample where we expect lower employee alignment. This differential relationship between the diffusion of incentives across middle managers and decarbonization rates is consistent with the role that middle managers play in strategy implementation (Wooldridge et al., 2008; Rouleau and Balogun, 2011; Mollick, 2012; Gartenberg et al., 2019).

We conduct several additional analyses that allow us to differentiate across incentive types and the role of governance in moderating the association between incentive diffusion and accounting-driven decarbonization rates. Regarding the first test, we analyze incentives with and without monetary awards. While prior studies find that monetary incentives can crowd out intrinsic motives from setting ambitious targets (Ioannou et al., 2016), our results show that incentive diffusion among top and middle managers are only associated with decarbonization rates in the presence of monetary rewards. One potential reason is that non-monetary awards are often recognitions given to a subset of employees and this creates competition that does not generate substantial real emissions reduction. Another reason is that top and middle managers often have multiple goals with tradeoffs between environmental-related goals and other goals such that monetary incentives are needed to influence their decision-making (Hahn et al., 2010; Merriman et al., 2016).

Regarding the second test, we consider the possibility that incentive diffusion is correlated with

emissions reduction through measurement changes when there is insufficient governance in place to monitor the integrity of the measures. We create a climate governance index based on three characteristics firms disclose in CDP: board oversight, emissions verification, and whether the information in CDP is also included in the firm's regulatory reporting. In the subsample with below-median climate governance index, having incentives for top executives is correlated with emissions reduction in the measurement category. This finding highlights the importance of having corresponding controls in place when providing decarbonization incentives to managers.

We recognize the correlational nature of our study given the lack of a natural experiment that randomly assigns the diffusion of incentives across firms. In robustness tests, we control for other environmental variables that could be correlated with both incentive diffusion and decarbonization rates, and our main results remain robust. Moreover, we test whether the relation between incentives and decarbonization rates differs across settings where we expect lower employee alignment to provide corroborating evidence. Conducting field experiments and collecting detailed data on employee behavior as a result of incentive schemes might be able to add significant insights to the results in our paper. Moreover, we acknowledge that, much like the literature on incentives for decarbonization, we cannot observe the strength of these incentives. Collecting data from individual organizations that might be willing to share data on the power of the incentives could also add new insights.

Our paper contributes to two lines of literature. The first relates to how firms manage decarbonization. Prior papers that examine how firms can achieve decarbonization from a managerial perspective focus on the use of emissions targets (Ioannou et al., 2016; Freiberg et al., 2021) and the use of contracts (e.g., green bonds, green covenants, compensation contracts) (Flammer, 2020, 2021; Cohen et al., 2023). We are the first to examine not just the reduction of emissions, but also separately consider whether the emissions are driven by real reductions in emissions, versus changes

in company structure, output, or accounting methodology. We find that incentive diffusion helps align interests within the firm in achieving real decarbonization, but also caution that in firms with weak climate governance, we find evidence of emissions reduction through changing measurements.

Our paper also contributes to the literature on ESG incentives and compensation. Prior papers that study incentive and compensation focus on the concept of ESG broadly rather than decarbonization specifically (e.g., Flammer et al., 2019; Cohen et al., 2023; Carter et al., 2023). Flammer et al. (2019) examine a panel dataset on ESG compensation and find that compensation is not merely symbolic, but is associated with better ESG performance. Recent papers examining the use of compensation to motivate decarbonization mostly focus on providing incentives to top executives (e.g., Flammer et al., 2019; Cohen et al., 2023). Few papers consider incentives for non-executive employees (Merriman et al., 2016) or the diffusion of incentives (Dahlmann et al., 2017). Merriman et al. (2016) use a lab experiment and find incentive effects for non-executive employees are more pronounced when environmental projects are more aligned with financial benefits. Dahlmann et al. (2017) examine CDP data between 2011 and 2014 and find that inclusion and diversity of incentives, combination of both monetary and nonmonetary incentives, are correlated with overall emissions reduction. We add to this line of research showing that, across a large period and sample, the diffusion of incentives across the hierarchy of an organization and within managerial levels is associated with more decarbonization. More importantly, we show that this association is driven by real emission reductions and document conditions under which the provision of incentives to middle managers might be more likely to be associated with emission reductions.

2 Hypothesis Development

2.1 Decarbonization and Employee Alignment

To achieve decarbonization targets, companies need to make significant changes to various aspects of their business, which requires the participation of multiple personnel for various reasons. First, information related to where decarbonization levers are within the firm is scattered across the firm. The role of information diffusion has been studied in the innovation management literature, where knowledge resides with individuals, and hence effective knowledge management process facilitates innovation (e.g., Subramaniam and Youndt, 2005; Li and Sandino, 2018). Second, the implementation of decarbonization projects requires the participation of multiple departments. For example, energy efficiency projects are related to office management, factory production process, packaging, product design, and product mix, each involving different business units and geographical locations.

However, the alignment of employee actions towards a common strategic goal is often challenging (Van den Steen, 2010). Employees might have different beliefs about the right course of action and different incentives and, therefore, priorities. In the context of a decarbonization strategy, employee alignment might be a particularly challenging task, as this belief misalignment might be exacerbated for several reasons. First, signals legitimizing the economic case for decarbonization, from regulators, customers, and investors might be weak, uncertain, and uneven across time and geographies. For example, while some evidence exists for customer demand for lower carbon products, other evidence suggests very little demand or willingness-to-pay for such products (Sammer and Wüstenhagen, 2006; Peattie, 2010; Zhong and Chen, 2019). Regulatory measures, such as carbon taxes and cap and trade systems, have been introduced in several geographies, but in much of the world, carbon emissions are not priced or carry low prices (World Bank, 2023). Second, employees might hold

different beliefs about the need to decarbonize the economy and levels of concern about climate change. For example, while close to 90% of survey responders in Greece and South Korea thought that climate change is a major threat to their country, that percentage was closer to 40% in Israel and Nigeria (Fagan and Huang, 2019).

2.2 How Incentives Help Align Interests

The prior literature has examined the role of incentives in aligning interests within organizations. One area of focus has been the use of incentives to address agency problems by aligning the objectives of agents and principals (Holmstrom and Milgrom, 1991). Another line of research has highlighted the role of incentives in aligning interests across hierarchical levels within organizations (Mookherjee, 2006; Mookherjee and Reichelstein, 2001). Other papers demonstrate that well-designed incentive schemes with interdependence can foster cooperation that enhances overall performance (Bushman et al., 1995; Wageman and Baker, 1997).

Similarly, we hypothesize that the use of incentives can help mitigate the lack of employee alignment in organizations trying to decarbonize. We further refine diffusion to represent incentives provided across different hierarchies in the company. Specifically, we consider top executives, middle managers, and all employees. Top executive alignment is crucial as it provides a consistent signal across the organization of leadership commitment to decarbonization. Prior papers on environmental incentives mostly focus on executive compensation (Cohen et al., 2023; Bonham and Riggs-Cragun, 2022; Carter et al., 2023). In turn, middle managers are crucial agents of change to facilitate information and effort communication across different parts of the company. Finally, rank-and-file employees across the firm carry out the orders for decarbonization activities to take place. As such, we hypothesize that providing incentives to all three types of employees is associated with more emissions reduction since decarbonization involves everyone in the firm.

We are particularly interested in the role of middle managers in creating alignment in the firm. A common challenge shared by organization leaders is an implementation gap, where there is a disconnect between the views of top executives and middle managers implementing the decarbonization projects (ENGIE Impact, 2023). Often, senior executives are more optimistic about the decarbonization transition but middle managers are falling back on business as usual. Prior research highlights that middle managers play an important role because they connect strategy development to strategy execution (Mollick, 2012; Gartenberg et al., 2019). Specifically, middle managers' behaviors and actions could accelerate or inhibit strategy implementation as they often have superior knowledge of routines, processes beliefs, and behaviors exhibited throughout the organization and frequent interactions with all levels of employees. As a result, they are at a unique position to influence norms, beliefs and behaviors inside the organization, with their actions being perceived as reflecting organizational priorities. As such, we hypothesize that providing incentives to middle managers is associated with more emissions reduction, incremental to providing incentives to top executives.

Hence, our first hypothesis predicts that providing incentives across different levels of organizational hierarchy is correlated with more real emissions reduction.

Hypothesis 1: Diffusing decarbonization incentives to a broader set of employees is associated with more real emissions reduction.

However, there are reasons to believe incentive diffusion is not correlated with real reductions in emissions. First, diffused incentives across a variety of employees can generate confusion on the responsibility of the task and create free-riding concerns. In this case, a more concentrated incentive design provides clarity on tasks that need to get done, especially when the tasks are well-defined and involve multiple departments (Oldham and Hackman, 1981; Pierce and Delbecq,

1977; Wally and Baum, 1994; Bolton and Farrell, 1990). Such a champion on decarbonization can also be effective in driving decarbonization across the firm through informal control mechanisms by instituting new norms and beliefs inside the organization (Bertels et al., 2010; Tayler and Bloomfield, 2011). Second, providing more incentives can crowd out employees' intrinsic motivation to engage in carbon reduction activities, especially when the incentives have low power (Frey and Jegen, 2001; Kunz and Pfaff, 2002; Ioannou et al., 2016). Third, providing incentives to more employees can create competition for rewards and recognition that could impede the rate of decarbonization (Lazear and Rosen, 1981; Charness et al., 2014; Connelly et al., 2014). Finally, given concerns about the quality of emissions measurements, incentives can cause employees to "game" a performance measure by engaging in activities not intended by the incentive (Holmstrom and Milgrom, 1991; Baker, 1992). Specifically, decarbonization incentives may cause managers to achieve lower emissions through means such as changing accounting methodology or through divesting business units, especially when governance over climate issues is weak. As such, it remains an empirical question as to whether incentive diffusion is associated with real decarbonization that corresponds to lower atmospheric greenhouse gases.

2.3 Where Might Incentive Diffusion Matter Most?

If incentive diffusion helps an organization achieve more decarbonization by aligning different employees' beliefs about the firm's decarbonization strategy, we hypothesize that this effect will be stronger where employee alignment on decarbonization strategy might be more challenging. We discuss three situations below.

First, employee alignment around decarbonization might be lower in more geographically decentralized organizations as these employees will likely be exposed to very different societal contexts around climate change awareness, regulatory measures, and business environments. Therefore, in these settings, the diffusion of incentives might be more important.

Hypothesis 2: Incentive diffusion is associated with more real emissions reduction when the geographical dispersion of emissions is less concentrated.

Second, employee alignment depends on the belief of employees within a firm. Prior literature finds that individual's concern and awareness about climate change affect their behavior, such as through policy support and real estate investment (Bouman et al., 2020; Choi et al., 2020; Baldauf et al., 2020). In countries where local concern and awareness about climate change is high, there is likely employee alignment on the firm's decarbonization strategy. As such, we expect incentive diffusion to be more important when local concern and awareness about climate change are low.

Hypothesis 3: Incentive diffusion is associated with more real emissions reduction when local concern and awareness about climate change is low.

Third, employee alignment depends on other institutional features that provide clarity as to the need for decarbonization. Existing literature documents that regulatory uncertainty deters firm investments due to the lack of clarity on the right course of action (Fabrizio, 2013; Engau and Hoffmann, 2011). In other words, regulation can bring clarity, and we predict that a firm located in a country with environmental disclosure regulation might be more likely to have employee alignment as the regulation might legitimize the need for decarbonization. As such, we expect incentive diffusion to be more important in countries without environmental disclosure regulations.

Hypothesis 4: Incentive diffusion is associated with more real emissions reduction in countries without environmental disclosure regulation.

3 Data and Summary Statistics

3.1 Sample: CDP Firms from 2011-2022

We obtain information on firms' emission changes and incentive provisions regarding climate change management through the survey conducted by CDP from 2011 to 2022. CDP is an interna-

tional not-for-profit organization that possesses the most comprehensive collection of self-reported environmental data from companies and cities worldwide and has been used as the data source for the literature on carbon emissions (Ioannou et al., 2016).

Table 1 provides the sample selection for our analysis. Of the 33,085 firm-years in CDP data from 2011 to 2022, we exclude 29% of the firm-years without an ISIN code, which we use to merge the CDP dataset to other datasets. We exclude 7.6% of the firm-years with assets less than or equal to 1 million (Carter et al., 2023). We exclude 5.4% of the firm-years missing control variables. Our final sample includes 19,118 unique firm-year observations and 3,535 unique firms, spreading across various countries and numerous industry groups.

Table 2 Panel A presents the frequency distribution across countries. Our sample encompasses a wide range of countries, with a significant number of observations coming from the U.S., Japan, the U.K., Canada, and France. This set of top countries is consistent with the CDP sample for the years 2011 through 2013 as reported by Ioannou et al. (2016), except for Germany, which is no longer among the top five countries in our sample. Table 2 Panel B presents the frequency distribution across industries. The majority of observations are from companies in the capital goods, materials, banks, and utilities.

3.2 Data: Incentive Diffusion Measures

We measure incentive diffusion using data responses from structured questions in the CDP survey, which require specific answers through drop-down options and tables. Specifically, the questions of interest are stated as follows: "Do you provide incentives for the management of climate change issues, including the attainment of targets?" If a company responses "Yes," then they are prompted to provide additional information regarding the position of the individuals eligible for incentives (such as board/executive team, corporate executive team, management group, or all employees), the

type of incentives available (with options including "monetary reward" and "non-monetary award"), and any additional comments describing the tasks assigned to the individuals.

Following Ioannou et al. (2016)'s Appendix B, we categorize the positions into three categories: all employees, top executives, and middle managers. Positions falling under the "top executives" category are positions that contain the words *'board', 'chief', 'c-suite', 'executive,'* and *'president'*.[1] Positions containing the words *'manager'* or *'management'* belong to the "middle managers" group.[2] The "all employees" category is self-explanatory; they are explicitly displayed as *'All employees'* in the CDP data.

Our diffusion variables consist of two types – indicator and count variables. In our first model specification (see Table 4), we use three indicator variables for all employees, top executives, and middle managers. These variables take the value of 1 if a firm provides any decarbonization incentives for employees within their respective groups. For example, if a firm-year has four rows of positions entitled to decarbonization incentives in the raw CDP data (CEO, procurement manager, energy manager, and all employees), then each of the three indicator variables will take the value of 1 when the data is aggregated to the firm-year level. Table 2 Panel C shows that on average, 43%, 48%, and 48% of firms have incentives for top executives, middle managers, and all employees, respectively. Table 3 shows that the correlation between the three indicator variables is low, ranging between 0.069 and 0.293, allowing us to include all three variables together in the model. Moreover, it suggests that even in cases where companies report providing incentives to all employees, it does not necessarily mean that the variables for top and middle managers are coded as 1. Instead, those

[1]The top executive positions can include roles such as board chair, board/executive board, director on board, corporate executive team, chief executive officer (CEO), chief financial officer (CFO), chief operating officer (COO), chief procurement officer (CPO), chief risk officer (CPO), chief sustainability officer (CSO), other c-suite officer, president, and executive officer. In the financial services industry, firms may also have positions such as chief investment officer (CIO), chief underwriting officer (CUO), or chief credit officer (CCO).

[2]The middle manager positions can include roles such as management group, business unit manager, energy manager, environmental, health, and safety manager, environment/sustainability manager, facilities manager, process operation manager, procurement manager, public affairs manager, and risk manager. In the financial services industry, firms may also have positions such as portfolio/fund manager and ESG portfolio/fund manager.

variables take the value of 1 if companies report specific incentives for specific managers.

For our second model specification (see Table 5), we use count variables for top executives and middle managers. These variables capture the number of positions from the top executives or middle managers entitled to decarbonization incentives. Building on the example above, the count variable for top executives would be 1 (CEO), and for middle managers, it would be 2 (procurement manager and energy manager). On average, firms provide incentives to 0.77 and 0.99 top executives and middle managers, respectively. Notably, some firms provide decarbonization incentives to as many as 10 top executives or middle managers.

3.3 Data: Change in Emissions

While previous studies primarily focus on greenhouse gas (GHG) emissions as the main outcome of interest (Dahlmann et al., 2017; Bolton and Kacperczyk, 2023), we are the first to not only examine the overall reduction of GHG emissions but that we disaggregate total change in scopes 1 and 2 GHG emissions into different sources. Based on CDP responses, we group the change in emissions into the following categories: *Real* (emissions reduction and use of renewable energy), *Output* (output), *Measure* (boundary and methodology), *Structure* (divestment, acquisition, and merger), and *Other* (other, physical change, unidentified).

Figure 1 shows the distribution over time. Reassuringly, *Real* emissions change is negative and exhibits a downward trend, showing a reduction in emissions by less than 5% in 2011 to more than 5% after 2018. *Output* emission changes show a positive trend each year, except for 2021, which can be attributed to the widespread impact of COVID-19 on the economy. In additional breakdown, we confirm that within *Structure*, divestment is associated with a negative emissions change and that acquisition and mergers are associated with a position emissions change.

Table 2 Panel D shows that the average total emissions reduction is 2%. Among all five cate-

gories of emissions change, only *Real* emissions change is on average negative at 5.8%. On average, changes in *Output*, *Measure*, and *Structure* increase emissions by 1.40, 0.91 and 0.54% annually. Table 3 shows that each of the five categories is not highly correlated with each other, with correlations ranging from -0.054 to 0.046. This suggests that the categories reflect meaningfully different dimensions of emissions change in firms.

3.4 Other Data

- **Emissions breakdown by country**

The CDP survey asks firms to break down their Scopes 1 and 2 emissions by country. Companies can select from a drop-down list of countries, and then they will report a numerical value of Scope 1 emissions in metric tons CO2e. For Scope 2 emissions, companies can report location-based and market-based emissions in metric tons CO2e. We choose the location-based method to capture the emissions that closely resemble the operational structure of the firm, rather than using market-based emissions that account for renewable energy credit or power purchase agreements.

Using the geographical breakdown of Scopes 1 and 2 emissions, we create a concentration measure using the Herfindahl-Hirschman Index (HHI) and label it as the *Geographical Emissions Concentration HHI (GEC HHI)*. The concentration ranges from 0 to 10,000, where a score of 10,000 means that a firm operates in only one geographical location, with 100% of the share of emissions. The lower the concentration, the more dispersed the emissions are within a company.

- **Other Refinitiv Datastream Financial Variables**

All our models include controls for the firm-year financial characteristics obtained from Refinitiv Datastream, following Ioannou et al. (2016). We control for firm size (natural logarithm of revenue), growth opportunities (price-to-book ratio), profitability (ROA), past growth (sales growth), capital intensity (capital expenditures over sales), and firm risk (stock price volatility). We log-transform

revenue to mitigate skewness. For the average firm in our sample, *Revenue* is USD 757 million, *Price-to-Book* ratio is 2.6, *ROA* is 4%, past *3-Yr Sales Growth* is 5%, *Capital Intensity* is 9%, and *Price Volatility* is 25%.

- **International Public Opinion on Climate Change**

We proxy for local concern and awareness using data from the International Public Opinion on Climate Change 2022, which is a survey co-created by Meta and Yale University based on responses from 108,946 monthly active Facebook users in 192 countries. The survey consists of 16 questions in five main areas: Climate Change Knowledge, Beliefs, and Engagement; Worry and Perceived Risks Regarding Climate Change; Responsibility for Actions on Climate Change, Energy and the Economy, and Climate Activism. To ensure the completeness of data, we assign countries across the years based on the 2022 survey results, as the 2021 survey result only includes 31 countries and is not sufficient for our sample.

The survey includes questions such as "How worried are you about climate change?" and "How much do you know about climate change?" Each question offers a range of responses. For example, the options for "How worried are you about climate change?" include "not at all worried," "not very worried," "somewhat worried," and "very worried." To maintain objectivity, we rely on the survey's executive summary to define which responses constitute "high awareness" of climate change. For example, the executive summary states that "respondents... are the most likely to say they are either "very worried" or "somewhat worried" about climate change," we aggregate these two corresponding answers at the country level to create an awareness percentage (Leiserowitz et al., 2022). We then take an average of all the questions to proxy for overall local concern and awareness.

- **Environmental Disclosure Regulation**

We identify countries with and without environmental disclosure regulations using data from

Krueger et al. (2021). Krueger et al. (2021) construct a dataset comprising country-level mandatory ESG disclosure regulations, primarily sourced from the Carrot & Sticks (C&S) project and the Sustainable Stock Exchange (SSE) Initiative. They further cross-validate this data with information obtained from government agencies, stock exchanges, and newspapers. To compile a list of environmental disclosure regulations, we keep ESG disclosure regulations that cover all E, S, and G dimensions (labeled "all-at-once" in Krueger et al. (2021)), and then manually check and retain only environmental-related disclosure regulations among the remaining regulations.

- **Climate Governance Index**

We construct a Climate Governance Index based on three disclosed characteristics of firms in the CDP: board oversight, emissions verification, and inclusion of CDP information in the firm's regulatory reporting. All three characteristics are indicator variables. Board oversight equals 1 if a firm answers "yes" to the question "Is there board-level oversight of climate-related issues within your organization?" Emissions verification for Scope 1 & 2 emissions equals 1 if the firm selects "Third-party verification or assurance process in place" for its emissions, but only if the type of verification or assurance is "reasonable" or "high."[3] Lastly, the inclusion of CDP information in the firm's regulatory reporting equals 1 when the firm indicates that it has published information about its response to climate change and GHG emissions performance in other regulatory filings. While other types of publication exist, such as other voluntary communications or disclosure frameworks, reporting a firm's response to climate change in regulatory fillings requires firms to have higher integrity and transparency. The final Climate Governance Index is a sum of all three indicator variables.

[3]Note that other types of verification include "not applicable," "limited assurance," "moderate assurance," and "third party verification/assurance underway."

4 Results

In this section, we start by testing whether incentives diffusion contributes to changes in emissions as our main analysis. Next, we study cross-sectional variation by examining where employee alignment on decarbonization strategy might be more challenging, such as in firms with higher geographical dispersion of emissions, in countries with less public concern about climate change, and in countries without environmental disclosure regulation. As additional tests, we study monetary versus non-monetary incentives and the role of governance in moderating the association between incentive diffusion and accounting-driven decarbonization rates. Finally, we conduct various robustness analyses to understand if our main results are robust.

4.1 Incentives Diffusion and Change in Emissions

In the main analysis, we study whether providing incentives to all employees, top executives, and middle managers is associated with more emissions reduction. We use OLS (ordinary least squares) to estimate the following specification for firm i in year t:

$$\begin{aligned} \textit{Change in Emissions}_{i,t} = \beta_0 + \beta_1 \textit{Incentive for All Employees}_{i,t} + \beta_2 \textit{Incentive for Top Executives}_{i,t} \\ + \beta_3 \textit{Incentive for Middle Managers}_{i,t} + \sum \textit{Controls} + \sum \textit{Fixed effects} + \epsilon \quad (1) \end{aligned}$$

The dependent variables are changes in total emissions (*Total)* and five other categories of changes in emissions – real emissions (*Real)*, output-driven emission changes (*Output)*, carbon accounting methodology changes (*Measure*), organizational structure emissions (*Structure*), and others (*Others). Incentive for All Employees* takes the value of 1 if all employees are entitled to climate-related incentives. In the indicator model, *Incentive for Top Executives* and *Incentive for Middle Managers* take the value of 1 if anyone from the board/corporate executive team or anyone from the

management group is entitled to decarbonization incentives. In the count model, *Incentive for Top Executives* and *Incentive for Middle Managers* are the natural logarithm of the number of positions with decarbonization incentives, in their respective groups. β_1, β_2, and β_3 are our variables of interest, capturing how the diffusion of decarbonization incentives is related to an organization's decarbonization rate.

Our main specification includes country, industry, and year fixed effects to account for country and industry time-invariant characteristics and time trends, respectively. Our research design compares the changes in emission reduction for firms in the same country and industry within the same year, but with different diffusion of decarbonization incentives. Standard errors are clustered at the industry level to address potential correlations across different firms within an industry.

Table 4 presents the main results. The first column shows the estimates for *Total* emissions change, and the next five columns show the estimate for different categories of emissions. The coefficients of interest on *All Employees Indicator*, *Top Executives Indicator*, and *Middle Managers Indicator* are negative and statistically significant in column 1, supporting our hypothesis that providing decarbonization incentives separately for top managers, middle managers, and all employees is associated with more emissions reduction. More importantly, such reduction in emissions comes from real emissions reduction as opposed to output-driven changes, organizational structure changes, or carbon accounting methodology changes. The estimates in column 2 suggest that providing incentives to all employees, top executives, and middle managers is correlated with 1.39%, 1.80%, and 0.72% more real emissions reductions.

In Table 5, we repeat the main specification in Table 4 using alternative variable specifications. We replace the indicator variables for *Top Executive* and *Middle Managers* with the respective count variables. We log transform the count of positions being incentivized to mitigate skewness. Similarly,

the coefficients of interest on *All Employees Indicator*, *Ln(Count of Top Executives Incentivized)*, and *Ln(Count of Middle Managers Incentivized)* are negative and statistically significant. The estimate of *All Employees Indicator* in column 2 is similar to the one in Table 4. The estimates of the count variables in column 2 suggest that every 100% increase in the number of top executives or middle managers is correlated with 1.32% ($1.907 \times \ln(2)$) and 0.31% ($0.452 \times \ln(2)$) more real emissions reductions, respectively. For the average firm, a 100% increase is going from 0.77 to 1.54 top executives and from 0.99 to 1.98 middle managers.

Providing comfort to our categorization of emissions changes, we find that firms with a higher growth rate tend to be associated with higher emissions increases related to all the other categories except for real emissions. Additionally, providing incentives to top executives is associated with positive emissions change related to output and structure, which suggests that such incentives are not compromising business growth in firms.

4.2 Cross-Sectional Analyses

In our cross-sectional analysis, we investigate three sets of conditions where internal organizational alignment on decarbonization strategy might be more challenging: First, in firms with higher geographical dispersion of emissions; Second, in countries with less public concern about climate change; and Third, in countries without environmental disclosure regulation.

4.2.1 Geographical Emissions Concentration HHI

We test whether the impact of incentive diffusion is more pronounced in firms with emissions spread across multiple geographical locations. Coordination and exchange of information on decarbonization methods may be challenging for such firms. To quantify this dispersion (or the lack of concentration), we leverage the geographical breakdown of scopes 1 and 2 emissions data from CDP and construct an emissions geographical concentration measure using the Herfindahl-Hirschman Index (HHI).

Table 6 shows the results partitioning our main results based on the geographical emissions concentration HHI. The *low GEC HHI* subsample includes firm-year observations with HHI values ranging from 0 to 5,000, while the *high GEC HHI* subsample comprises values above 5,000 up to 10,000. Columns 1 and 2 show the results for the *low GEC HHI* subsample, while columns 2 and 4 display those for the *high GEC HHI* subsample. We use the indicator variables for *Top Executives* and *Middle Managers* in columns 1 and 2, and the count variables in columns 3 and 4.

We find that the coefficient on middle managers is only significantly associated with real emissions reduction in the subsample with lower geographical concentration – *low GEO HHI*. The estimate of *Middle Managers Indicator* in column 1 suggests that providing incentives to middle managers is correlated with 0.81% more real emissions reductions. The corresponding coefficient in column 2 is not statistically significant (coefficient difference between columns 1 and 2 p-value: 0.292, untabulated). One reason is that middle managers play a unique role in aligning efforts in different geographical regions in a firm, as they are connecting strategy development at the senior management level to strategy execution at the lower employee level (Gartenberg et al., 2019).

On the other hand, we find that the estimated coefficient on top executive incentives does not vary across our subsamples. Both coefficients exhibit a significantly negative correlation, suggesting an important role for incentives independent of the geographic concentration of emission sources. The same is true for the estimated coefficient on incentives for all employees. We speculate that the association between incentives and decarbonization rates is equally strong across subsamples for top executives and all employees for different reasons.

In the case of top executives, they are responsible for setting the strategic direction of the firm and making high-level decisions, in which incentives can be equally important regardless of employee alignments (Hambrick and Mason, 1984). In contrast, middle managers are typically responsible for

implementing the strategic decisions made by top executives, and they often have direct oversight of the employees who carry out the day-to-day operations of the firm. As such, in low-employee-alignment settings, middle managers are particularly important to clarify decarbonization priorities, overcome resistance, and increase employee alignment (Wooldridge et al., 2008).

In the case of all employees, one reason is that the nature of the incentives provided to all employees reflects firm culture instead of specific decarbonization actions. For example, many firms provide incentives to all employees for using public commutes, or provide awards to employees with innovative ideas on decarbonization. While these incentives are associated with emissions reduction, they likely reflect a broader firm emphasis on decarbonization, but not incentives provided on an employee's daily tasks in the firm. Instead, for low-level employees, their direct impact on decarbonization rates is tied to their day-to-day operations and the extent to which they adhere to the practices and procedures set by their managers, which reflects the incentives provided to middle managers Wooldridge et al. (2008).

4.2.2 International Public Opinion on Climate Change

Second, we focus on a subset of firms where there may be less employee alignment inside the firms regarding the need for decarbonization and related technologies, based on local concern and awareness about climate change. To measure this local concern and awareness, we use data from the International Public Opinion on Climate Change 2022, which includes responses from 108,946 monthly active Facebook users in 192 countries. In countries where climate awareness is high, we expect firm employees to have better clarity on the firm's decarbonization strategy. Conversely, in countries with low climate awareness, we anticipate more disagreement and less employee alignment about the decarbonization path for firms.

Table 7 presents the results partitioning based on the international public opinion on climate

change. The *low awareness* sample includes countries with below-median public opinion on climate change, while the *high awareness* includes countries with above-median public opinion on climate change. Consistent with our hypothesis, we find that providing incentives to middle managers is correlated with more real decarbonization only in countries with below-median public opinion on climate change. The estimate of *Middle Managers Indicator* in column 1 suggests that providing incentives to middle managers is correlated with 1.06% more real emissions reductions. The corresponding coefficient in column 2 is not statistically significant (coefficient difference between columns 1 and 2 p-value: 0.141, untabulated).

The coefficients on top executives and all employees remain negative and statistically significant in both subsamples. This result once again highlights the unique role of middle managers in aligning different opinions across the firm, whereas top executives and all employees are important for decarbonization strategy and execution regardless of potential misalignment in employees' belief in decarbonization strategy.

4.2.3 Environmental Disclosure Regulation

Third, we consider the impact of external pressures that potentially enhances employee alignment on decarbonization within firms. Specifically, we look at environmental disclosure regulations that can help align employee beliefs about the significance of decarbonization efforts. We anticipate that the effect of incentive diffusion is more pronounced for firms headquartered in countries without environmental disclosure regulations.

Table 8 presents the results of the environmental disclosure regulation analysis. Approximately 60% of the firm-year observations belong to countries without environmental disclosure regulation, while the remaining 40% are from countries with such regulations. Consistent with our hypothesis, we find that providing incentives to middle managers is positively correlated with more real

decarbonization, but only in countries without environmental disclosure regulation. The estimate of *Middle Managers Indicator* in column 1 suggests that providing incentives to middle managers is correlated with 1.07% more real emissions reductions. The corresponding coefficient in column 2 is not statistically significant (coefficient difference between columns 1 and 2 p-value: 0.075, untabulated).

Similar to the prior two cross-sectional tests, the coefficients on top executives and all employees remain negative and statistically significant in both subsamples. Overall, these results provide corroborating evidence that incentive diffusion is associated with more real emissions reductions by enhancing employee alignment on the rate of decarbonization. Specifically, middle managers play an important role in fostering such alignments.

4.3 Additional Analyses

We conduct two additional analyses. First, we consider how our results differ between monetary and non-monetary incentives. Second, we examine the role of governance in moderating the association between incentive diffusion and accounting-driven decarbonization rates.

4.3.1 Monetary Rewards

We study the effect of incentive diffusion on decarbonization rates by analyzing two types of incentives: those with monetary awards and those without. We introduce interaction terms between each diffusion variable and the indicator variables *Monetary* and *Non-Monetary*.

Table 9 presents the results for the indicator and count models for real emissions reduction. In both columns 1 and 2, the coefficients on the interaction terms between *All Employees* and incentive types are negative and statistically significant, suggesting that incentive diffusion for all employees is associated with decarbonization rates in the presence of both non-monetary recognition and monetary rewards.

However, our results show that incentive diffusion is only significantly associated with decarbonization rates when monetary rewards are given to top executives. The coefficients of *Top Executives* × *Non-Monetary Indicator* and *Ln(Count of Top Executives Non-Monetarily Incentivized* are negative but not statistically significant. We observe a similar pattern for middle managers. One exception is that the coefficient of *Middle Managers* × *Non-Monetary Indicator* is positive and marginally statistically significant. We caution to draw conclusions on this positive coefficient, as the coefficient on the count variable *Ln(Count of Middle Managers Non-Monetarily Incentivized* is negative and not statistically significant.

While prior research suggests that monetary incentives could crowd out intrinsic motives from setting ambitious targets (Ioannou et al., 2016), our results show that incentive diffusion is associated with decarbonization rates in the presence of monetary rewards. One possible explanation for this is that non-monetary awards may only apply to a subset of employees, potentially creating competition that does not lead to significant real emissions reduction. In addition, prior literature highlight tradeoffs between environmental-related goals and other goals such that monetary incentives are needed to influence their decision-making (Hahn et al., 2010; Merriman et al., 2016). Such tradeoffs are more likely to be present in decisions made by top executives and middle managers instead of all employees, which is consistent with our findings.

4.3.2 Climate Governance Index

Having demonstrated that more diffused incentives are associated with more real emissions reduction, does this mean more incentives are always better? One concern is that excessive incentives without proper governance can provide motives for employees to change emissions through over means, such as through emissions measurement adjustments.

To study this possibility, we examine the relation between incentive diffusion and emissions

reduction through measurement changes, particularly in cases where there is inadequate governance in place to monitor the integrity of the measures. To proxy for climate governance, we create a climate governance index based on three characteristics firms disclose in CDP: board oversight, emissions verification, and inclusion of CDP information in the firm's regulatory reporting. The Climate Governance Index is calculated as the sum of all three indicator variables, with values ranging from 0 to 3.

The low *Climate Governance Index* (CGI) subsample includes firm-year observations with values of 0 and 1, with 85% of these observations indicating only board oversight of climate change issues. The high CGI subsample includes firm-year observations with values of 2 and 3, with 89% meeting two out of the three criteria, and 11% fulfilling all three criteria. The *low CGI* sample accounts for 74% of observations in the data.

In Table 10, we find that in the subsample with *low CGI*, providing incentives for top executives is associated with emissions reduction in the measurement category. The estimate of *Top Executives Indicator* in column 1 suggests that providing incentives to top executives is correlated with 0.34% more measure-related emissions reductions. This result emphasizes the importance of having corresponding controls in place when providing decarbonization incentives to top executives, particularly when firms want to address emissions measurement accuracy.

4.4 Robustness Analyses

In our study, we do not causally demonstrate that randomly assigning firms diffused incentives will lead to higher decarbonization rates. Incentives are often part of many concurrent decisions firms make to promote decarbonization within the organization, and as such, controlling for variables like target ambition and environmental disclosure can be akin to throwing the baby out with the bathwater. Nonetheless, in our first robustness test, we control for additional environmental vari-

ables to illustrate that our main results remain statistically significant. Specifically, we include the number of emissions reduction targets and the average annual targeted emissions reduction amount from CDP; MSCI environmental score; and environmental disclosure score from Bloomberg.

In Table 11 Panel A, columns 1 and 3 show the results when we include additional environmental controls, and columns 2 and 4 show the results without the additional environmental controls for the same sample size. As not all firms have these environmental controls, our sample size dropped from 19,118 to 13,818. Columns 1 and 3 show that our main coefficients of interest on the incentive diffusion variables remain negative and statistically significant after including these environmental controls.

In our second robustness test, we limit the sample to firms with good data quality to ensure the integrity and consistency of our findings since we rely on CDP survey data. Following Ioannou et al. (2016), we consider two subsamples of firms with better data quality. The first are firms with external verification or assurance over their emissions numbers. The second are firms that also report the CDP information in external reports, such as in their annual reports or sustainability reports.

In Table 11 Panel B, columns 1 and 3 of Panel B show the results when we limit ourselves to companies with emissions verification, while columns 2 and 4 of Panel B show the results when we limit ourselves to companies with any external reporting outside of the CDP survey. Our main coefficients of interest on the incentive diffusion variables remain negative and statistically significant in all specifications, except for middle managers in the count model (p-value = 0.148).

5 Conclusion

This paper addresses a critical challenge faced by firms today: aligning employee incentives on decarbonization efforts. Our key contribution lies in the study of the importance of diffused

incentives across different levels of an organization, with particular attention to the role of middle managers. Our cross-sectional analysis demonstrates that incentives provided to middle managers are especially critical in firms that experience more difficulty in reaching employee alignment on decarbonization strategies. This underscores the role of middle managers in transforming strategy to execution and connecting top-level executives with other employees in the firm to achieve real decarbonization.

One distinctive aspect of our research design is the ability to decompose decarbonization rates into their corresponding categories, separating real emissions reductions from other forms of decarbonization, such as changes in measurements and organizational structure. This decomposition allows for a more precise understanding of how incentives correlate with tangible environmental progress. While we find that incentives diffusion is correlated with real decarbonization, we show that such diffusion is not always ideal. The focus must be on genuine environmental improvements, which means that higher incentives must be complemented with proper climate governance, such as assurance mechanisms and board oversight.

In conclusion, our paper offers a rich contribution to the literature on corporate sustainability and incentives. It highlights the intricacies and strategic considerations involved in designing incentives that truly align with a firm's decarbonization goals. Future research could further explore the dynamic relationship between incentives and decarbonization or employ different methodological approaches to provide additional validation of our results. Ultimately, our study emphasizes the need for a thoughtful, well-governed approach to incentive design, opening avenues for firms to create significant change in their environmental performance through carefully tailored incentive structures.

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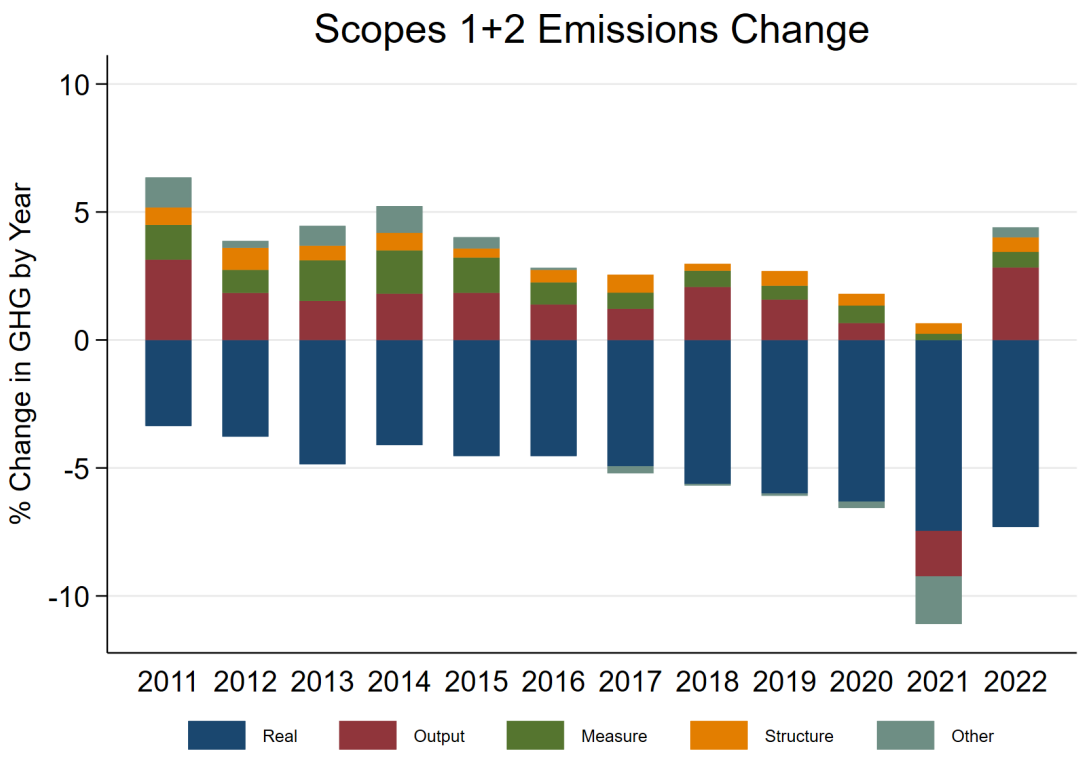
Figure 1: Change in Emissions



This figure plots the change in scopes 1 and 2 emissions by different categories.

Table 1: Sample Selection

	Sample Size
Firm-year in CDP from 2011 to 2022	33,085
Drop firm-year without ISINs	(9,647)
Drop firm-year without assets data	(1,291)
Drop firm-year with assets less than or equal to 1 million	(1,234)
Drop firm-year without controls data	(1,795)
Firm-year available for analysis	19,118

This table presents the sample selection.

Table 2: CDP Sample and Summary Statistics

Panel A: Distribution of Firm-Year by Country

	Count	Percent With Incentives	Mean Positions Incentivized
Argentina	6	0.67	1.67
Australia	535	0.73	2.26
Austria	110	0.80	3.46
Belgium	129	0.78	3.21
Bermuda	27	0.33	0.37
Brazil	506	0.71	1.99
Cambodia	2	0.00	0.00
Canada	871	0.70	1.91
Cayman Islands	8	0.50	0.50
Chile	40	0.78	1.43
China	222	0.64	0.85
Colombia	74	0.84	1.58
Czech Republic	8	0.75	1.50
Denmark	214	0.50	1.29
Egypt	11	0.18	0.09
Finland	280	0.76	2.37
France	815	0.83	2.94
Germany	608	0.75	2.64
Greece	43	0.65	1.21
Guernsey	12	0.92	1.00
Hong Kong	115	0.69	1.73
Hungary	12	0.92	1.83
India	492	0.75	2.42
Indonesia	13	0.92	0.77
Ireland	132	0.70	2.27
Israel	39	0.67	1.74
Italy	345	0.76	2.53
Japan	3,020	0.75	1.14
Kazakhstan	5	0.00	0.20
Kuwait	4	0.75	0.75
Lithuania	2	0.00	0.00
Luxembourg	37	0.54	1.97
Malaysia	30	0.53	1.10
Malta	2	1.00	0.00
Marshall Islands	2	1.00	2.00
Mexico	113	0.69	2.21
Mongolia	3	0.67	0.67
Netherlands	235	0.84	2.71
New Zealand	101	0.64	1.47
Nigeria	4	0.25	0.00
Norway	309	0.73	1.57
Panama	2	1.00	1.50
Peru	10	0.00	0.10
Philippines	34	0.79	1.32
Poland	36	0.42	0.89
Portugal	89	0.72	1.84
Qatar	5	0.60	1.00
Russia	80	0.51	1.65
Saudi Arabia	6	1.00	2.67
Singapore	67	0.70	1.85
South Africa	681	0.72	2.47
South Korea	707	0.83	1.35
Spain	395	0.85	3.45
Sweden	503	0.64	1.57
Switzerland	462	0.70	2.16
Taiwan	464	0.79	1.55
Thailand	82	0.83	2.02
Turkey	255	0.87	2.54
USA	4,209	0.74	2.12
United Arab Emirates	7	0.71	1.86
United Kingdom	1,488	0.78	2.51
Total	19,118	0.74	2.01

Table 2: CDP Sample and Summary Statistics

Panel B: Distribution of Firm-Year by Industry

	Count	Percent With Incentives	Mean Positions Incentivized
Automobiles & Components	630	0.78	1.87
Banks	1,217	0.74	2.27
Capital Goods	2,329	0.71	1.60
Commercial & Professional Serv	509	0.65	1.56
Consumer Discretionary Distrib	466	0.66	1.93
Consumer Durables & Apparel	624	0.74	1.73
Consumer Services	394	0.75	2.56
Consumer Staples Distribution	403	0.76	2.42
Energy	857	0.77	1.71
Equity Real Estate Investment	602	0.83	2.81
Financial Services	784	0.66	1.88
Food, Beverage & Tobacco	996	0.79	2.54
Health Care Equipment & Servic	447	0.66	1.73
Household & Personal Products	273	0.83	3.49
Insurance	692	0.75	2.18
Materials	2,266	0.77	2.03
Media & Entertainment	317	0.54	1.38
Pharmaceuticals, Biotechnology	581	0.77	2.19
Real Estate Management & Devel	269	0.71	1.87
Semiconductors & Semiconductor	458	0.69	1.21
Software & Services	509	0.75	2.45
Technology Hardware & Equipmen	942	0.74	1.54
Telecommunication Services	546	0.81	2.46
Transportation	814	0.79	1.83
Utilities	1,193	0.78	2.22
Total	19,118	0.74	2.01

Continued on following page

Table 2 (continued)

Panel C: Diffusion Variables

	count	mean	sd	min	p50	max
All Employees Indicator	19,118	0.43	0.50	0	0	1
Top Executives Indicator	19,118	0.48	0.50	0	0	1
Middle Managers Indicator	19,118	0.48	0.50	0	0	1
Count of Top Executives Incentivized	19,118	0.77	1.11	0	0	13
Count of Middle Managers Incentivized	19,118	0.99	1.37	0	0	10
All Employees × Monetary Indicator	19,118	0.26	0.44	0	0	1
Top Executives × Monetary Indicator	19,118	0.40	0.49	0	0	1
Top Executives × Non-Monetary Indicator	19,118	0.02	0.13	0	0	1
Middle Managers × Monetary Indicator	19,118	0.39	0.49	0	0	1
Middle Managers × Non-Monetary Indicator	19,118	0.03	0.16	0	0	1
Top Executives Monetarily Incentivized	19,118	0.64	1.03	0	0	13
Top Executives Non-Monetarily Incentivized	19,118	0.14	0.52	0	0	11
Middle Managers Monetarily Incentivized	19,118	0.78	1.26	0	0	10
Middle Managers Non-Monetarily Incentivized	19,118	0.24	0.71	0	0	10

Continued on following page

Table 2 (continued)

Panel D: GHG Change and Financial Variables

	count	mean	sd	min	p50	max
Total	19,118	-2.05	27.79	-100.00	-1.00	120.00
Real	19,118	-5.71	13.06	-85.40	-1.42	11.00
Output	19,118	1.40	8.05	-25.00	0.00	48.00
Measure	19,118	0.91	7.58	-20.80	0.00	52.10
Structure	19,118	0.54	5.48	-19.00	0.00	37.00
Other	19,118	0.05	7.26	-33.00	0.00	39.00
Revenue (Millions)	19,118	757.31	2,960.26	0.18	17.23	21,990.05
Price to Book	19,118	2.64	3.47	-4.61	1.68	23.81
ROA	19,118	0.04	0.06	-0.16	0.04	0.24
Sales Growth	19,118	4.97	10.73	-24.18	3.85	50.59
Capital Intensity	19,118	8.96	15.18	0.00	4.01	99.88
Price Volatility	19,118	24.54	7.68	11.36	23.43	48.48

Table 3: Correlation Matrix

	Total	Real	Output	Measure	Structure	Other	All Employees Indicator	Top Executives Indicator	Managers Middle Indicator	Top Executives Incentivized	Middle Managers Incentivized
Total	1.000										
Real	0.504***	1.000									
Output	0.383***	-0.054***	1.000								
Measure	0.436***	0.023***	0.019***	1.000							
Structure	0.338***	-0.001	0.033***	0.046***	1.000						
Other	0.434***	0.025***	0.016**	0.032***	0.036***	1.000					
All Employees Indicator	-0.018**	-0.035***	0.024***	-0.002	-0.012	0.012	1.000				
Top Executives Indicator	-0.068***	-0.107***	0.009	-0.034***	-0.001	-0.013*	0.069***	1.000			
Middle Managers Indicator	-0.047***	-0.071***	0.000	-0.008	0.009	-0.010	0.122***	0.293***	1.000		
Count of Top Executives Incentivized	-0.061***	-0.099***	0.000	-0.022***	0.005	-0.014*	0.058***	0.732***	0.272***	1.000	
Count of Middle Managers Incentivized	-0.043***	-0.059***	0.002	-0.015**	0.008	-0.009	0.115***	0.285***	0.746***	0.367***	1.000
Observations	19,118										

* $p < .10$, ** $p < .05$, *** $p < .01$

Table 4: *GHG Change* and Diffusion of Incentives - Indicator Model

	(1) Total	(2) Real	(3) Output	(4) Measure	(5) Structure	(6) Other
All Employees Indicator	-1.380***	-1.388***	0.171	-0.015	-0.062	0.124
	(-3.53)	(-5.42)	(1.08)	(-0.12)	(-0.72)	(1.51)
Top Executives Indicator	-1.040**	-1.797***	0.621***	-0.205	0.152*	0.192
	(-2.18)	(-6.35)	(3.58)	(-1.49)	(1.71)	(1.62)
Middle Managers Indicator	-1.116**	-0.720***	-0.011	-0.011	0.101	-0.120
	(-2.62)	(-3.35)	(-0.07)	(-0.09)	(1.11)	(-1.08)
Ln(Revenue)	-0.509**	-0.223	0.103	-0.082	-0.086**	-0.130***
	(-2.50)	(-1.34)	(1.17)	(-1.25)	(-2.13)	(-3.21)
Price to Book	-0.122	-0.103**	0.038	-0.004	-0.026**	-0.003
	(-1.64)	(-2.60)	(1.26)	(-0.26)	(-2.26)	(-0.17)
ROA	1.611	-0.587	5.255***	-1.234	-3.676***	1.388
	(0.30)	(-0.21)	(3.01)	(-1.16)	(-4.42)	(0.94)
Sales Growth	0.365***	0.011	0.091***	0.027***	0.093***	0.031***
	(11.38)	(1.03)	(9.03)	(3.95)	(13.26)	(3.63)
Capital Intensity	-0.007	-0.015	0.029**	-0.015***	-0.006	0.007
	(-0.28)	(-1.55)	(2.48)	(-2.96)	(-1.13)	(1.21)
Price Volatility	0.024	0.011	0.034***	-0.000	-0.019**	-0.008
	(0.64)	(0.62)	(2.97)	(-0.01)	(-2.06)	(-0.72)
N	19118	19118	19118	19118	19118	19118
Adj. R-squared	0.061	0.056	0.067	0.014	0.032	0.027
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Industry	Industry	Industry	Industry	Industry	Industry

t statistics in parentheses

* $p < .10$, ** $p < .05$, *** $p < .01$

This table reports the results on the effect of incentive diffusion on decarbonization rates. Our sample period starts from 2011 until 2022. The outcome variables are percentage changes in greenhouse gas emissions by categories. We provide a detailed description of the variables in Appendix A. All regressions include country, industry, and year fixed effects. The table reports ordinary least squares (OLS) coefficient estimates and (in parentheses) t-statistics based on robust standard errors clustered by industry. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 5: *GHG Change* and Diffusion of Incentives - Count Model

	(1) Total	(2) Real	(3) Output	(4) Measure	(5) Structure	(6) Other
All Employees Indicator	-1.368***	-1.400***	0.175	-0.000	-0.062	0.129
	(-3.52)	(-5.53)	(1.10)	(-0.00)	(-0.73)	(1.61)
Ln(Count of Top Executives Incentivized)	-1.283***	-1.907***	0.538***	-0.129	0.197*	0.107
	(-2.65)	(-7.55)	(3.10)	(-0.85)	(1.99)	(0.80)
Ln(Count of Middle Managers Incentivized)	-0.911**	-0.452**	-0.009	-0.126	0.065	-0.101
	(-2.11)	(-2.15)	(-0.07)	(-0.98)	(0.69)	(-1.08)
Ln(Revenue)	-0.491**	-0.232	0.113	-0.080	-0.088**	-0.121***
	(-2.42)	(-1.41)	(1.24)	(-1.23)	(-2.16)	(-2.94)
Price to Book	-0.124	-0.105**	0.039	-0.004	-0.025**	-0.003
	(-1.66)	(-2.63)	(1.27)	(-0.25)	(-2.25)	(-0.17)
ROA	1.676	-0.506	5.243***	-1.240	-3.688***	1.391
	(0.31)	(-0.18)	(3.00)	(-1.16)	(-4.44)	(0.95)
Sales Growth	0.365***	0.011	0.091***	0.027***	0.093***	0.031***
	(11.38)	(1.04)	(9.05)	(3.93)	(13.24)	(3.62)
Capital Intensity	-0.007	-0.015	0.029**	-0.016***	-0.006	0.007
	(-0.28)	(-1.60)	(2.50)	(-2.96)	(-1.13)	(1.24)
Price Volatility	0.023	0.011	0.034***	-0.000	-0.018**	-0.008
	(0.61)	(0.60)	(2.97)	(-0.03)	(-2.05)	(-0.74)
N	19118	19118	19118	19118	19118	19118
Adj. R-squared	0.061	0.057	0.066	0.014	0.032	0.027
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Industry	Industry	Industry	Industry	Industry	Industry

t statistics in parentheses

* $p < .10$, ** $p < .05$, *** $p < .01$

This table reports the results on the effect of incentive diffusion on decarbonization rates. Our sample period starts from 2011 until 2022. The outcome variables are percentage changes in greenhouse gas emissions by categories. We provide a detailed description of the variables in Appendix A. All regressions include country, industry, and year fixed effects. The table reports ordinary least squares (OLS) coefficient estimates and (in parentheses) t-statistics based on robust standard errors clustered by industry. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 6: *GHG Change* and Diffusion of Incentives - By Geographical Emissions Concentration HHI

	Real Emissions Reduction as dependent variable			
	(1)	(2)	(3)	(4)
	Geographical Emissions Concentration HHI			
	Low	High	Low	High
All Employees Indicator	-1.373***	-1.121***	-1.370***	-1.116***
	(-3.58)	(-3.29)	(-3.65)	(-3.28)
Top Executives Indicator	-1.546***	-2.027***		
	(-4.07)	(-5.78)		
Middle Managers Indicator	-0.811**	-0.250		
	(-2.37)	(-0.70)		
Ln(Count of Top Executives Incentivized)			-1.990***	-1.855***
			(-4.94)	(-4.86)
Ln(Count of Middle Managers Incentivized)			-0.488*	-0.140
			(-1.73)	(-0.38)
Ln(Revenue)	-0.249	-0.472*	-0.210	-0.521*
	(-1.10)	(-1.72)	(-0.96)	(-1.88)
Price to Book	-0.161***	-0.073	-0.164***	-0.075
	(-2.96)	(-1.06)	(-3.06)	(-1.09)
ROA	-1.027	0.281	-0.854	0.330
	(-0.25)	(0.07)	(-0.21)	(0.08)
Sales Growth	0.006	0.003	0.006	0.003
	(0.34)	(0.14)	(0.36)	(0.15)
Capital Intensity	-0.025	-0.015	-0.026	-0.015
	(-1.45)	(-0.95)	(-1.48)	(-0.99)
Price Volatility	-0.001	0.017	-0.002	0.019
	(-0.02)	(0.64)	(-0.06)	(0.70)
N	7640	7716	7640	7716
Adj. R-squared	0.068	0.061	0.070	0.060
Country FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Cluster	Industry	Industry	Industry	Industry

t statistics in parentheses

* $p < .10$, ** $p < .05$, *** $p < .01$

This table reports the results on the effect of incentive diffusion on decarbonization rates by *Geographical Emissions Concentration HHI* (GEC HHI). The low GEC HHI sample includes firm-year observations with values ranging from 0 to 5,000. The high GEC HHI sample includes firm-year observations with values above 5,000 up to 10,000. Our sample period starts from 2011 until 2022. The outcome variables are percentage changes in real greenhouse gas emissions. We provide a detailed description of the variables in Appendix A. All regressions include country, industry, and year fixed effects. The table reports ordinary least squares (OLS) coefficient estimates and (in parentheses) t-statistics based on robust standard errors clustered by industry. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 7: *GHG Change* and Diffusion of Incentives - By International Public Opinion on Climate Change

	Real Emissions Reduction as dependent variable			
	(1)	(2)	(3)	(4)
	International Public Opinion on Climate Change			
	Low	High	Low	High
All Employees Indicator	-1.478***	-1.270***	-1.525***	-1.251***
	(-4.66)	(-3.84)	(-4.83)	(-3.86)
Top Executives Indicator	-1.455***	-1.934***		
	(-3.58)	(-4.73)		
Middle Managers Indicator	-1.062***	-0.466		
	(-3.62)	(-1.51)		
Ln(Count of Top Executives Incentivized)			-1.430***	-2.172***
			(-3.15)	(-6.66)
Ln(Count of Middle Managers Incentivized)			-0.701**	-0.278
			(-2.35)	(-0.97)
Ln(Revenue)	-0.357	-0.011	-0.390	0.006
	(-1.38)	(-0.05)	(-1.51)	(0.03)
Price to Book	-0.077	-0.155**	-0.078	-0.161**
	(-1.47)	(-2.47)	(-1.45)	(-2.56)
ROA	-3.400	3.311	-3.296	3.439
	(-0.84)	(1.14)	(-0.82)	(1.20)
Sales Growth	0.002	0.019	0.002	0.019
	(0.10)	(1.61)	(0.13)	(1.55)
Capital Intensity	-0.025*	-0.003	-0.025*	-0.003
	(-1.81)	(-0.22)	(-1.83)	(-0.27)
Price Volatility	0.025	0.010	0.025	0.009
	(0.99)	(0.43)	(0.97)	(0.36)
N	10466	8296	10466	8296
Adj. R-squared	0.056	0.067	0.056	0.068
Country FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Cluster	Industry	Industry	Industry	Industry

t statistics in parentheses

* $p < .10$, ** $p < .05$, *** $p < .01$

This table reports the results on the effect of incentive diffusion on decarbonization rates by *International Public Opinion on Climate Change* – a proxy for local concern and awareness. The low awareness sample includes countries with below-median public opinion on climate change, while the high awareness sample includes countries with above-median public opinion on climate change. Our sample period starts from 2011 until 2022. The outcome variables are percentage changes in real greenhouse gas emissions. We provide a detailed description of the variables in Appendix A. All regressions include country, industry, and year fixed effects. The table reports ordinary least squares (OLS) coefficient estimates and (in parentheses) t-statistics based on robust standard errors clustered by industry. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 8: *GHG Change* and Diffusion of Incentives - By Environmental Disclosure Regulation

	Real Emissions Reduction as dependent variable			
	(1)	(2)	(3)	(4)
	Environmental Disclosure			
	No	Yes	No	Yes
All Employees Indicator	-1.355***	-1.499***	-1.385***	-1.470***
	(-4.19)	(-3.75)	(-4.30)	(-3.72)
Top Executives Indicator	-1.548***	-2.001***		
	(-4.27)	(-4.42)		
Middle Managers Indicator	-1.069***	-0.184		
	(-3.41)	(-0.52)		
Ln(Count of Top Executives Incentivized)			-1.717***	-2.014***
			(-4.61)	(-5.13)
Ln(Count of Middle Managers Incentivized)			-0.593*	-0.254
			(-1.91)	(-0.70)
Ln(Revenue)	-0.415*	0.249	-0.431*	0.256
	(-1.79)	(1.23)	(-1.87)	(1.29)
Price to Book	-0.081	-0.126*	-0.082	-0.130*
	(-1.61)	(-1.93)	(-1.60)	(-1.98)
ROA	-2.799	1.498	-2.694	1.625
	(-0.67)	(0.52)	(-0.65)	(0.57)
Sales Growth	0.006	0.018	0.006	0.018
	(0.36)	(1.23)	(0.35)	(1.25)
Capital Intensity	-0.043***	0.017	-0.043***	0.017
	(-2.83)	(1.61)	(-2.90)	(1.57)
Price Volatility	0.017	0.029	0.017	0.026
	(0.74)	(1.31)	(0.75)	(1.19)
N	11691	7425	11691	7425
Adj. R-squared	0.057	0.066	0.056	0.067
Country FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Cluster	Industry	Industry	Industry	Industry

t statistics in parentheses

* $p < .10$, ** $p < .05$, *** $p < .01$

This table reports the results on the effect of incentive diffusion on decarbonization rates by *Environmental Disclosure Regulation*. We categorize the countries into two groups: countries with environmental disclosure regulations and countries without environmental disclosure regulations. Our sample period starts from 2011 until 2022. The outcome variables are percentage changes in real greenhouse gas emissions. We provide a detailed description of the variables in Appendix A. All regressions include country, industry, and year fixed effects. The table reports ordinary least squares (OLS) coefficient estimates and (in parentheses) t-statistics based on robust standard errors clustered by industry. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 9: *GHG Change* and Diffusion of Incentives - By Monetary Rewards

	(1) Real	(2) Real
All Employees × Monetary Indicator	-1.395***	-1.379***
	(-4.75)	(-4.68)
All Employees × Non-Monetary Indicator	-1.342**	-1.287**
	(-2.09)	(-2.03)
Top Executives × Monetary Indicator	-1.759***	
	(-5.57)	
Top Executives × Non-Monetary Indicator	-0.097	
	(-0.09)	
Middle Managers × Monetary Indicator	-0.916***	
	(-3.73)	
Middle Managers × Non-Monetary Indicator	1.202*	
	(1.88)	
Ln(Count of Top Executives Monetarily Incentivized)		-1.962***
		(-7.23)
Ln(Count of Top Executives Non-Monetarily Incentivized)		-0.981
		(-1.64)
Ln(Count of Middle Managers Monetarily Incentivized)		-0.613***
		(-2.76)
Ln(Count of Middle Managers Non-Monetarily Incentivized)		-0.054
		(-0.17)
Ln(Revenue)	-0.234	-0.226
	(-1.39)	(-1.37)
Price to Book	-0.101**	-0.104**
	(-2.52)	(-2.56)
ROA	-0.452	-0.475
	(-0.17)	(-0.17)
Sales Growth	0.011	0.011
	(1.06)	(1.03)
Capital Intensity	-0.014	-0.015
	(-1.48)	(-1.54)
Price Volatility	0.011	0.011
	(0.61)	(0.59)
N	19118	19118
Adj. R-squared	0.056	0.057
Country FE	Yes	Yes
Industry FE	Yes	Yes
Year FE	Yes	Yes
Cluster	Industry	Industry

t statistics in parentheses

* $p < .10$, ** $p < .05$, *** $p < .01$

This table reports the results on the effect of incentive diffusion on decarbonization rates by monetary rewards or non-monetary awards. Our sample period starts from 2011 until 2022. The outcome variables are percentage changes in greenhouse gas emissions by categories. We provide a detailed description of the variables in Appendix A. All regressions include country, industry, and year fixed effects. The table reports ordinary least squares (OLS) coefficient estimates and (in parentheses) t-statistics based on robust standard errors clustered by industry. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 10: *GHG Change* and Diffusion of Incentives - By Climate Governance Index

	Measure Emissions Reduction as dependent variable			
	(1)	(2)	(3)	(4)
	Climate Governance Index			
	Low	High	Low	High
All Employees Indicator	0.074	-0.328	0.094	-0.332
	(0.52)	(-1.37)	(0.66)	(-1.39)
Top Executives Indicator	-0.344**	0.275		
	(-2.26)	(1.19)		
Middle Managers Indicator	0.041	-0.115		
	(0.29)	(-0.51)		
Ln(Count of Top Executives Incentivized)			-0.274*	0.259
			(-1.71)	(1.02)
Ln(Count of Middle Managers Incentivized)			-0.112	-0.098
			(-0.72)	(-0.49)
Ln(Revenue)	-0.064	-0.101	-0.060	-0.098
	(-0.83)	(-0.92)	(-0.79)	(-0.91)
Price to Book	-0.006	0.013	-0.006	0.013
	(-0.35)	(0.44)	(-0.34)	(0.45)
ROA	-0.747	-3.183	-0.759	-3.224
	(-0.63)	(-1.55)	(-0.64)	(-1.56)
Sales Growth	0.020***	0.049**	0.020***	0.049**
	(2.84)	(2.51)	(2.81)	(2.50)
Capital Intensity	-0.018***	-0.002	-0.018***	-0.002
	(-2.82)	(-0.25)	(-2.83)	(-0.23)
Price Volatility	0.002	0.002	0.001	0.002
	(0.14)	(0.14)	(0.12)	(0.14)
N	14618	4497	14618	4497
Adj. R-squared	0.013	0.016	0.013	0.016
Country FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Cluster	Industry	Industry	Industry	Industry

t statistics in parentheses

* $p < .10$, ** $p < .05$, *** $p < .01$

This table reports the results on the effect of incentive diffusion on decarbonization rates by *Climate Governance Index* (CGI). We construct the CGI based on three disclosed characteristics of firms in the CDP: board oversight, emissions verification, and inclusion of CDP information in the firm's regulatory reporting. The low CGI sample includes firm-year observations with values of 0 and 1, with 85% of these observations indicating only board oversight of climate change issues. The high CGI sample includes firm-year observations with values of 2 and 3, with 89% meeting two out of the three criteria and 11% satisfying all three criteria. Our sample period starts from 2011 until 2022. The outcome variables are percentage changes in real greenhouse gas emissions. We provide a detailed description of the variables in Appendix A. All regressions include country, industry, and year fixed effects. The table reports ordinary least squares (OLS) coefficient estimates and (in parentheses) t-statistics based on robust standard errors clustered by industry. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 11: Robustness Tests

Panel A: Additional Environmental Controls

	Real Emissions Reduction as dependent variable			
	(1)	(2)	(3)	(4)
	Indicator Model		*Count Model*	
	With New Controls	Without New Controls	With New Controls	Without New Controls
All Employees Indicator	-1.086***	-1.438***	-1.098***	-1.444***
	(-4.06)	(-5.12)	(-4.14)	(-5.22)
Top Executives Indicator	-0.714**	-1.276***		
	(-2.43)	(-4.44)		
Middle Managers Indicator	-0.731***	-0.939***		
	(-2.86)	(-3.58)		
Ln(Count of Top Executives Incentivized)			-0.636**	-1.166***
			(-2.23)	(-4.12)
Ln(Count of Middle Managers Incentivized)			-0.548**	-0.767***
			(-2.33)	(-3.03)
Ln(Revenue)	0.071	-0.270	0.066	-0.278
	(0.36)	(-1.31)	(0.34)	(-1.36)
Price to Book	-0.052	-0.066	-0.053	-0.067
	(-1.18)	(-1.46)	(-1.19)	(-1.46)
ROA	-1.931	-2.726	-1.918	-2.700
	(-0.55)	(-0.76)	(-0.55)	(-0.75)
Sales Growth	0.007	0.013	0.007	0.013
	(0.49)	(0.88)	(0.50)	(0.89)
Capital Intensity	-0.014	-0.018	-0.014	-0.018
	(-1.26)	(-1.56)	(-1.26)	(-1.57)
Price Volatility	-0.015	-0.002	-0.015	-0.002
	(-0.64)	(-0.10)	(-0.65)	(-0.11)
#Targets	-0.151		-0.155*	
	(-1.63)		(-1.67)	
Average Target Amount	-0.059***		-0.059***	
	(-5.95)		(-5.94)	
MSCI E Score	-0.291***		-0.292***	
	(-3.83)		(-3.82)	
Environmental Disclosure Score	-0.010		-0.010	
	(-0.96)		(-1.03)	
N	13818	13818	13818	13818
Adj. R-squared	0.074	0.062	0.074	0.062
Country FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Cluster	Industry	Industry	Industry	Industry

t statistics in parentheses

* $p < .10$, ** $p < .05$, *** $p < .01$

(Continued)

Table 11 (continued)

Panel B: High-Data-Quality Samples

	Real Emissions Reduction as dependent variable			
	(1)	(2)	(3)	(4)
	Indicator Model		*Count Model*	
	GHG Verification	External Reporting	GHG Verification	External Reporting
All Employees Indicator	-1.052***	-1.273***	-1.052***	-1.276***
	(-3.82)	(-4.85)	(-3.86)	(-4.91)
Top Executives Indicator	-1.157***	-1.664***		
	(-3.50)	(-5.82)		
Middle Managers Indicator	-0.586**	-0.615***		
	(-2.19)	(-2.74)		
Ln(Count of Top Executives Incentivized)			-1.231***	-1.760***
			(-4.81)	(-6.78)
Ln(Count of Middle Managers Incentivized)			-0.352	-0.389*
			(-1.46)	(-1.80)
Ln(Revenue)	-0.120	-0.159	-0.121	-0.165
	(-0.50)	(-0.96)	(-0.51)	(-1.00)
Price to Book	-0.136***	-0.101**	-0.137***	-0.103**
	(-2.72)	(-2.50)	(-2.74)	(-2.53)
ROA	-0.790	-0.926	-0.766	-0.863
	(-0.21)	(-0.31)	(-0.21)	(-0.29)
Sales Growth	-0.019	0.007	-0.019	0.007
	(-1.22)	(0.59)	(-1.24)	(0.57)
Capital Intensity	-0.018	-0.015	-0.018	-0.015
	(-1.41)	(-1.52)	(-1.41)	(-1.57)
Price Volatility	0.028	0.009	0.028	0.009
	(1.17)	(0.50)	(1.16)	(0.48)
N	12973	17831	12973	17831
Adj. R-squared	0.064	0.058	0.065	0.058
Country FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Cluster	Industry	Industry	Industry	Industry

t statistics in parentheses

* $p < .10$, ** $p < .05$, *** $p < .01$

This table reports the robustness tests on the effect of incentive diffusion on decarbonization rates, for both the indicator and count models. The outcome variables are percentage changes in real greenhouse gas emissions. Panel A shows the results when we consider more environmental controls. Columns 1 and 3 of Panel A show the results when we include additional controls on the number of emissions reduction targets, average target amount, MSCI E score, and Bloomberg's environmental disclosure score. Columns 2 and 4 of Panel A keep the same sample size and show the results using the main regression specifications. Panel B shows the results when we limit our analysis to high-data-quality samples. Columns 1 and 3 of Panel B show the results when we limit ourselves to companies with emissions verification, while columns 2 and 4 of Panel B show the results when we limit ourselves to companies with any external reporting outside of the CDP survey. We provide a detailed description of the variables in Appendix A. All regressions include country, industry, and year fixed effects. The table reports ordinary least squares (OLS) coefficient estimates and (in parentheses) t-statistics based on robust standard errors clustered by industry. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Appendix

Appendix A: Variable Definition

Variable	Description	Data Source
Main analysis		
All Employees Indicator	1 if all employees are entitled to climate-related incentives, 0 otherwise	CDP
Top Executives Indicator	1 if anyone from the board or corporate executive team is entitled to decarbonization incentives, 0 otherwise	CDP
Middle Managers Indicator	1 if anyone from the management group is entitled to decarbonization incentives, 0 otherwise	CDP
Ln(Count of Top Executives Incentivized)	Natural logarithm of the number of positions from the board or corporate executive team entitled to decarbonization incentives	CDP
Ln(Count of Middle Managers Incentivized)	Natural logarithm of the number of positions from the management group entitled to decarbonization incentives	CDP
Ln(Revenue)		Refinitiv
Price to Book	Market value of equity over book value of equity at the end of the calendar year	Refinitiv
ROA	Net income over average total assets	Refinitiv
Sales Growth		Refinitiv
Capital Intensity	Capital expenditures over sales	Refinitiv
Price Volatility	Annual standard deviation of stock returns	Refinitiv
Other analysis		
All Employees × Monetary Indicator	1 if all employees are entitled to monetary decarbonization incentives, 0 otherwise	CDP
All Employees × Non-Monetary Indicator	1 if all employees are entitled to non-monetary decarbonization incentives, 0 otherwise	CDP
Top Executives × Monetary Indicator	1 if anyone from the board or corporate executive team is entitled to monetary decarbonization incentives, 0 otherwise	CDP
Middle Managers × Monetary Indicator	1 if anyone from the management group is entitled to monetary decarbonization incentives, 0 otherwise	CDP
Top Executives × Non-Monetary Indicator	1 if anyone from the board or corporate executive team is entitled to non-monetary decarbonization incentives, 0 otherwise	CDP
Middle Managers × Non-Monetary Indicator	1 if anyone from the management group is entitled to non-monetary decarbonization incentives, 0 otherwise	CDP

(Continued)

Appendix A, continued

Variable	Description	Data Source
HHI of Scope 1 & 2 Emissions within a Firm	Herfindahl–Hirschman index for the emissions of subsidiaries in relation to the firm they are in	CDP
Environmental Disclosure	1 if the country has an environmental disclosure in a given year	Krueger et al. (2021) and Public Sources
International Public Opinion on Climate Change	Average score of all the aggregate response data based on the executive summary of the 2022 Climate Change Opinion Survey	Data for Good at Meta
Climate Governance Index	Range from 0 to 3, 1 if the firm has board oversight of decarbonization issues, 1 if the firm has reasonable assurance or high verification for greenhouse gas emissions, and 1 if the firm has disclosed decarbonization information in a regulatory disclosure	CDP
#Targets	Total number of emissions reduction targets a company reported in a year	CDP
Average Target Amount	The average annual emissions reduction amount reported with the targets	CDP
MSCI E Score	Environmental Pillar Score	MSCI
Environmental Disclosure Score	Disclosure score related to a firm's environmental information	Bloomberg

This table provides the descriptions and sources of variables used in this paper.